HEALTH AND ECONOMIC IMPACT ASSESSMENT OF WALKING AND CYCLING INTERVENTIONS IN ACCRA, GHANA: AN INVESTMENT CASE USING THE WHO HEAT TOOL

WORLD HEALTH ORGANIZATION, GHANA OFFICE & DEPARTMENT OF HEALTH PROMOTION, PHYSICAL ACTIVITY UNIT, GENEVA, SWITZERLAND. 2023

Health and Economic Impact Assessment of Walking and Cycling Interventions in Accra, Ghana: an investment case using the WHO HEAT tool

World Health Organization, Ghana Office & Department of Health Promotion, Physical Activity Unit, Geneva, Switzerland.

2023

Contents

List of Figures and Tables

Foreword

Regular physical activity is a well-established protective factor for the prevention and treatment of the leading noncommunicable diseases (NCDs), namely heart disease, stroke, diabetes and breast and colon cancer. It also contributes to the prevention of other important NCD risk factors such as hypertension, overweight and obesity, and is associated with improved mental health, delay in the onset of dementia and improved quality of life and well-being.

Policy actions aimed at increasing physical activity for all people, of all ages and abilities, are consistent with valuing health as a universal right and an essential resource for everyday living, and not merely the absence of disease or infirmity.

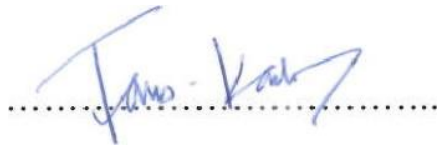
Further, the multiple benefits from increasing population levels of physical activity through, for example, walking, cycling, active recreation, sports, and play, are interconnected with, and contribute to, achieving the shared goals, and ambition of the 2030 SDG Agenda.

Walking and cycling are key means of transportation and leisure, enabling people to engage in regular physical activity daily, but their role and popularity are declining as the use of personalized motor transport has increased as urbanization increases.

Policies that improve road safety, promote, and prioritize access by pedestrians and cyclists to secure, comfortable, and equitable infrastructure for walking and cycling, as well as access to reliable and affordable public transport have been proven to reduce the use of personal motorized transportation, especially for short trips, carbon emissions, traffic congestion, and health-care costs, whilst improving health, community well-being and quality of life.

Fast unplanned urbanization in Ghana means a reduction in walking and cycling space and levels. The current estimated prevalence of physical inactivity of 22% for 2016 tends to increase if no interventions for both, better public and non-motorized transport, are put in place. That is why the development of this multisectoral investment case for walking and cycling is timely and important, to shift the paradigm towards sustained efforts and greater infrastructural development to promote walking and cycling in Ghana. This exercise shows how increased levels of walking and cycling can tackle issues of urban design, non-communicable diseases, road traffic accidents and deaths, and climate change to cite some.

Finally, I want to use this opportunity to thank the Government of Ghana, officials from all relevant Ministries, Departments and Agencies in Ghana and colleagues from WHO Headquarters, WHO African Regional Office, and Country Office who have worked tirelessly to develop this important document.



Professor Francis Kasolo
WHO Country Representative in Ghana

Executive summary

Walking and cycling are the most affordable and sustainable transport modes, particularly when integrated into reliable and affordable transport systems. Promoting the scaling up of walking and cycling infrastructure requires making the investment case by presenting the reasoning for action and assessing the costs of investing and the benefits generated by these investments. The World Health Organization's health and economic assessment tool (HEAT) for cycling and walking is an online tool designed to facilitate evidence-based decision-making toward this goal.

The Greater Accra Passenger Transport Executive (GAPTE) and the Accra Metropolitan Assembly (AMA) are committed to having Accra as one of the greenest and healthiest cities in Africa and have focused on the expansion of sustainable transport strategies, including non-motorised transport (NMT). Based on this commitment, we assessed the expansion of walking and cycling infrastructure in the Greater Accra Metropolitan Area (GAMA).

The results show that the return on investment for the 500 km^2 of infrastructure for walking and cycling between 2022 and 2032 was considered very high in GAMA. The benefit-cost ratio after a 10-year investment would be US$ 37 per US$ 1 dollar invested. Benefit-cost ratio (BCR) above US$ 5 per US$ 1 spent is considered a very high value for money. In the context of GAMA, the intervention has the potential of generating more than 7 times the threshold of US$ 5 per US$ 1 spent. A high value for money for the infrastructure is still being observed even when more conservative parameters are assumed, in a sensitivity analysis.

Based on our findings, we thus recommend Ghana to:

- Invest in a comprehensive expansion of walking and cycling infrastructure considering regulations on land use and road safety, the comfort of infrastructure, and mass communication to increase levels of physical activity.
- Invest in the sustainable, greener expansion of mass public transportation.
- Invest in decarbonising vehicles and encouraging the less use of cars and more use of walking and cycling.
- Invest in monitoring and evaluation for assessment and reassessment of the walking and cycling interventions, including monitoring air pollution levels.

Acknowledgments

To support countries to meet the agreed reduction target of 15% in the prevalence of physical inactivity by 2030 and the 2030 Sustainable Developments Goals, technical assistance on the use of the World Health Organization (WHO)' Health and Economic Assessment Tool (HEAT) for walking and cycling was provided by the Physical Activity Unit, Department of Health Promotion, WHO, Geneva, Switzerland.

Funds to enable this work were from the Norwegian Agency for Development Cooperation (NORAD) under the noncommunicable diseases (NCDs) prevention and control programme. The work was coordinated and led by the WHO Ghana Country Office, Department of Non-Communicable Diseases.

For more information on physical activity, walking and cycling and the application of the WHO HEAT tool in Ethiopia, please contact Dra Fiona Bull, head of the Physical Activity Unit, WHO, Geneva, Switzerland (bullf@who.int).

This report was prepared by Mr. Alex Johnson (Accra Metropolitan Assembly), Mr. Elvis Narh (Accra Metropolitan Assembly), and Dra Andreia Costa Santos (consultant in health economics, WHO, Geneva, Switzerland). The authors would like to thank the especial contribution from Dra Joana Ansong, Technical Officer, NCDs/ Risk Factors, WHO Ghana Country Office, without which this technical assistance could not have been successful.

The report was reviewed by (see Annex 1. List of Participants)

The preliminary results of the analysis were presented and discussed with a wide group of relevant stakeholders at the Accra Metropolitan Assembly in May 2023, including Ghana Environmental Protection Agency (EPA), Ghana Health Services, the Ministry of Transport, the Ministry of Finance, and technical officers from the World Health Organization and World Bank.

concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Cover photo: DreamTime. Browse 119 professional Ghana bicycle stock photos, images & pictures available royalty-free. 119 Ghana Bicycle Stock Photos, Images & Pictures. Available in: https://www.dreamstime.com/photos-images/ghana-bicycle.html. Accessed on 30/01/2023.

List of Abbreviations

AMA	Accra Metropolitan Assembly
ABS	Aayalolo Bus Service
BCR	Benefit Cost Ratio
BRT	Bus Rapid Transport
CPESDP	Coordinated Programme of Economic and Social Development Policies
GAMA	Greater Accra Metropolitan Area
GAPPA	Global Action Plan on Physical Activity
GAPTE	Greater Accra Passenger Transport Executive
HEAT	Health and Economic Assessment Tool for Walking and Cycling
LMICs	Low- and Middle-Income Countries
NCDs	Noncommunicable Diseases
NMT	Non-motorised Transport
OECD	Organisation for Economic Cooperation and Development
PA	Physical activity
PM	Particulate Matter
RNTP	Revised National Transport Policy for Ghana
SDGs	Sustainable Development Goals
UN	United Nations
VSL	Value of Statistical Life
WHO	World Health Organization

1. INTRODUCTION

Rapid economic growth and unplanned urbanisation have contributed to the increase in the number of motor vehicles in low- and middle-income countries (LMICs), with an increased shift from walking and cycling to private motorized vehicles [1]. Nowadays, more than 55% of the world's inhabitants live in urban centres, and by 2050 the proportion is expected to grow to 68%, with Asia and Africa seeing a rise of almost 90% [2]. This rapid and unplanned urban expansion has also contributed to the increase in non-communicable diseases (NCDs), mental health conditions, road traffic accidents, air pollution, and diminished safe spaces for walking and cycling [3–5]. Building sustainable and environmental-friendly cities with the provision of essential services, such as mass public transport and supporting non-motorised transportation, are some of the key solutions for urbanisation that allow human wellbeing and progress [6].

Accra, the capital of Ghana, is one of the fastest urbanising cities in Africa, with an annual population growth rate of around 2% since the mid-2000s [7]. With a population of 5.5 million inhabitants, in 2021, the Greater Accra Metropolitan Area (GAMA) faces a daily influx of 2.5 million business commuters [8]. Although walking is still one of the main methods of commuting in GAMA (34%), car ownership has increased as personal incomes have risen, but it is also a reflection of poor public transport experience [9–11]. Increased car ownership and poor transport system in GAMA contribute to the crescent level of physical inactivity – currently at 21.8% among adults 18 years old, and 87.5% among adolescents [12,13] – one of the main risk factors for NCDs [14]. NCDs including cancer, cardiovascular disease, chronic respiratory diseases, and diabetes, are responsible for 43% of all deaths in Ghana [14].

Walking and cycling are simple, cost-effective ways of achieving the recommended physical activity (PA) levels for personal health and well-being [15]. In addition to the health benefits, investing in walking and cycling has also recognisable economic, social, and environmental benefits, as they reduce healthcare costs and the social cost of deaths related to physical inactivity, traffic accidents, air pollution, and the environmental costs of carbon and other emissions, they also increase sales for local businesses and individuals' productivity by reducing presenteeism and absenteeism [16–18].

Studies from high-income countries have shown that characteristics of the built environment, such as the availability of quality infrastructure for walking and cycling (e.g., sidewalks, bike paths, crosswalks) promote PA among populations, as well as public parks and recreational amenities, providing settings for leisure-time for individuals and their families [19]. Evidence from low- and middle-income countries (LMICs) is limited, with scarce availability of longitudinal studies. However, a recent systematic literature review based on cross-sectional studies suggested that land-use mix diversity - the presence of reliable public transport, quality infrastructure for walking and cycling, law enforcement for road traffic and safety measures to prevent crime - was positively associated with increased levels of walking and cycling, as a mean of transportation linked to PA (transport PA) [20]. The study also found that the presence of recreation facilities resulted in an increase in PA during leisure time [20].

This report presents the investment case for walking and cycling in the GAMA region. Using the World Health Organization's (WHO) health and economic assessment tool (HEAT) for walking and cycling and based on scenarios where walking and cycling instead of driving are encouraged - at the population level -, alongside investments on sustainable mass public transport systems, we show the potential impact of investing in walking and cycling infrastructure as a way for human health and environmentally sustainable progress.

2. CURRENT NON-MOTORISED TRANSPORT (NMT) STRATEGIES IN GHANA

The most recent and Revised National Transport Policy for Ghana (RNTP, 2020) reiterates the vision of Ghana as a transport hub for West Africa, aimed at becoming "*an integrated, efficient, cost-effective and sustainable transportation system responsive to the needs of society, supporting growth and poverty reduction and capable of establishing and maintaining Ghana as a transportation hub of West Africa" (*[21]*, page 43).*

To achieve the goal of an integrative transport hub, the government of Ghana defined its national and international commitments based on 10 identified strategic themes: 1) transport for all, 2) Ghana as a transport hub, 3) sustainable transport, 4) improved private and public investment in transport, 5) integrated and harmonised transport planning, 6) legal mandate for implementation of transport policies and plans, 7) enforcement of rules, regulations and standards, 8) research and development, 9) development of human development and capacity, 10) application of new technologies to transport. Themes 1 to 3 focus on the transport system that needs to be created to underpin the socio-economic development planned for Ghana as well as fulfilling the technical, financial, and quality requirements of its users, service providers and investors. Themes 4 to 10 focus on the areas where institutions, practices and procedures need to be strengthened or changed to enable the sector as a whole to plan, prepare for and achieve the levels of performance expected of it by its many stakeholders [21].

All these strategic themes are in line with the United Nations (UN) Sustainable Development Goals (SGDs) for 2030, specifically goal number 11 of providing access to safe, affordable, accessible and sustainable transport systems for all [22], with the African Union's Agenda 2063 goal 1.3 of social security and protection, including persons with disabilities, and goal 1.4 of modern, affordable and liveable habitats and quality basic services [23], and with the Coordinated Programme of Economic and Social Development Policies (CPESDP) goal 3.5 of ensuring public safety and security and goal 1.4 of strengthening social protection, especially for children, women, persons with disability and the elderly [24].

Non-motorised transport is assessed in section 3.7 of the RNTP for Ghana [21] (page 41). NMT is recognised as an important way of transport, especially in the informal sector, and is predominantly used in the North of the country as a mode of transport. Walking is the most common form of NMT, followed by bicycles, push carts, wheelbarrows, and animal drawn carts. The non-polluting and sustainable form of transport are recognised as main characteristics of NMT, and its role as a facilitator of integration between transport modes, especially public transport, are valued and seen as a strategy of sustainable development. Thus, the RNTP aims at integrating NMT facilities in all transport infrastructure development strategies by (1) providing dedicated safe, reliable, and appropriate facilities for NMT users across all transport modes, (2) maintaining and free-up all existing NMT facilities from encroachment, and (3) expanding NMT infrastructure. However, many challenges are identified to support NMT's retainment and expansion in the country [21].

Vulnerability of NMT users to road fatalities and lack of investment in mass public transportation are the main issues related to the sustainability of NMTs [25]. The number of road traffic accidents presented to a single hospital in Accra was estimated at over 18,000, between January 2016 and December 2017, with 182 deaths [26]. The lack of security measures, law enforcement for existing policies, drivers no recognition or respect for cyclists or pedestrians, and the encroachment of the few and already irregular pedestrian walkways by traders selling all forms of trade items, are the main elements contributing to the high number of road traffic accidents and fatalities. As a background for this unsustainable and dangerous situation is the lack of reliable and affordable public mass transportation and the crescent use of private cars [21].

The number of passenger cars registered in the region was almost 1.25 million in 2017 (or 60% of the national registration), with an average annual increase of 8.4% over the past 10 years [10]. Mass public transport (5%) is virtually inexistent in GAMA, with informal private-operated public transport dominating the bulk of urban bus passenger transport in the region in 95% [27]. Without working in parallel to deal with these key issues, the retainment and expansion of NMT in the region are under threat. The shift to a sustainable mode of transport where mass public transport, law enforcement, and the integration of a safe and comfortable infrastructure for non-motorised transport, is urgent to promote the social and economic development of the region.

3. INVESTMENT CASE TO ASSESS THE IMPACT OF WALKING AND CYCLING INTERVENTIONS IN GAMA

Walking and cycling are the most affordable and sustainable transport modes, particularly when integrated into reliable and affordable transport systems. Promoting the scaling up of walking and cycling infrastructure requires making the investment case, by presenting the reasoning for an action, and providing an assessment of the costs of investing and the benefits generated by these investments. The WHO's health and economic assessment tool (HEAT) for cycling and walking is an online tool designed to facilitate evidence-based decision-making toward this goal [28].

3.1. The World Health Organization's (WHO) health and economic assessment tool (HEAT) for walking and cycling

WHO HEAT was originally developed to support NMT policies in Europe. Its large use by policymakers and transport urban planners around the world stimulates the adaptation of the tool for global use by WHO. The latest version of the tool (5.0.6) reflects the context and parameters of countries of all income levels (see: https://www.heatwalkingcycling.org/#news).

WHO HEAT estimates the value of reduced mortality that results from regular walking or cycling by answering the following question: **If *X* people cycle or walk *Y* distance on most days, what are the health impacts on premature mortality and their economic value.** These estimates can be further refined by considering the mortality effects of exposure to air pollution and traffic crashes while walking or cycling, and/or assessing the changes in carbon emissions resulting from shifting from motorized trips to walking or cycling [29,30].

When providing the cost of an intervention, the WHO HEAT can assess the value for money, through a cost-benefit analysis of transport interventions or infrastructure projects, by comparing the current situation with a new intervention in terms of cost and benefits. A summary of the basic WHO HEAT functioning is presented in Figure 1: once defining the type of assessment to be conducted, the outcomes of interest and time horizon, the analyst have the option to enter only two parameters for the analysis (volume of travel and population size) - the simplest version of the

tool -, or adjust the default parameters according to their data availability - a more advanced use of the tool. The tool then calculates the impact of the interventions in terms of deaths and carbon emissions averted by the intervention (s) using established methodology. WHO HEAT can be used by a wide variety of professionals at both national and local levels, primarily transport planners, traffic engineers and special interest groups working on transport, walking, cycling or the environment [30].

3.2. Scope of the technical assistance on WHO HEAT for the investment case in walking and cycling in GAMA.

The technical assistance on WHO HEAT involved several stakeholders from different governmental and non-governmental agencies (see Annex 1, for details of participants). It included representatives from the municipality (Accra Metropolitan Assembly), Ministry of Health, Ministry of Environment, and discussions with development banks, (e.g., World Bank) and Ministry of Finance. The technical sessions were led by a consultant from WHO headquarters, virtually via Zoom, and covered the following topics and number of sessions that lasted between 1.5-2 hours each:

- Introduction and objectives of the technical assistance (1 session)
- Definition of policy interventions (5 sessions)
- Discussion for the cost analysis (3 sessions, but data collection took about 4 months)
- HEAT exercise, including discussion on inputs (2 sessions)

Data collection was conducted by the local WHO consultant, with the support from key stakeholders from governmental agencies. Data analysis, including the costing exercise, was conducted, and led by the Department of Transport at Accra Metropolitan Agency and supervised by WHO HQ consultants.

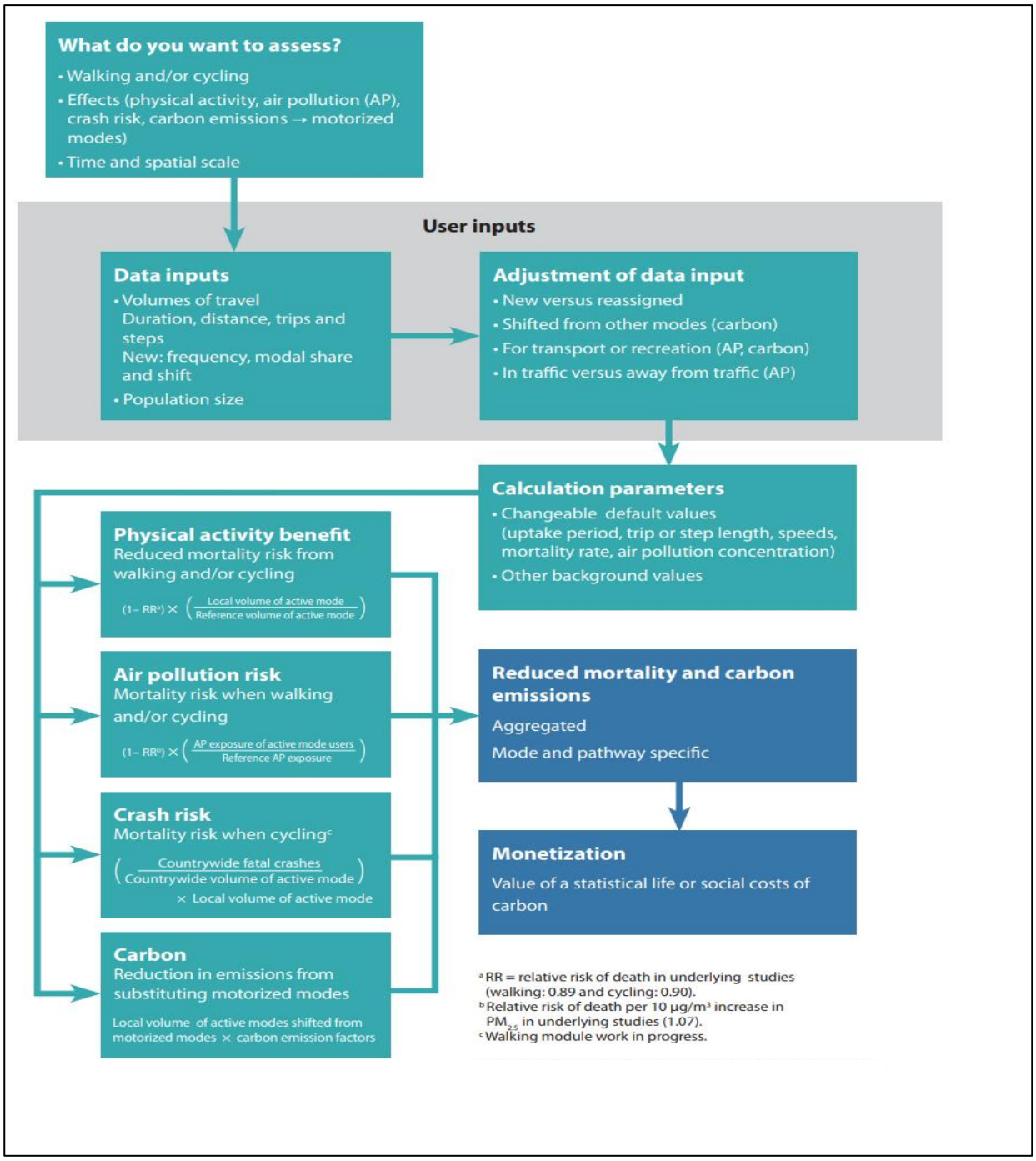


Figure 1. Basic functioning of WHO HEAT (source: Kahlmeier, et al, 2017)

3.3. Definition of the policy interventions in walking and cycling

Participants in the WHO HEAT technical assistance defined the interventions in walking and cycling based on the most recent RNTP, Ghana Environmental Protection Agency Regulations [31] and Department of Urban Roads strategies based on their Pedestrian Road Safety Action Plan for

the Accra Metropolitan Assembly, 2018-2022 [32], the National Road Safety Policy and WHO Global Action Plan on Physical Activity (GAPPA) [33]. The Ministry of Transport together UN Environment Programme and the Institute for Transportation and Development Policy has started developing the national regulatory framework for safe NMT interventions [34].

The walking and cycling intervention were defined as 500 km of walking pavements and 500 km of parallel (to walking pavements) cycle lanes covering six main roads and adjacent communities' streets and avenues:

- N4 Aburi Road_Derby Avenue A- Independence Avenue-Liberation Road
- N4 Aburi Road_Derby Avenue B
- N6 North Liberia Road_Nsawam Road B
- N6 Nsawam Road_Graphic Road A
- George Bush Motorway A
- George Bush Motorway B

The map below shows the scope of the proposed intervention.

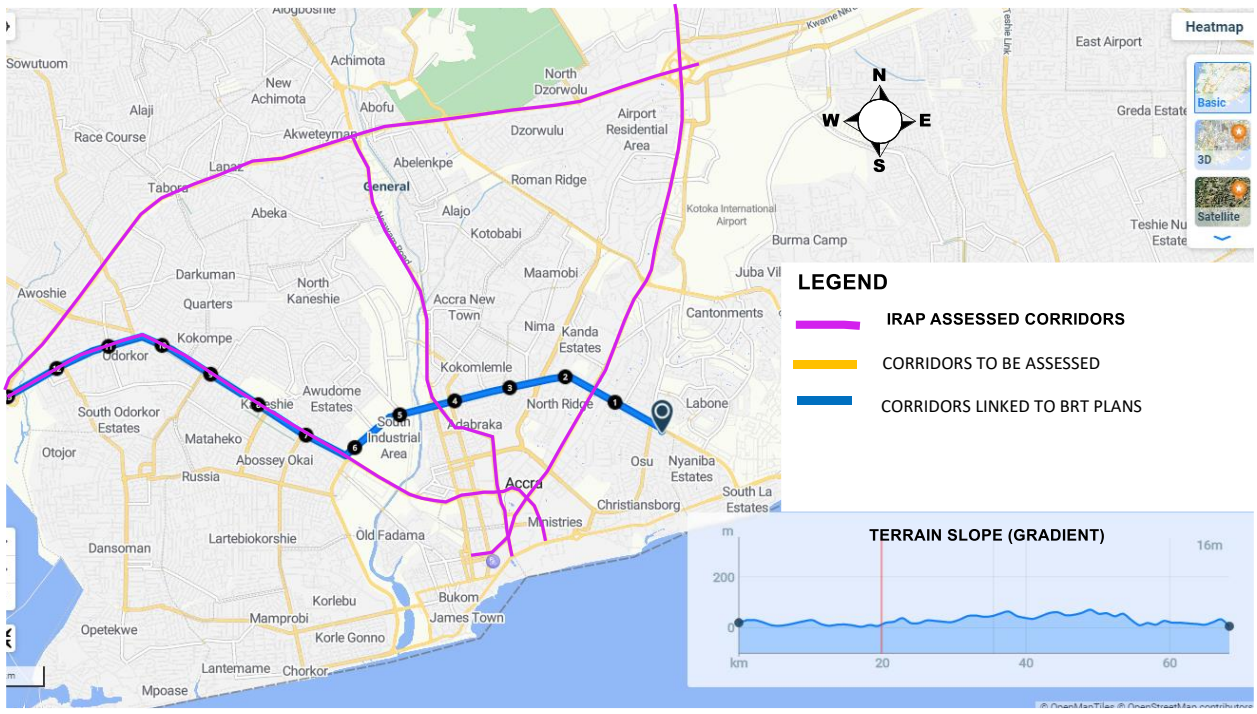


Figure 2. Map of Potential Corridors for a 500km interventions for walking and cycling – GAMA

Participants identified the following activities and aspects that should be included in the assessment of the interventions:

1. **Set-up planning**: apart from the planning for the infrastructure, it is essential to also have:
    - multisectoral governmental agencies' engagement
    - community awareness and engagement (including planning mass communication campaigns)
    - regulatory frameworks, safety regulations, training of officials, and law enforcement
    - definition of monitoring and evaluation indicators and plans for assessment
2. **Implementation**: apart from the retrofit and expansion of walking pathways and building of cycling lanes, all based on efficient use of road spaces, it is essential to also have:
    - street lightening
    - curb ramps for people with disabilities
    - universal access, and gender sensitive design
    - security and monitoring
    - resting spaces (covered benches, green areas with space for children)
    - well shaded footpath with urban afforestation and/or street coverage
    - traffic calming
    - air pollution monitoring
    - road safety measures
3. **Maintenance, community engagement, and monitoring**: apart from the maintenance of infrastructure (which is rarely accounted for or financed), it is essential to also have:
    - continue community awareness and engagement, with mass communication
    - continue training of officials
    - continue air pollution monitoring
    - monitoring and evaluation assessment and replanning

3.4. Data collection on cost of interventions and data analysis

Data were collected from internal reports and databases at the Department of Urban Roads and the Accra Metropolitan Assembly, from July to October 2022. Data on costs were collected following three cost categories, based on discussions with participants and following standard economic costing analysis [35]: set up planning, implementation and maintenance, engagement and monitoring of walking and cycling infrastructure.

- ***Set up costs*** are related to activities that typically occur at the beginning of the project, but which are likely to last the lifetime of the intervention, such as production of materials, recruitment and initial training of staff, engagement sessions, etc. These costs are usually overlooked by urban, transport or other planners and, although relatively small compared to the costs of implementation and maintenance - when spread over the period of the project -, they tend to "eat-up" a substantial amount of initial investments for implementation – which usually are available by phases (i.e., total cost not fully covered up front), if not properly accounted for, in the budget.
- ***Implementation costs*** are costs related to the development and execution of the implementation strategy; they include capital costs related to vehicles, equipment, buildings space for storage, and recurrent costs with personnel, contracts, overheads, continue social mobilisation, training, supplies, vehicles operation and maintenance, and other costs for the project implementation. These costs tend to be the bulk of the costs and they are the ones that policy planners tend to concentrate the most.
- ***Maintenance, community engagement, and monitoring*** refer to any cost to keep the intervention running in good working conditions. They also include capital and recurrent costs necessary for keeping the project, including community engagement and monitoring and evaluation.

In economic analysis, set up and capital costs are annualised to reflect the present value of future costs [35]. Annualisation gives the net present rate to the set up and capital costs (or cash flow) in every year of the intervention lifetime. The lifetime for the intervention was defined as 10 years. The discount rate for annualisation of costs was defined in 3%, and costs were annualised for 5 years (annualisation rate of 2.829) and 10 years (annualisation rate of 8.530).

Only financial costs were considered in this analysis. Opportunity costs related to donations and in-kind services were not accounted in this project. Although it is recognised that opportunity costs may play an important role in economic analysis, especially in lower- and lower-middle income countries (as Ghana), the costing exercise departure from the technical identification of all potential resources necessary for the implementation of interventions and costed those resources. It did not account for any potential in-kind donations. Costs were estimated as total cost (5 and 10 years) and cost per year.

4. BASELINE AND ALTERNATIVE SCENARIOS FOR WALKING AND CYCLING ASSESSMENT IN GAMA USING THE WHO HEAT

WHO HEAT can be used for different assessments, including [30]:

- Assessment of current (or past) levels of cycling and/or walking
- Assessment of changes overtime, as for example comparing the baseline (current situation) and the alternative (before and after)
- A cost-benefit analysis for the comparison of costs and benefits of new projects.

For the investment case in walking and cycling in GAMA we combined a cost-benefit analysis of an assessment of changes overtime for the intervention, based on the scenarios discussed below.

4.1. Current non-motorised transport situation in GAMA

In Gama, 36% of commuters use a public transport for their journeys. Small to medium-sized private buses (*trotro*, as they are known locally) and taxis respond for about 95% of all public transport journeys in the region; large public urban buses – the metro mass transit (MMT) -, accounts for only 5% of the transport journeys. Although about 20% cheaper than *trotros* and taxis, commuters perceive the MMT as a service that is poorly delivered. The main reasons for the poor rating of the service are related to the overcrowding of buses, nonadherence to time schedule, long time to reach the destination, non-availability of buses at respondents' origins and destinations, and long waiting times for buses, among the main reasons for non-preference [27].

Walk represents 34% of all journeys, while the remaining share of 30% is split between travel by cars and motorcycles (20.5%), cycling (9%) and commuter rail (0.5%) [9,36]. In GAMA, commuters using public transport or cars take on average 2 hours in traffic [37].

The RNTP envisages the expansion of the MMT services by investing in dedicated lanes to reduce the time of travel, availability, and reliability of the service. An example of such investment is the

Aayalolo Bus Service (ABS), a bus rapid transport (BRT) system that was introduced in GAMA in November 2016, covering a small corridor of Amasaman-Accra city [38]. This system covers a limited distance of dedicated lanes, which when combined, covers only about 5% of the 21.2 km journey between Amasaman and Accra city, instead of having dedicated lanes that cover the whole distance of the journey. However, the available dedicated lanes were strategically positioned at several different locations on the journey to help reduce the journey time and make the service more rapid. Queue jumpers were also installed at traffic lights to give preference to the ABS buses when they arrive at the traffic lights [39].

However, infrastructure for safe walking pavements was only contemplated for the perimeters close to the bus stops, without linking these infrastructures to local communities in and around the buses routes; cycling corridors were not contemplated in the transport project [38,39].

Without an expansion of a public, reliable, and affordable mass transport system, together policies for land use and safety policies for NMT, the use of cars and motorcycles will increase, with an estimated rise in 33% a year from the current 20.5% use of this type of transport, with a consequent reducing in walking and cycling by about 13% [36]. Levels of air pollution – currently eleven times the safe level of 5μg/m^3 of particulate matter (PM) 2.5, as established by the most recent WHO Air Quality Guidelines [40] -, and traffic accidents are also expected to increase if no actions are taken for a more sustainable transport system.

4.2. Alternative scenarios for walking and cycling interventions in GAMA

The Greater Accra Passenger Transport Executive (GAPTE) and the Accra Metropolitan Assembly (AMA) are committed to have Accra as one of the greenest and healthiest cities in Africa and has focused on sustainable transport strategies, as one of their key interventions, contemplating, together the Ministry of Transport, the introduction of a public mass transport system that is frequent, reliable, and affordable, and the promotion of walking and cycling infrastructure. Based on this commitment, two alternative scenarios were contemplated in this analysis. Alternative scenario 1 assesses the expansion of walking and cycling infrastructure in a 5-year period, covering 250 km of roads, while alternative scenario 2 focuses on a full 500 km of infrastructure in 10 years.

Both alternative scenarios assume an expansion of the mass public transport system. For alternative scenario 1 it was assumed public transport coverage will increase from 36% to 40% and to 45% in alternative scenario 2. Safety measures and regulation of land use are also assumed to be put in place for the expansion of the walking and cycling infrastructure.

4.3. Parameters used in the scenarios assessed in the WHO HEAT

The parameters used in the analysis are shown in Table 1. The parameters-based assumptions are conservative, given uncertainties related to the implementation of a public mass transport system and the necessary land use regulation and safety measures. Some of these parameters were assessed in a one-way sensitivity analysis (see sensitivity analysis section below).

Population in GAMA. The population in GAMA is expected to increase at a 2.2% rate per year [41].

Coverage. Currently, 34% of commuters walk and 9% cycle. The assumption for scenarios 1 and 2 is that, given the availability of safe, comfortable and more infrastructure of walking and cycling, 40% of commuters will opt for walking and 15% to cycle by 2027, while by 2032, 45% of commuters will be walking and 20% cycling in GAMA. The assumptions are based on the literature and on the effectiveness of mass media campaigns in promoting physical activity [20,33,42–44]. As we also assumed an increasing in public transport availability and affordability, alongside regulation of land use and safety measures for NMT, we are also assuming a partial shift among car drivers to walking and cycling – i.e., they would use cars to cover only part of their journeys, if encouraged to do so through, for example, mass media campaign and land use regulations [33,42,44,45].

Minutes per day of walking and cycling. With the expansion of safe walking and cycling infrastructure and safe and reliable public transport availability, it was also assumed that commuters will increase their time for walking and cycling, and those who use cars would reduce their use of cars and opt for more physical activity, reducing their time at traffic [33,42,44,45]. This assumption, of course, is based on the effectiveness of mass communication campaigns to encourage walking and cycling [46], as well as campaigns like no cars zones and car-free days, and

regulations for the entry of cars in specific zones (e.g., congestion charges and/or low emission zones) [47,48]. The reduction in traffic was assumed to 90 minutes in 5 years and to 60 minutes in 10 years, from the current 120 minutes [49].

Table 1. Parameters used in the HEAT tool, 2022 (baseline)

	Baseline 2022	Alternative scenario #1 2027	Alternative scenario #2 2032
Population (in million)	5.51*	6.13*	6.84*
Coverage			
Walking	34%**	40%	45%
Cycling	9%**	15%	20%
Minutes/day MPVA (mean)			
Walking	45^	50	60
Cycling	2^	20	30
All-cause mortality rate			
Walking	723[a]	Estimated by HEAT	Estimated by HEAT
Cycling	569[a]	Estimated by HEAT	Estimated by HEAT
Air pollution concentration			
PM2.5 (ug/m3)	55[b]	Estimated by HEAT	Estimated by HEAT
Road fatality rates (/100,000)			
Walking	26.2†	15.7 (40% reduction)[&]	13.1 (50% reduction)[&]
Cycling	10.2†	6.1 (40% reduction)[&]	5.1 (50% reduction)[&]
Time spent in traffic	120	90	60

*UN Population Prospect (2020) [41] – estimates for 2027 and 2032.
**Ministry of Transport, Ghana (2016) [49].

^Tatah et al. (2022) [50].
[a]HEAT tool default using data from the WHO Global Health Observatory (Global Health Observatory (who.int)).
[B]BreathLife (2022) [51].
†Blankson & Lartey (2020) [26].
University of Colorado Denver/University of New Mexico: Road fatality reduction: Cycling lanes reduce fatalities for all road users, study shows: Roads are safer for motorists, pedestrians and cyclists in cities with robust bike facilities -- ScienceDaily

All-cause mortality rates. These rates were available by default in the WHO HEAT tool. These modal-estimated rates were seen as accurate by the analysis team, and in the absence of other source of data, these data were used. The impact to subsequent years (alternative scenarios 1 & 2, 2027-2032) are calculated by the WHO HEAT and outcomes presented in terms of reduced mortality due to more physical activity, better air quality, and reduced traffic accidents [30].

Air pollution concentration. Concentration of PM2.5 in Accra is estimated in 55µg/m^3 [52], 11 times higher than the limit established by the most recent WHO Air Quality Guidelines [40]. In

the transport sector, high level of air pollution is driven by the widespread use of second-hand polluting cars, usually coming from high-income countries, in GAMA[11]. The impact to subsequent years (alternative scenarios 1 & 2, 2027-2032) are also calculated by the WHO HEAT in terms of deaths averted and carbon emissions averted (in tonnes per year).

Road fatality rates. Baseline data was obtained from the literature based on studies conducted in Accra [26,53]. The impact of the walking and cycling interventions on road fatality rates were assumed based on the literature [54] and on the Decade of Action for Road Safety, 2021-2030 that aims a reduction of at least 50% of road deaths and injuries by 2030 [55], where law enforcement, safe vehicles and transportation are put in place.

To assess the two economic outcomes, deaths and carbon emissions averted, WHO HEAT uses the value of statistical life (VSL) and international price of carbon, respectively [30]. The VSL is derived using a method called "willingness to pay" assessment. It aggregates individuals' willingness to pay to secure a marginal reduction in the risk of premature death. The VSL is not the value of an identified person's life but rather an aggregation of how society values small changes in risk of death. According to economic theory, the willingness to pay captures perceptions of risks and potential costs borne by the individual person rather than society, including immaterial costs (such as suffering). Thus, it should account for multiple domains, including consumption, inability to work, the healthcare costs the individual pays (and not insurers) and their own pain and suffering. Thus, it represents the societal economic value of reduced premature mortality [30,56].

The VSL in WHO HEAT is calculated using the Equation 1 below, which is based on a temporal-spatial benefit transfer function. It adjusts the 2005 Organisation for Economic Cooperation and Development (OECD) VSL base of US$ 3.013 million by an average OECD consumer index price (CPI), for the period of analysis (e.g., 2005-2022) [57]. This inflation-adjusted VSL is then multiplied by a temporal-spatial benefit transfer ratio, *where the most recent GDP per capita for the target country and OECD are used* (e.g., 2022). As in OECD (2011) [57], income elasticities are distinguished using the World Bank income group but are assumed as β=1.25 for low- and middle income countries and β=0.8 for high-income countries (Equation 1). The choice of income elasticities is based on the published literature: β=1.25 is derived from Narain and Sall, 2016 [58], while β=0.8 is the mid-point for the OECD countries [59].

$$VSL_{country,2022} = VSL_{OECD,2005,USD} x (1 + \%\Delta P_{2005-2022}) x \left(\frac{Y_{country,2022}}{Y_{OECD,2022}}\right)^{\beta}$$ (Equation 1)

The VSL for Ghana was estimated by WHO HEAT in US$ 139,000 and the international price of carbon in US$ 83, in 2022 prices.

4.4. Sensitivity analysis

We used one-way sensitivity analysis [60] to assess three main parameters of greater uncertainty:

- Coverage of cycling from 9% to 11% in 2027, and 15% in 2032, *and* minutes of cycling per day from 2 to 10 and 15 minutes per day, in 2027 and 2032, respectively.
- Minutes of walking from 45 minutes per day to 48 minutes per day in 2027, and 51 minutes per day in 2032.
- Time spent in traffic from 120 minutes to 100 minutes in 2027 and 90 minutes in 2032.

5. RESULTS

5.1. Costing analysis

Table 2 shows the estimated **set up costs**. From a total estimated cost of US$ 171,497 for ten years (US$ 17,150/year), 22% of the set up costs would be spent to develop the regulatory framework for walking and cycling, law enforcement related to it and the initial development of training of officers for monitoring of the areas and law enforcement, while 18% would be spent on planning the walking and cycling intervention, what include the collection of data at governmental agencies level, pre-feasibility scoping and mapping of potential corridors, and monitoring evaluation. About 16% would be spent on the engagement of stakeholders' intergovernmental agencies and other international agencies to discuss the intervention and mobilise human and financial resources, and 16% would go for initial safeguards (hazard removal) and identification of affected individuals due to relocation and pre- and post-planning for air pollution monitoring (Table 2).

Community engagement and mass media campaign (mostly in radios) would require 9% of the initial investments, and 8% of set up costs would go for project definition and management capacity. The remaining 10% would be spent on communication and overheads. The set up costs per km^2 was estimated in US$ 34.3 (Table 2).

Table 2. Set up costs (in US$)

Cost category	Description of activities	Total cost 10 years (US$)	Cost/year (US$)	Cost/Km (US$)	%
A. Meetings		**26,796**	**2,680**	**5.4**	**16%**
Stakeholders' engagement	All agencies involved in the planning and management of the built environment covering policy, services, and infrastructure	26,796	2,680	5.4	
B. Walking and cycling mobility planning		**31,616**	**3,162**	**6.3**	**18%**
Institutional level data collection	Institutional benchmarking of participating institutions and needs assessment for the walking & cycling project	5,275	528	1.1	
Pre-feasibility scoping and mapping of potential corridors	Land-use and active walking & bike-use corridors identification, list of connecting mode lines, modelled bike corridor traffic data	2,638	264	0.5	
Technical surveys - countermeasures mapping	Updating existing countermeasure data mapped in 2016 with current site activities	1,407	141	0.3	
Monitoring and evaluation	Definition of indicators, pre- and post-surveys for perception and attitude towards walking and cycling activities, etc.	7,444	744	1.5	
Materials for logistic diagnosis and mapping exercise	Reflector jackets, raincoats, vehicles (maintenance), GPS equipment, android phones, PVT VISSIM (1 seat license), fuel	14,852	1,485	3.0	
C. Safety and environment		**28,094**	**2,809**	**5.6**	**16%**
Community mobilisation for safeguards	Develop framework for Bike Corridor Hazard Removal (Including Relocation of Encroaching Activities and Illegal Structures), survey and Identification of Affected Individuals, Meeting of Affected Community Members, Groups and Businesses/Relocation & Hazard Removal from Corridor Right-of-Way	13,733	1,373	2.7	
Monitoring for air pollution impact	Pre- and post-assessment of air pollution impact	14,361	1,436	2.9	
D. Project definition and management capacity		**14,093**	**1,409**	**2.8**	**8%**
Production of corridor and services map for relocation of utilities, technical briefing for construction works and pre-tendering meetings	Bicycle Corridor Conceptual Development Framework; Facilities, Alignment, Countermeasure Application	3,550	355	0.7	
Secretarial, planning and documentation plus logistic for diagnostic study & mapping exercise	Capacity Building & Orientation of Selected Staff of Lead and Support Agencies, Supervision Role of Selected Institutional Staff in Project Implementation, Operation and Management	10,543	1,054	2.1	
E. Community engagement		**15,123**	**1,512**	**3.0**	**9%**
Meetings with the local community representatives	Presentation of the intervention planning and discussion about their potential concerns; benefits of interventions and plans for community engagement.	703	70	0.1	

Community engagement (media campaign)	Radio campaign (mainly route), TV and pamphlets	14,420	1,442	2.9	
F. regulatory framework for walking and cycling		**38,288**	**3,829**	**7.7**	**22%**
Review and development of regulations (initial activity)	Development of the regulatory framework for walking and cycling and safety (including parking and areas for vendors) and land use; ways to enforce the law including application and collection of fines, definition of fines.	11,524	1,152	2.3	
Training of officers	Training of officers for monitoring of areas and law enforcement.	26,764	2,676	5.4	
G. Communication		**11,862**	**1,186**	**2.4**	**7%**
Internet and software operation & maintenance	Internet and voice data for online communication and software operation and maintenance	5,024	502	1.0	
Miscellaneous	Others	6,838	684	1.4	
H. Overheads	Contribution to governmental agencies overheads	**5,624**	**562**	**1.1**	**3%**
	TOTAL COSTS	**171,497**	**17,150**	**34.3**	**100%**

The bulk of **implementation costs**, estimated in a total of US$ 88.5 million in 10 years, would be spent on grade separation and road treatment (US$ 39.6 million, 45%) and grade separation for pedestrians (US$ 20 million, 22.6%) – Table 3. About 12% of those costs would be spent on lighting. The remaining 20% of implementation costs would be for pedestrians' and cyclists' safety and comfort. The implementation cost per km^2 was estimated in US$ 177,054 (Table 3).

Table 3. Implementation costs (in US$)

Cost category	Total cost 10 years (US$)	Cost/year (US$)	Cost/Km (US$)	%
Air pollution monitoring (include equipment)	42,330	4,233	84.66	0.05%
Bicycle Lane (on-road)	4,379	438	8.76	0.00%
Central hatching	4,768	477	9.54	0.01%
Central median barrier (no duplication)	325,786	32,579	651.57	0.37%
Centreline rumble strip / flexi-post	54,561	5,456	109.12	0.06%
Clear roadside hazards - driver side	47,664	4,766	95.33	0.05%
Clear roadside hazards - passenger side	74,557	7,456	149.11	0.08%
Delineation and signing (intersection)	63,000	6,300	126.00	0.07%
Footpath provision driver side (>3m from road)	1,669,214	166,921	3,338.43	1.89%
Footpath provision driver side (adjacent to road)	1,686,664	168,666	3,373.33	1.91%
Footpath provision driver side (informal path >1m)	11,007	1,101	22.01	0.01%
Footpath provision passenger side (>3m from road)	551,271	55,127	1,102.54	0.62%
Footpath provision passenger side (adjacent to road)	436,357	43,636	872.71	0.49%
Footpath provision passenger side (informal path >1m)	76,079	7,608	152.16	0.09%
Footpath provision passenger side (with barrier)	1,238,929	123,893	2,477.86	1.40%
Grade separated pedestrian facility	19,967,143	1,996,714	39,934.29	22.55%
Grade separation and road treatment	39,566,596	3,956,660	79,133.19	44.69%
Parking improvements	15,707	1,571	31.41	0.02%
Pedestrian fencing	24,571	2,457	49.14	0.03%
Protected turn lane (unsignalised 3 leg)	4,964,929	496,493	9,929.86	5.61%
Protected turn lane (unsignalised 4 leg)	165,000	16,500	330.00	0.19%
Protected turn provision at existing signalised site (3-leg)	482,071	48,207	964.14	0.54%
Protected turn provision at existing signalised site (4-leg)	83,214	8,321	166.43	0.09%
Refuge Island	15,429	1,543	30.86	0.02%
Resting spaces (covered benches, green areas with space for children)	81,033	8,103	162.07	0.09%
Restrict/combine direct access points	69,700	6,970	139.40	0.08%
Road surface rehabilitation	2,457	246	4.91	0.00%
Roadside barriers - driver side	283,650	28,365	567.30	0.32%
Roundabout	2,250,000	225,000	4,500.00	2.54%
Security and monitoring	112,390	11,239	224.78	0.13%
Service road	66,929	6,693	133.86	0.08%
Shoulder rumble strips	4,707	471	9.41	0.01%
Shoulder sealing driver side (<1m)	8,186	819	16.37	0.01%
Shoulder sealing passenger side (<1m)	97,714	9,771	195.43	0.11%
Shoulder sealing passenger side (>1m)	6,843	684	13.69	0.01%
Side road grade separated pedestrian facility	936,429	93,643	1,872.86	1.06%
Side road signalised pedestrian crossing	136,571	13,657	273.14	0.15%
Side road unsignalised pedestrian crossing	15,643	1,564	31.29	0.02%
Sideslope improvement - driver side	1,471	147	2.94	0.00%
Sideslope improvement - passenger side	29,743	2,974	59.49	0.03%
Signalise intersection (3-leg)	306,214	30,621	612.43	0.35%
Signalise intersection (4-leg)	54,964	5,496	109.93	0.06%
Signalised crossing	896,357	89,636	1,792.71	1.01%

Cost category	Total cost 10 years (US$)	Cost/year (US$)	Cost/Km (US$)	%
Skid Resistance (paved road)	11,771	1,177	23.54	0.01%
Street lighting (intersection)	3,039,286	303,929	6,078.57	3.43%
Street lighting (mid-block)	7,842,690	784,269	15,685.38	8.86%
Street lighting (ped crossing)	270,000	27,000	540.00	0.30%
Traffic calming	29,807	2,981	59.61	0.03%
Urban afforestation	12,571	1,257	25.14	0.01%
Unsignalised crossing	32,250	3,225	64.50	0.04%
Unsignalised raised crossing	249,643	24,964	499.29	0.28%
Upgrade pedestrian facility quality	91,143	9,114	182.29	0.10%
Wide centreline	15,829	1,583	31.66	0.02%
TOTAL COST	**88,527,217**	**8,852,722**	**177,054**	**100%**

Maintenance costs that are typically not accounted or underestimated by planners; they were estimated in US$ 24.3 million, for a 10-year intervention (Table 4). We included community awareness and engagement - with most of the costs corresponding to mass media campaigns, mostly in radio (the communication channel with more capillarity among the community) -, air pollution monitoring, and monitoring and evaluation activities, in the maintenance costs, as they are ongoing necessary costs to maintaining the project. The cost per km^2 for maintenance, community engagement and monitoring were estimated in US$ 48,690 (Table 4).

Table 4. Maintenance, community engagement and monitoring (in US$)

Cost category	Total cost 10 years (US$)	Cost/year (US$)	Cost/Km (US$)	%
Maintenance of roads and pavement infrastructure	15,166,926	1,516,693	30,334	62%
Lighting, security, plants, and resting spaces	3,091,813	309,181	6,184	13%
Community awareness and engagement	1,168,559	116,856	2,337	5%
Training of officials	1,996,289	199,629	3,993	8%
Air pollution monitoring	1,850,219	185,022	3,700	8%
Monitoring and evaluation	1,071,179	107,118	2,142	4%
TOTAL COST	**24,344,985**	**2,434,498**	**48,690**	**100%**

The total cost for the walking and cycling infrastructure was estimated in over US$ 113 million, in 10 years. Regarding the share of costs, 78% were estimated for implementation and 22% for maintenance, community engagement and monitoring; set up costs were estimated in 0.2% (Figure 1).

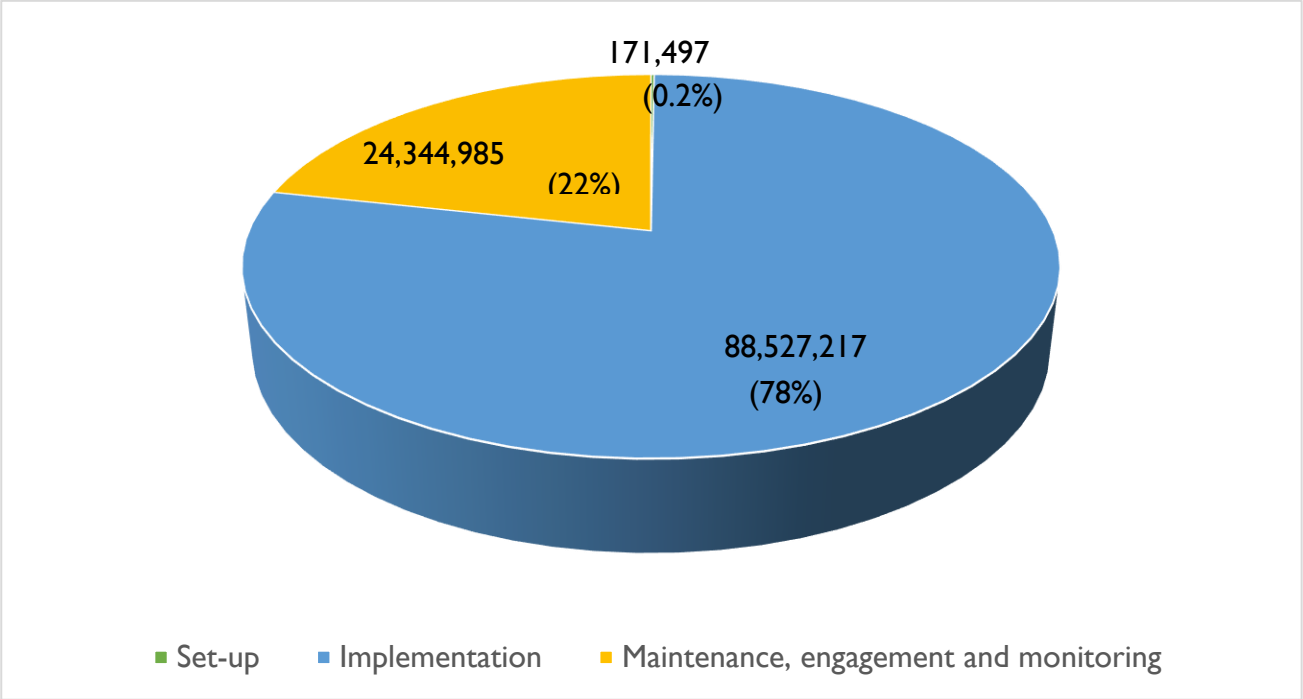


Figure 3. Share of Total Cost of the Walking and Cycling Interventions in GAMA

5.2. Health and economic impact assessment

The return on investment for the 500 km^2 of infrastructure for walking and cycling between 2022 and 2032 was considered very high in GAMA. The benefit-cost ratio after 5-year investment would be US$ 33 per US$ 1 spent, and for a 10-year investment would be of US$ 37 per US$ 1 dollar invested. Benefit-cost ratio (BCR) above US$ 5 per US$ 1 spent are considered very high value for money [61]. In the context of GAMA, the intervention has the potential of generate more than 7 times the threshold of US$ 5 per US$ 1 spent (Table 5).

Table 5. Return on investment of walking and cycling infrastructure in GAMA, 2022-2032

Scenarios	Deaths averted	Carbon emissions averted (tonnes)	Total economic benefits (in US$), discounted	Total cost of interventions (in US$), discounted	Benefit-Cost Ratio
Alternative scenario 1 (250 Km, 5 years)	2,425	18,598,326	1,880,736,058	56,521,850	33.27
Alternative scenario 2 (500 Km, 10 years)	5,658	40,915,597	4,182,456,551	113,043,699	37.00

The main contributor for the high BCRs was the costs averted with carbon emissions that accounted for more than US$ 4 billion in costs of carbon saved related to 41 million tonne in 10 years (2022-2032). The carbon emissions averted BCR was estimated in US$ 30.04 [(41 million tonnes multiplied by US$ 83) divided by US$ 113 million]. The health component related to the number of deaths averted had an estimated BCR of US$ 6.96 [(5,658 multiplied by US$ 139,000) divided by US$ 113 million] per US$ 1 dollar spent, which still well above the very high threshold of US$ 5 per US$ 1 spent (Table 5). Both outcomes, deaths averted, and carbon emissions averted, provide important economic benefits to the society in GAMA. All costs are discounted.

5.3. Sensitivity analysis

A more conservative assessment for the walking and cycling interventions would reduce the BCRs in about 40% (Table 6). However, in both scenarios, the BCRs are still well above the very high threshold for value for money of US$ 5 per US$1 spent, with alternative 1 potentially generating a BCR of US$ 19 per US$ 1 spent and alternative 2, a BCR of 22.47 per US$ 1 spent. Again, the cost of carbon played a central role in the cost-benefit analysis, with BCRs of US$ 14.74 and US$ 17.55, respectively for 2027 and 2032, while the cost per death averted had BCRs of US$ 4.23 and US$ 4.92 (Table 6). BCRs above US$ 4 per US$ 1 spent is considered good value for money [61].

Table 6. Sensitivity analysis (in US$)

Scenarios	Deaths averted	Carbon emissions averted (tonnes)	Total economic benefits (in US$), discounted	Total cost of interventions (in US$), discounted	Benefit-Cost Ratio
Alternative scenario 1 (250 Km, 5 years)	1,722	10,035,290	1,072,287,070	56,521,850	18.97
Alternative scenario 2 (500 Km, 10 years)	3,998	23,903,302	2,539,696,066	113,043,699	22.47

6. DISCUSSION AND RECOMMENDATIONS

This analysis reiterates walking and cycling as a cost-effective, good value for money intervention that generates substantial health, economic and environmental benefits to the society. More than 5,600 deaths and almost 41 million tonnes of carbon emissions would be averted in a 10-year period if safe and comfortable walking and cycling infrastructure are made available in GAMA, with economic benefits of over US$ 4 billion, with a BCR of US$ 37 per US$ 1 spent, a very high value for money, according to economic threshold standards. The economic benefits were mostly pushed by the savings in carbon emissions, given the widespread use of second-hand polluting cars, usually coming from high-income countries, in GAMA.

These potential economic benefits are, however, conservative, as more could be achieved if walking and cycling infrastructure are integrated to a reliable, safe, and affordable mass public transportation. A study commissioned by WHO in 2020 found that the expansion of effective mass public transport infrastructure and services (i.e., greener, safe, reliable and affordable), such as decarbonised BRT and light railway, as well as the expansion of walking and cycling by users, reduction of use of cars and focus on greener vehicles, would avert 5,500 premature deaths from improvements in air quality plus an additional 33,000 saved lives due to increased physical activity, and almost 159 million carbon emissions averted, during a 30-year period (2020-2050). Those benefits would translate into almost 18 billion economic benefits generated by sustainable transportation, including expansion of NMT [36].

Benefits of walking and cycling infrastructure associated with the reduction of morbidity due to NCDs and traffic injuries (e.g., hospitalisations and treatment) and long-term loss in productivity, i.e., absenteeism and presenteeism, would yield further economic benefits and an even higher BCR. Average costs of selected NCDs and road traffic injuries to the health system and individuals in GAMA are considerable high [62], however, the lack of data on morbidity associated with the lack of walking and cycling, and air pollution level in the region prevented us to expand our analysis to include morbidity cases. A study on the cost of inaction on physical activity indicates an estimated cost in US$ 96.5 million (INT$ 251.3 million) for Ghana between 2020-2030 [63].

Law enforcement and road safety measures are also important interventions that need to be considered to achieve the estimated benefits. The cost estimates produced by this technical assistance considered the costs associated with these activities, but they are likely to be underestimated because we did not assess the current application of these activities in GAMA. Our estimates were based on previous internal reports in AMA dated from about 8 years ago. Besides, given the lack of a regulatory framework for walking and cycling (and other NMTs) in the country or city, it is likely we have not considered all principles of NMT policies, regulations and best practices [34]. Road safety measures also need to be reviewed to support users for walking and cycling, in accordance with the decade of action for rad safety, if the country aims to achieve the target of reduction of at least 50% in road fatalities and injuries [55]. Thus, it is imperial to have such policies developed and put in place, together a review of law enforcement and road safety measures for an effective implementation of sustainable transport, including walking and cycling. The recently published WHO Global Status Report on Physical Activity shows that, although Ghana has a national policy for walking and cycling, a national strategy for road safety, national policy on public transport, street design standards on walking and cycling and road safety legislations, those are not necessarily based on best practice [64,65].

Even though studies show that the availability of walking and cycling infrastructure are positively correlated with increasing of physical activity [1,20], they also show that continue public awareness and engagement are needed to increase and retain levels of walking and cycling [42]. Mass media campaigns for physical activity are cost-effective ways of increasing physical activity levels, as shown in the latest WHO report [46,66], and should be considered as part of a continue strategy for promoting walking and cycling.

WHO GAPPA also identified 20 evidence-based policy recommendations to guide national efforts to increase population levels of physical activity. Of particular interest are the action recommendations for creating and maintaining active environments that promote equitable and safeguard the rights of all people, of all ages, to engage in physical activity – action area 2 of WHO GAPPA [33]. WHO is developing a practical toolkit on walking and cycling - to be launched soon - to help countries advancing in the implementation of these sustainable interventions.

This study shows that to achieve the health and economic benefits of expanding walking and cycling infrastructure, the offer of safe and comfortable infrastructure should also be associated to

strong regulatory, safety measures and law enforcement activities. It also shows that the availability of sustainable mass public transportation is key to even expand the benefits of walking and cycling. These interventions would support Ghana plans with its RNTP in advancing and achieve the United Nations (UN) Sustainable Development Goals (SGDs) for 2030, specifically goal number 11 of providing access to safe, affordable, accessible and sustainable transport systems for all [67], the African Union's Agenda 2063 goal 1.3 of social security and protection, including persons with disabilities, and goal 1.4 of modern, affordable and liveable habitats and quality basic services [23], and the Coordinated Programme of Economic and Social Development Policies (CPESDP) goal 3.5 of ensuring public safety and security and goal 1.4 of strengthening social protection, especially for children, women, persons with disability and the elderly [24]. Furthermore, it will help the country in advancing and achieving the SDG Goal 3 of reducing deaths due to NCDs by one third by 2030 [67].

Financing is a key element to allow for these activities-interventions related to be brought forward, and in addition to the support of development banks and country direct budget financing, other financial mechanisms such as private and public partnerships, bonds, and land use taxes should be explored as a way to financing walking and cycling.

Based on our findings, we thus recommend Ghana to:

- Invest in a comprehensive expansion of walking and cycling infrastructure considering not only key costing components that are often left overlooked by planners, such as set up and maintenance costs, but also costs related to regulations, safety, comfort of infrastructure, and mass communication to increase levels of physical activity.
- Invest in sustainable, greener expansion of mass public transportation.
- Invest in decarbonise vehicles and encourage the less use of cars and more use of walking and cycling.
- Invest in monitoring and evaluation for assessment and reassessment of the walking and cycling interventions, including the monitoring of air pollution levels.

7. REFERENCES

[1] Oyeyemi AL, Adegoke BOA, Oyeyemi AY, et al. Perceived environmental correlates of physical activity and walking in African young adults. Am J Health Promot 2011;25:e10-19.
[2] United Nations. 68% of the world population projected to live in urban areas by 2050, says UN. United Nations: Department of Economics and Social Affairs, New York 2018.
[3] McMichael AJ. The urban environment and health in a world of increasing globalization: issues for developing countries. Bull World Health Organ 2000;78:1117–26.
[4] Juma K, A. Juma P, Shumba C, et al. Non-Communicable Diseases and Urbanization in African Cities: A Narrative Review. In: Eze Anugwom E, Awofeso N, editors. Public Health in Developing Countries - Challenges and Opportunities, IntechOpen; 2020.
[5] Babajide O, Martins DC, Maani N, et al. Improving Decision-Making for Population Health in Nonhealth Sectors in Urban Environments: the Example of the Transportation Sector in Three Megacities—the 3-D Commission. J Urban Health 2021;98:60–8.
[6] UN-Habitat, editor. The value of sustainable urbanization. Nairobi, Kenya: UN-Habitat; 2020.
[7] World Population Review. Accra population 2020. Available at: https://worldpopulationreview.com/world-cities/accra-population. AccessedMay 20, 2021.
[8] Owusu G. Indigenes' and migrants' access to land in peri-urban areas of Accra, Ghana. International Development Planning Review 2008;30:177–98.
[9] Quarshie M. Cycling in Ghana: An in-depth study of Accra 2004.
[10] Driver and Vehicle Licensing Authority, Ghana. Vehicle registration data 1995–2017 n.d.
[11] Columbia Climate School. Why Ghana Relies Heavily on Used Cars. Available at: https://news.climate.columbia.edu/2023/01/10/why-ghana-relies-heavily-on-used-cars/. AccessedJanuary 20, 2023.
[12] Guthold R, Stevens GA, Riley LM, et al. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. The Lancet Global Health 2018;6:e1077–86.
[13] Guthold R, Stevens GA, Riley LM, et al. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. The Lancet Child & Adolescent Health 2020;4:23–35.
[14] Ghana Non-Communicable Disease Alliance, NCD Alliance. The Ghana Advocacy Agenda of People Living With NCDs 2019.
[15] World Health Organization. More active people for a healthier world: global action plan on physical activity 2018-2030. 2018.
[16] Jarrett J, Woodcock J, Griffiths UK, et al. Effect of increasing active travel in urban England and Wales on costs to the National Health Service. The Lancet 2012;379:2198–205.
[17] Mueller N, Rojas-Rueda D, Cole-Hunter T, et al. Health impact assessment of active transportation: A systematic review. Preventive Medicine 2015;76:103–14.
[18] University College London for Transport for London. Street appeal: The value of street improvements Summary Report 2019.
[19] Sallis JF, Floyd MF, Rodríguez DA, et al. Role of built environments in physical activity, obesity, and cardiovascular disease. Circulation 2012;125:729–37.
[20] Elshahat S, O'Rorke M, Adlakha D. Built environment correlates of physical activity in low- and middle-income countries: A systematic review. PLoS ONE 2020;15:e0230454.
[21] Ministry of Transport, Ghana. Revised National Transport Policy 2020.
[22] United Nations. Sustainable transport, sustainable development. Interagency report for second Global Sustainable Transport Conference. 2021.

[23] African Union. Agenda 2063: The Africa We Want. A shared strategic framework for inclusive growth and sustainable development & a global strategy to optimize the use of Africa's resources for the benefit of all Africans. 2015.
[24] Replubic of Ghana. Coordinated Programme of Economic and Social Development Policies (CPESDP) goal 3.5. An Agenda for Jobs: Creating Prosperity and Equal Opportunity for All. 2017.
[25] Stucki M. Policies for Sustainable Accessibility and Mobility in Urban Areas of Africa 2015.
[26] Blankson PK, Lartey M. Road traffic accidents in Ghana: contributing factors and economic consequences. Gmj 2020;54:131.
[27] Birago D, Opoku Mensah S, Sharma S. Level of service delivery of public transport and mode choice in Accra, Ghana. Transportation Research Part F: Traffic Psychology and Behaviour 2017;46:284–300.
[28] Rachel A. Benefits of investing in cycling 2014.
[29] Götschi T, Kahlmeier S, Castro A, et al. Integrated Impact Assessment of Active Travel: Expanding the Scope of the Health Economic Assessment Tool (HEAT) for Walking and Cycling. IJERPH 2020;17:7361.
[30] Kahlmeier S, Götschi T, Cavill N, et al. Health economic assessment tool (HEAT) for walking and for cycling: methods and user guide on physical activity, air pollution, injuries and carbon impact assessments. World Health Organization. Regional Office for Europe. 2017.
[31] Ghana Environmental Protection Agency (EPA). Environmental Assessment Regulations 1999.
[32] Accra Metropolitan Assembly. Pedestrian Road Safety Action Plan for the Accra Metropolitan Assembly, 2018-2022 2017.
[33] World Health Organization. GAPPA – WHO Global Action Plan on Physical Activity 2018-2030: more active people for a healthier world 2019.
[34] ITDP. Basics of NMT design. Available at: g.itdp.nmttoolkit.
[35] Drummond M, Stoddart GL, Torrance GW. Methods for the economic evaluation of health care programmes. Oxford [Oxfordshire] ; New York: Oxford University Press; 1987.
[36] Essel D, Spadaro JV. Health and economic impacts of transport interventions in Accra, Ghana 2020.
[37] KhoPhi's Dev Blog. The Cost of Commuting in Accra. Available at: https://blog.khophi.co/the-cost-of-commuting-in-accra/. AccessedMay 20, 2021.
[38] The World Bank. Toolkit on Intelligent Transport Systems for Urban Transport: Case Study for Accra, Ghana n.d.
[39] Abekah-Nkrumah G, Opoku Asuming P, Telli H. The effects of the introduction of a bus rapid transit system on commuter choices in Ghana - Policy Brief 33400 2019.
[40] WHO global air quality guidelines. Geneva: WHO; 2021.
[41] United Nations Department of Economic and Social Affairs, Population Division. World Population Prospects 2020. Available at: https://population.un.org/wpp/. AccessedAugust 20, 2021.
[42] Leavy JE, Rosenberg M, Bauman AE, et al. Effects of Find Thirty every day ®: Cross-Sectional Findings From a Western Australian Population-Wide Mass Media Campaign, 2008-2010. Health Educ Behav 2013;40:480–92.
[43] Leavy JE, Bull FC, Rosenberg M, et al. Physical activity mass media campaigns and their evaluation: a systematic review of the literature 2003-2010. Health Education Research 2011;26:1060–85.
[44] World Health Organization. WHO Guidelines on Physical Activity and Sedentary Behaviour 2020.
[45] C40 Cities Climate Leadership Group. How to drive a modal shift from private vehicles to public transport, walking and cycling 2019.

[46] Geneva: World Health Organization (WHO). Technical briefing for Appendix 3 of the Global Action Plan for Non-Communicable Diseases. Physical inactivity interventions. 2022.
[47] Glazener A, Wylie J, van Waas W, et al. The Impacts of Car-Free Days and Events on the Environment and Human Health. Curr Envir Health Rpt 2022;9:165–82.
[48] Transport for London. Congestion Charge marks 20 years of keeping London moving sustainably 2023.
[49] Ministry of Transport, Ghana. Transportation master plan Greater Accra region. Final report. 2016.
[50] Tatah L, Pearce M, Goel R, et al. Physical Activity Behaviour and Comparison of GPAQ and Travel Diary Transport-Related Physical Activity in Accra, Ghana. IJERPH 2022;19:7346.
[51] World Health Organization, Climate and Clean Air Coalition, UN Environment Programme, et al. Breathlife: A global campaign for clean air - Accra. Available at: https://breathelife2030.org/. AccessedMay 20, 2021.
[52] WHO Global Platform on Air Quality and Health. Ambient air pollution, Accra, Ghana. Available at: https://breathelife2030.org/city_data/accra/. AccessedFebruary 18, 2023.
[53] Blankson P-K, Amoako JKA, Asah-Opoku K, et al. Epidemiology of injuries presenting to the accident centre of Korle-Bu Teaching Hospital, Ghana. BMC Emerg Med 2019;19:39.
[54] Bates L, Soole D, Watson B. The Effectiveness of Traffic Policing in Reducing Traffic Crashes. In: Prenzler T, editor. Policing and Security in Practice, London: Palgrave Macmillan UK; 2012, p. 90–109.
[55] World Health Organization. Global Plan Decade Action for Road Safety, 2021-2030 2021.
[56] Kniesner TJ, Viscusi WK. The Value of a Statistical Life. Oxford Research Encyclopedia of Economics and Finance, Oxford University Press; 2019.
[57] OECD. The Economic Consequences of Outdoor Air Pollution. OECD; 2016.
[58] Narain U, Sall C. Methodology for Valuing the Health Impacts of Air Pollution Discussion of Challenges and Proposed Solutions 2016.
[59] OECD. Mortality Risk Valuation in Environment, Health and Transport Policies. OECD; 2012.
[60] Briggs A, Sculpher M, Buxton M. Uncertainty in the economic evaluation of health care technologies: The role of sensitivity analysis. Health Econ 1994;3:95–104.
[61] Department of Transport, United Kingdom. Value for money indicator 2019 2022.
[62] Santos AC, Nonvignon J, Blankson P-K, et al. Economic costs of air pollution in Accra, Ghana 2020.
[63] Santos AC, Willumsen J, Meheus F, et al. The cost of inaction on physical inactivity to public health-care systems: a population-attributable fraction analysis. The Lancet Global Health 2023;11:e32–9.
[64] World Health Organization. Global status report on physical activity 2022.
[65] World Health Organization. Country Profile - Ghana: Global Status Report On Physical Activity 2022.
[66] World Health Organization. Draft Updated Appendix 3 of the WHO Global NCD action plan 2013-2030 2022.
[67] World Health Organization. Invisible numbers: the true extent of noncommunicable diseases and what to do about them. Geneva: World Health Organization; 2022.

8. Annex 1– List of Participants

NAME	INSTITUTION/ORG	POSITION
Alex Johnson	Accra Metropolitan Assembly	Director, Metropolitan Transport Department
Richard K. Oduro	Accra Metropolitan Assembly	Director, Metropolitan Development Planning Unit
Ing. David Afosah-Anim	Accra Metropolitan Assembly	Director, Metropolitan Urban Roads Department
Ing. Patience Onny	Department of Urban Roads	Road Safety Engineer
Ing. Akua Sakyibea Vander-Pallen	Department of Urban Roads	Transport Planner
Ing. Magnus Quarshie	Centre for Cycling Expertise	CEO
Joseph Yidana	Accra Metropolitan Assembly	Assistant Development Planning Officer
Rejard Alaala	Accra Metropolitan Assembly	Assistant Physical Planning Officer
Johnson Ade	Ghana Environmental Protection Agency	Assistant Programme Officer
George Buer Kpentey	Ghana Environmental Protection Agency	Assistant Programme Officer
Mrs. Comfort Kugblenu	Ghana Health Services	Senior Public Health Officer