Integration of Green Infrastructure into Transportation Planning in African cities

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1. Abstract

Green infrastructure concept emerged as a solid tool in all areas of specialization in town planning development projects. Transportation planning is an important sector that has significant influence on effectiveness or functionality of all sectors of the environment. The concern lies on how countries can make development in this sector more sustainable and efficient. However, there exist a gap in literature for an integrated framework to aid engineering organization, the planners and the government in planning the start-up of new transport efficient projects in the context of greening and sustainability in African cities. This study attempts to identify existing framework that have been proposed by major cities in Africa that ensure green transportation projects and review frameworks used by developed countries. This review identifies several approaches that have been employed by developed nations and recommends a ready-to-use framework of sequenced tasks that will aid proper integration of green infrastructure in transportation development. This research also reviews GI. literature with a focus on transportation development and including methods and techniques adopted in these reviewed approaches in African cities.

Key words: Green Infrastructure, Transportation planning, Sustainability, Environment

2. Introduction

Most environmental professionals have started incorporating different ecological integrated concepts that supports design of liveable and sustainable environment. However, in the area of transportation planning, planners and policy makers seem to be lagging behind in providing such an ecological integrated concept (Beatly, 2010). Contemporary studies focuses on a unified approach to design of sustainable system that integrates all scales including the transportation sector ranging from molecular to global (Van Der Ryn and Cowen, 2007). Green infrastructure has been proposed by most professions as an approach to designing sustainable city systems in transportation planning in developed nations. Although, the principles and concepts underpinning are not and can be traced through the beginning of environmentalism, landscape architecture and planning in the 19th century Europe (Pankhurst, 2010). Then it was termed concepts as sustainable environment, liveable cities, smart growth, compact cities etc. However, the G.I concept is being paired with other mitigative tools that will aid in achieving a sustainable environment. Due to the cost implications associated with the provision of the infrastructure required for the implementation of sustainable (mitigative) tools, developing nations has been encouraged to

first employ adaptive measures as G.I infrastructure (UNCCC, 2015). As this is an efficient way to solidify the resilience of cities to the effects of climate change and encouraging sustainable development.

In African cities most of the effects of climate change are as a result of mans uncontrolled and indiscriminate activities and this can be managed. The disparity between land use and mobility has been an issue in the implementation of a sustainable transportation infrastructure. The transportation sector contributes immensely to greenhouse gas emissions in the world and in major African countries like South Africa, transportation has grossly its own share in the total emission from 32% from 36 016 Gg CO2 eq in 2000 to 47 607 Gg CO2 eq in 2010 (Peters, 2017). As a result they have set targets in line with the Paris agreement at COP 21 to reduce the emissions by 34% in GHGs by 2020 and a 42% reduction by 2025 (Peters, 2017) with the formulation of the Green Transport Strategy. In Nigeria, steps are still underway but there is still a gap in a policy framework that supports green infrastructure in transportation planning. The draft transportation policy strategy has little or no framework that support integrating green planning. Generally, in transportation planning, this concept is relatively new as underlying factors supporting its implementation has a great deal of gray infrastructure. This is one of the reasons why most cities are still have not developed an integrative policy framework that supports green infrastructure approach

However, green infrastructure have been defined using the adaptive management approach and this has been designed primarily to support managers in dealing with highly connected systems like transportation (Wietske and Jeffrey, 2005). This approach is instrumental to developing economies as there are no massive funds required in its implementation. Therefore developing a new standard of measuring, or technique and analytical framework that will make integration easier for cities (Jeffrey & Geary, 2004) in the transportation sector with both developed and developing economies is very much required. This is due to disregard of the 'green' and concentrating on energy efficiency in public transportation infrastructure paying little attention to improving livability and urban happiness through expanding the dimensions of nature (Beatly, 2010).

The aim of this paper is to provide a comprehensive review of green infrastructure in transport planning as could be seen in African cities. It is noteworthy that a number of studies on green infrastructure over the last decade with little focus on the transportation sector. There also exists a gap on finding an integrating framework on green infrastructure to transportation development in African cities. This paper suggests steps that can be taken to address this gap. This paper builds on existing literature in developed countries. This is followed by a discussion of existing general practices approaches that could be employed in integrating the concept of green infrastructure in transportation planning. The research concludes on selecting an adaptable approach to the geography of African cities. On that note, the current challenges, on-going progress and sectors that need further research are outlined and discussed.

3. Methodology

The paper is a desk-based review of a number of articles focused on green infrastructure transportation development in African cities with emphasis on Nigeria and South Africa in order to identify salient issues in green transport infrastructure with relation to the concept and why integration into policies have proved challenging till date. This paper also reviews different conceptual framework for green infrastructure that has been designed by developed countries and that could be adapted into the Nigerian transportation sector. It further recommends a framework(s) or a guide to develop one to be adapted into cities in Africa in their transportation policies to ensure sustainability.

The review begins by defining green infrastructure and analyzing the cost and benefit of this approach to its counterpart, traditional infrastructure. It further reviews the concepts and theoretical framework supporting the green infrastructure generally and relating them to the transportation sector. The review concludes with a short summary of the lessons learnt.

4. Overview

a. Defining Green Infrastructure

The concept of green infrastructure has been defined by many authors and professionals but before attempting to define this, it is imperative to understand, an understanding of its counterpart, the traditional or gray infrastructure. Thus, gray infrastructure refers to the sub-structure system such as aqueducts, traditional road pavements, pipelines on which the development of a city depends (Mell, Roe & Davies, 2009). Whereas green infrastructure is a network of multi-functional green spaces, both new and existing, both rural and urban, which supports the natural and ecological processes and is integral to the health and quality of life of sustainable communities (TCPA, 2008) Simply put, green infrastructure can be said to be the concept of adapting traditional infrastructure respecting and paying attention to nature, ecology and its principles. The term 'green' may mean different things to different people. It can be grouped into two forms, green (nature, trees) and the engineered structural part such as bicycle parts, public transportation infrastructures using renewable energy sources, viaducts etc that are designed to be environmentally friendly (Benedict & McMahon, 2006).

Also, green infrastructure on transportation sector follows some outlines which includes low carbon infrastructure, climate resilient, transport infrastructure, public transportation systems, renewable energy, water conservation infrastructure with improved irrigation systems.

b. Cost Benefit Analysis of Green & Traditional Infrastructure

There has been reluctance by cities especially in Africa to attempt the integration of G.I into policies (Rohde and Muller, 2015). Due to the doubts on the positive implications on economic development. However, the question of the feasibility of green infrastructure as a good instrument for economic development is not debatable as it does not only save the environment, it helps achieve sustainable development and promote urban happiness. As could be seen in Gauteng city-region, South Africa and some other cities where G.I was used to address local transportation challenges in South Africa.

The European commission posited that the main feature of the Green Infrastructure Strategy is its integration into relevant policies through: ecosystem-based adaptation into climate change policies; nature-based solutions into research and innovation policies but the onus lies in providing an adaptable framework that will support such integration sustainably.

A recent study shows that the there is only an increase of between 0% and 7% construction costs per year (see table 1 below). The table further showed that in the transportation sector, the global increment cost of switching from traditional infrastructure projects to green infrastructure projects is would be between US$ 0 billion to US$ 400 billion per year between 2015 and 2020 which is insubstantial compared to the cost of rehabilitation and reconstruction projects for a city to recover after a climate change hazard. Also for Sub-Saharan Africa, North Africa and South Africa where the level of infrastructure is already low, even though measurement of such data is challenging due to lack of adequate research in that area. Also even with the inadequate data, it is seen that the additional cost of adapting infrastructure is minimal. World Bank (2010), noted that only cost between 5% and 7% more than would have otherwise have been spent, whilst maintenance costs would be 30% for traditional structures for climate resilient structures.

Table 1: Global Traditional vs. Green Infrastructure Costs 2015 - 2020

Sector	Traditional Infrastructure Cost (US$ Billion / year)	Green Infrastructure Cost (US$ Billion / year)
Power Generation	320	380
Electricity Distribution	270	260
Buildings	320	620
Industry	280	310
Water	772	772
Telecoms	646	646
Road	245	< 245
Transportation Vehicles	3,300	3,370
Rail	120	120
Airports	120	< 120
Ports	40	40
Oil & Gas Distribution	155	< 155
Total	*6,590*	*6,500 - 7000*

Source: OECD (2012)

Generally, it is important to rethink the way infrastructure provision and development are envisaged in African cities through green infrastructure. This is because it has the ability to deliver such services using a flexible planning approach that could be tailored to address pecific challenges unique to African cities (Culwick and Bobbins, 2015). Moreover, it can be said to require less capital budget and provide additional benefits compared with the use of sole traditional engineered infrastructure. In other words, the concept can aid in the enhancement of services delivery and minimizing disaster risks and protecting the environment. Due to the effects of climate change on the environment, African cities are in need of a more resilient approach to adapt to these effects. Also, with the contribution of the transportation sector, the encouragement of integrating green infrastructure is very important.

c. The State of Urban Sustainable Transport in African cities

Urban population has been rapidly growing and with the galloping urbanization therein, the growing demand for urban transport services, facilities has also been simultaneous. The existing transport facilities are inadequate to support the current population, let alone the future (Pirie, 2013). Previous study shows that the population of Abuja (Nigeria), Accra (Ghana), Kampala (Uganda), Johannesburg (South Africa), Dar es Salam (Tanzania), Kumasi, Nairobi (Kenya), etc., are predicted to double more between 2000 and 2025 and to triple by 2050 (InHabitat, 2010).

The inadequacy in transportation services and infrastructure has a major contribution on the slow growth of the economy as congestion slows down efficiency and economic growth (Piere, 2013). In Dakar, for instance, it is estimated that 1 million working hours are lost per day due to congestion (Kunieda and Ganthier, 2007). And with the population growth and the effects of climate change, major Africa cities will have their economies suffering more economic issues in the nearest future. The existing transport infrastructure is insufficient and inefficient as the low capacity in government hinders efficiency in service delivery, increasing the growth of private transport. Moreover the existing infrastructure are seen to be more socially exclusive, environmentally unfriendly and economic promoting (United cities and local governments, 2009). Generally, urban mobility is seen to be very low as it varies from 1.7 trips per person per day in Morogoro (Tanzania) to 1.9 in Dar es Salam, 2.2 in Kinshasa and Nairobi (Pirie, 2013). In this regard, due to the effects of low mobility on the economy, the normal response to this is to construct more road space, buy more vehicles. This is the frequent encouragement of the traditional infrastructure without much focus on the effects on the environment. This frequent response of government to the transport needs of people addresses the symptoms, abandoning the root causes of these issues. Over the years, focus

has been always pointed at promoting traditional infrastructure through motorized mobility. However, gradually, a wake has been seen in most African cities as there is seen to be a shift to affordable, socially equitable accessibility using appropriate technology in line with the principle of sustainable development (Pirie, 2013).

Although this shift is gradual and limited to few cities, a challenge presents itself in filing the gap of providing a formidable framework that will aid the integration of this green infrastructure concept into transportation planning policies as an adaptive tool to the effects of climate change.

d. Green Infrastructure

Green Infrastructure emerged after various attempts to incorporate climate change issues into international political agenda in the 2000s brought energy (Irek and Thomas, 2008) and resource efficiency to the center of the discussion on sustainable development and city sustainability. With the population growth, urbanization and uncontrolled expansion of cities into urban sprawl, discussions have been ongoing in international communities in the search or new concepts and methods to define and measure city sustainability. The above mentioned further led to the development of the concept green infrastructure. From the 1990's other concepts such as sustainable city, green urbanism, liveable city and compact city among others were propounded. While most of them are still current, and are very much in the center of most debate, this term with regards to transport infrastructure due to its major contribution to climate change. Hence, it also borders on energy use and resource efficiency prompted this focus on 'green'. This is because it has a bearing on sustainability and eco-friendliness. In South Africa a framework for assessing and valuating green infrastructure was designed by Groot et al, (2012) to support the different strategies designed and also ensure successful integration of this concept into different sectors especially the transportation sector. This could also serve as bedrock for most cities in developing their own indigenous frameworks (figure 1).

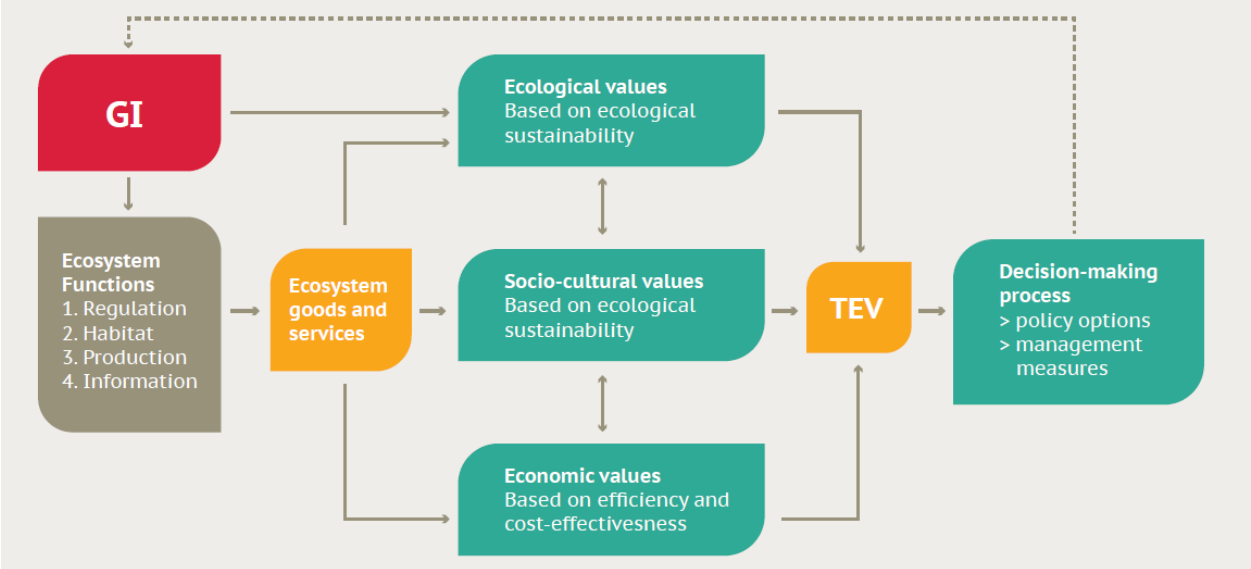

Figure 1: Framework for assessment and valuation of green infrastructure
Source: Based on De Groot et al. (2002:394).

5. Concepts and Approaches

a. Specific Frameworks

Major groups like professional associations and world leaders have realized that the current infrastructures and urban planning paradigms have been an hindrance to achieving sustainable urban development and living (Novotny et al, 2010). Even though the role of

green infrastructure is well documented, it is difficult to integrate spatial planning approaches and green infrastructure planning in urban contexts let alone transportation planning. This is because land use decision making takes place within a broad framework driven by the demand for housing and other services. In South Africa for instance, as well as many African cities, green land uses generally are always competing against other urban land uses (Cilliers et al, 2011) and a proper understanding of the purpose of 'green' to our environment, has not been very relevant during planning decisions. Most sustainable projects and related researches deal with environmental processes at a regional scale which finds it difficult to be translated in a practical way to the local government level that has the task of implementing such projects (Cilliers and Cilliers, 2016). Globally green infrastructure in transportation development has limited conceptual framework which has made it challenging for its adaptation by most countries even in Africa. However, in the developed societies, many green concepts and approaches have been developed generally and will be further stated below

b. American Society of Landscape Architects (ASLA) Sustainable Sites Initiative Benchmarks and Performance Guidelines

This initiative is an interdisciplinary efforts established by landscape architects in the Lady Bird Johnson Wildflower Center at The University of Texas at Austin and the United States Botanic Garden to create voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices (Cilliers and Cilliers, 2016). This Sustainable Sites Initiative was funded by the Meadows Foundation and Landscape Structures (ASLA, 2009). The framework is presented in nine topics as represented in Figure 2. This is to show the plan outline starting from the selecting of site to the monitoring and innovation. The framework showed a detailed presentation of how the sustainable land design is integrated.

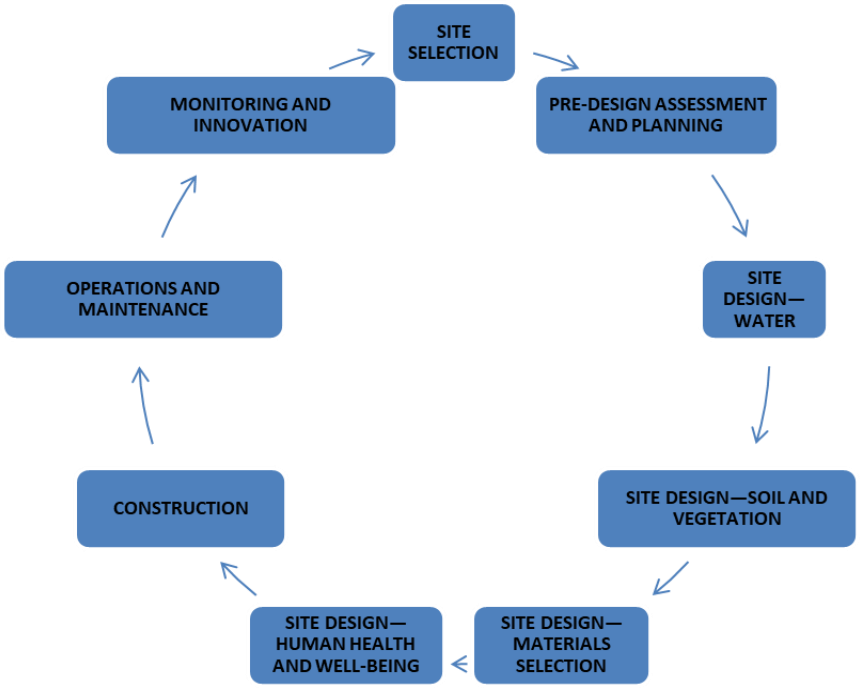

Figure 2: Sustainable Sites Initiative Framework
Source: ASLA, 2009 Benchmark and Performance Guidelines

This framework focused on achieving sustainable land design and landscaping functions which was limited to transportation development.

c. BREEAM

''BREEAM (building research establishment environmental assessment method) is a building certification system established in 1990. It is a method of environmental auditing, providing a set of standards for best practice in sustainable development for the design, construction, operation and environmental performance of buildings'' (Cilliers and Cilliers, 2016); The main criteria for calibration include measures affecting energy, water use, indoor environment, pollution, transport, materials, waste, ecology, and management processes (BREEAM,2012). In transportation, its aim was to ensure transport and movement strategies reduce the impact of the development upon the existing transport infrastructure and improve environmental and social sustainability through transport (BREEAM, 2012). In this framework, there was a breakdown of the assessment requirements and detailed activities but with limited considerations of how the local community and relevant stakeholders can take part in the different stages.

d. The LEED Concept

LEED is an internationally recognized green building certification system that provides third-party verification that a building or district was designed and built using strategies aimed at improving performance across all metrics (LEED 2012). It is preferred by urban development professionals in developed countries (Novotny et al, 2010). These metrics include energy savings, water efficiency, CO2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their effects (USGBC). There are six categories of certification: (1) new construction; (2) commercial interiors; (3) core and shell; (4) existing buildings; (5) homes; and (6) neighborhood developments. In the US, the USGBC manages the certification program while the Canada Green Building Council (CaGBC) manages the program in Canada even though both organizations are independent (Beauchamp and Adamowski, 2013).

As LEED is mostly dedicated to buildings, the USGBC has developed the LEED for neighborhood development (LEED ND) rating system to guide and assess sustainable community development (Beauchamp and Adamowski, 2013). The 2009 LEED ND, for example, is a set of performance standards for certifying the planning and development of new neighborhoods. The intent is to promote healthful, durable, affordable, and environmentally sound practices in building design and construction. Prerequisites and credits in the rating system address five topics: smart location and linkage, neighborhood pattern and design, GI and buildings, innovation and design process, and regional priority credit. The system was created as a partnership between the USGBC, the Natural Resources Defense Council, and the Congress for the New Urbanism (CNU) and registration opened in April 2010 (Beauchamp and Adamowski, 2013).

The CNU is the leading organization promoting workable, mixed-use neighborhood development, sustainable communities, and healthier living conditions and is one of the major leaders of LEED. The CaGBC has developed the Canadian Alternative Compliance Paths (ACP) for the LEED ND 2009 rating system (Beauchamp and Adamowski, 2013).. The ACP are formally approved approaches that provide clarity and guidance for Canadian projects, addressing sections of the rating system that contain US-specific standards or wording (CaGBC, 2012). The approach herein was designed using a rating system where projects are accredited. Following the registration of such project, the design team begins to collect information and perform calculations to satisfy prerequisite and credit documentation requirements. The basic steps outlined in this approach includes site analysis and programming, preliminary planning and final design. However, transportation networks were fully incorporated during the preliminary planning and its interaction with land use before the final design. This approach is much more used in the United States of America (Sarte, 2010). However, the lop sides to this approach is that it focuses mainly on new development and cannot be adapted to brownfield development and initiating a project form these criteria

remains very tedious. Despite all these, it could serve as a benchmark for similar societies to develop their own strategies and frameworks therein

e. US Environmental Protection Agency Green Approach; Municipal Handbook

The EPA has developed a *Municipal Handbook* (USEPA, 2012), a series of documents aimed at helping local officials implement GI in their communities. The documents cover specific terms to help municipalities introduce GI in the design of storm management facilities. (Beauchamp and Adamowski, 2013). One chapter identifies and discusses the most common funding options available to communities for funding green storm water infrastructure, storm water fees, and loan programs. Another chapter covers street design and various other topics are also discussed. Additionally, the EPA has developed the *Water Quality Scorecard* (USEPA, 2009). This approach does not address the local communities' integral participatory roles in green infrastructure development and has little focus on transportation sector.

f. The British Columbia Approach

In BC, the Rainwater Management and Green Infrastructure seminar was initiated by an inter-governmental partnership (IGP) on 11 June 2007. The Water Sustainability Action Plan for British Columbia provides a partnership umbrella for an array of on-the ground initiatives that promote a "water-centric" approach to community planning and development (Beauchamp and Adamowski, 2013). One of the tools developed under this umbrella is the water balance model for BC. Developed by an IGP (BC and Fisheries and Ocean Canada) as an extension of *Storm Water Planning: A Guidebook for British Columbia,* the water balance model enables users to visualize ways to implement GI solutions to achieve rainwater runoff source control at the site level. The Water Sustainability Action Plan for British Columbia is sponsored by the province of BC, and its elements are delivered through partnerships. Under the Action Plan umbrella, the Water Sustainability Committee of the BC Water and Waste Association is the managing partnership and is responsible for providing leadership, facilitation, and organizational services for program delivery (Beauchamp and Adamowski, 2013). Basic information is provided in a guidebook, refocusing the approach to sustainable ecosystem management. The use of the term "storm water" suggests there is a problem, whereas "rainwater" is seen as a resource (BCWWA, 2005). The past two decades has seen an evolution to an integrated approach.

The approach introduced the concept of performance targets to facilitate implementation of the integrated strategy for managing the complete rainfall spectrum (BCWWA, 2005). Rainfall capture means include measures such as rain gardens and infiltration soak ways, runoff controls (which delays overflow runoff by means of detention storage ponds), and flood mitigation (which reduces flooding by providing sufficient hydraulic capacity to "contain and convey") (BCWWA, 2005). Defining rainfall tiers simply enables a systematic approach to data processing and identification of rainfall patterns, distributions, and frequency. The integrated approach proposed (BCME, 2013) is presented in seven steps:
(1) Secure political interest and support;
(2) frame the watershed problems and opportunities through a land use working session, drainage working session, ecology working session, and interdisciplinary roundtable session;
(3) develop objectives and alternative scenarios through flood management scenario modeling and source control scenario modeling;
(4) collect meaningful data and refine scenarios according to concurrent rainfall and stream flow data, data on soils and groundwater, water quality data, and data on fish and their habitats;
(5) evaluate alternatives and develop component plans;
(6) develop an implementation program;

(7) refine through adaptive management.
BC's approach is one of the frameworks used for analysis and some of its proposals will serve as a platform or guide to developing a more efficient framework for green infrastructure.

g. Sustainable Infrastructure and Water Centric Sustainable Communities Approach

Contemporary studies have specifically examined the engineering of GI: in 2010, S. B. Sarté who conducted a research on 'Sustainable Infrastructure and Water Centric Sustainable Communities which was published by Novotny et al. (2010). Also Ahern (2010), who developed a six methodology water-centric approach to green planning. Sarté offers several forms of guidance for project planning, creating a unique approach for each project by combining different philosophy or development frameworks. Sarté identified 13 frameworks, the most popular being LEED and BREEAM which has been briefly discussed above. However four approaches were identified to analyze sustainable infrastructure and four existing frameworks to organize green projects were suggested as stated by (Beauchamp and Adamowski, 2013):

1. Framework 1: pillars of sustainability. This approach presents an analysis based on five elements: water, energy, materials, ecology and community. Analysis of the project is formatted in these terms and it is proposed to proceed with a development evolution of the design following five levels of progression.
2. Framework 2: the scale density framework. The approach is defined in four words: water, wastewater, energy, solid waste. The needs analysis is defined according to four levels: the city, the district, the block and the building. The organization becomes a pyramidal structure and presents an overall picture of the final proposal.
3. Framework 3: the transect. This approach defines territory into seven areas: T1 (natural), T2 (rural), T3 (suburban), T4 (general urban), T5 (urban center), T6 (urban core), and SD (special district). This approach is a form of territorial organization to establish a balance between each of the zones and to identify needs. The overall plan is determined based on a progression from one area to another by introducing measures of sustainable development.
4. Framework 4: the built form-ecology framework. This approach interconnects human actions with natural ecological systems. The method uses drivers to guide development. On the horizontal axis are biodiversity, water, air, land and energy. The vertical axis is divided into habitation/settlement, industry/resource extraction and recreation. The principle consists of establishing an equilibrium balancing all these elements according to the criteria in the appropriate box. All these approaches or developmental frameworks are elements of reflection appropriate to define a development project and to define a sustainable strategy.

However, none of these outlined frameworks define a formula to initiate a project and carry through to final detailed engineering.

Also, Ahern examined best practices for planning the urban environment in a sustainable manner. The proposal was on a water-centric approach to sustainable planning (Ahern, 2010). Ahern proposed this using a six step methodology: 1) ecosystem services (goals and assessments); 2) resilience factors; 3) resilience planning strategies; 4) developing scenarios; 5) urban resilience-sustainability planning; and 6) planning implementation–adaptation. (Beauchamp and Adamowski, 2013). However, this approach did not give a detailed description of how to achieve this, to the local institution level. It focused more on integrating the work of many professionals.

This study showed the various approaches and frameworks that have been developed for green planning and sustainable development but no framework has been developed with the

Green infrastructure in transportation development were more detailed in cities strategies which will be illustrated below

h. The Green Transport Strategy (GTS)

Due to the greenhouse gas emissions produced by the transport sector in South Africa and climate change issues, the department of transport in South Africa developed a strategy on how to reduce these emissions. This will contribute significantly to the national effort to reduce emissions as agreed to by the South African government at COP21 in Paris through the Nationally Determined Contribution (NDC). This will in turn reduce the environmental and human health impacts associated with the transport sector and result in a more resilient sector (Staatskoerant, 2017).

Following the Research undertaken by GIZ, SANEDI and a host of other research organizations on behalf of the South African government some conclusions that led to the establishment of the strategy arose. This focused on reducing the need to travel and avoiding unnecessary trips through walk able communities, integrated land use planning or transit oriented development and improving vehicle occupancy rates. Given that the road transport sub-sector is responsible for 86% of direct emissions from transport, shifting of passengers to public transport and freight to rail is a necessity (Staatskoerant, 2017). Finally, Biogas and solar powered electric mobility outstrip any other cleaner fossil fuel in terms of GHG reductions. In their strategy key measures to facilitate the modal shift from road to freight and private to public transport was identified. The strategy also stressed on the promotion of non-motorized transport and development of the associated infrastructure to support this plan

The GTS has identified and proposed key measures to facilitate the modal shift from road to freight and private to public transport. There also exists an important need to promote non-motorised transport and develop the associated infrastructure to support this. The strategy focused on 4 implementation themes and 8 strategic pillars (Table 2) and the implementation tools to support it was very comprehensive and the various stakeholder duties were outlined and addressed (Staatskoerant, 2017).

Table 2: Strategic Pillars of the Green Transport Strategy

Green Roads	1. Shift passengers from private to public transport, including rail 2. Shift freight transport from road to rail 3. Provide infrastructure to promote non-motorized transport
Green Rail	4. Extend the rail network to provide reliable, safe and affordable high-speed transport
Green transport technologies	5. Reduce the carbon footprint of fossil fuels 6. Promote alternative fuels such as compressed natural gas (CNG) or biogas, liquefied natural gas (LNG), fuel cell and liquid biofuels as transport fuels. 7. Promote electric and hybrid-electric vehicles 8. Explore the option of Fuel cell/ hydrogen technology
Green Fuel Economy Standards	9. Provide norms, standards and regulations that promote fuel

	economy in vehicles and improve emission standards of fuel in South Africa

Source: The Draft Green Transport Strategy, 2017

This strategy employs the use of measuring, reporting and verification (MRV) framework which is required to be developed by the person and team responsible for implementing each project on this strategy (Staatskoerant, 2017). This plan could be used as a platform for other African cities to adapt to their communities but focus was more on the engineered part of green infrastructure and little emphasis on the 'green' part of this concept. This neglect affects most strategies as it is assumed that it is an integral part without making it form a part of their strategy. Also at the local authority level, there was not a comprehensive breakdown regarding how they intend to be fully part of this strategy which when future frameworks are designed, that part should be addressed.

5. Conclusion

Most of the above listed frameworks were tailored specifically to satisfy the needs of designated professionals and public servants. Most of these frameworks focused on storm water control, landscaping, waste water etc. and the approaches to guide the design of these areas. But no designed framework on how to integrate green infrastructures into urban transportation planning when creating urban development. Also most of these concepts were focused on the engineered aspect of green infrastructure and little structure for the 'green' part of green infrastructure. The main thrust lies on individual countries to develop strategies and frameworks to support green infrastructure in their transportation planning design just as South Africa has done through mainstreaming as their draft green transport strategy. Nigeria is yet to develop a green transport strategy and their transport policy is yet to be reviewed as the 1993 transport policy is still in use and does not support the integration of green infrastructure. If this is neglected, transportation sector will continue to be a major contributor to greenhouse gas emissions and their contribution will keep increasing which is not good for the environment. Lagos state government has proposed an action plan for sustainable transport planning but has not been fully publicized for adaptation.
Borrowing a leaf from Cilliers, as done for planning green spaces in rural South Africa, there are areas that should be considered for a framework to border on. Hence this study recommends that to develop a framework for green infrastructure in transport development the following should be first considered,

a. Identifying the value of the green infrastructure proposed. This should be done within the local context, outlining the challenges and opportunities present in the specific areas and in Africa, the unique cultural needs of the people
b. Identify the framework to interlink both the traditional and green infrastructure in a sustainable manner. This is in order to defeat the fear that the later has come to remove the former totally from existence.
c. Identifying methods and beneficiaries of green infrastructure in those transportation sectors. This is one of the lacking issues in earlier frameworks. The beneficiaries for each transport infrastructure and mode should be identified and integrated fully in the design process.
d. Quantifying the value of green infrastructure design. This is very vital in the design process, and also in the decision making process. These issues will be quantified with regards to the indirect benefits which include the social values, environmental values, child and aged friendly transport networks and the direct benefits which include the economic values. This is to ensure that the projects are more sustainable.

Finally, this research shows that the proposal of green infrastructure in transportation design will meet the challenges of climate change and make the African environment more resilient to these effects. However, developing a framework based on these recommendations would form another topic of empirical study.

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