Global Scientific JOURNALS

GSJ: Volume 9, Issue 4, April 2021, Online: ISSN 2320-9186
www.globalscientificjournal.com

EXPLORING THE DESIGN OF TRANSPORT INTERCHANGE AS A SYSTEM FOR SUSTAINABLE MOBILITY.

Author Details:

[1]Braide Opakiriba Ibifuro.
+234 08068688019, braideopakiriba@yahoo.com,
Department of Architecture, Rivers state University, Nigeria.

[2]Arc. Tonye D. Pepple.
+2348033100431, tdpeppleassociates@gmail.com
Department of Architecture, Rivers state University, Nigeria.

Abstract

Since the introduction and adoption of the Kyoto protocol on 11th December 1997, there has been a popular theory amongst urban researchers and intellectuals 'that each generation is merely a custodian of this planet, and that earth and its biosphere should be passed on to future generation intact and undiminished'. Many jurisdictions of developed economies of the world have responded to the emerging global threat of climate change by incorporating, as public policy, the principle of environmental sustainability as an additional yet fundamental project objective. We find ourselves today in a society where one of the objects of success is owning your means of transportation i.e. cars, private jets, yacht, etc.; yes for obvious reasons, that could be true but if every individual has to depend on private vehicles for transport, apart from the environmental issues associated with it, it comes with lots of accidental risks and puts both the urban and rural development in jeopardy. Transport interchange also called intermobility, amongst every other initiative, holds the key to mobility problems in urban and regional areas and aids the pursuit of sustainable mobility, accessibility and sustainable development. This paper carefully examines the existing typologies of transport interchange and proposes desirable systems for sustainable mobility. It further explores the functions of the different zones required for a public transport Interchange (PTI) to function properly and the role it plays in intermodal mobility.

Keywords:

Sustainable mobility, sustainable development, intermodal transport, public transport interchange, urban transport interchange, transportation, city-hub.

1.0 Introduction and Background

The transportation of people and goods account for nearly a fourth of global carbon dioxide emissions, making it one of the greatest challenges facing cities today but it also presents a greater opportunity for low carbon urban development. Cities around the world have begun to recognize these opportunities and are busy transitioning from the current fossil fuel dependency to a future built on energy efficiency and renewable energy. A gradual shift that protects the plant while improving people's lives. Mobility is one of the most important aspects that influence climate change, air quality and especially the quality of life of citizens.

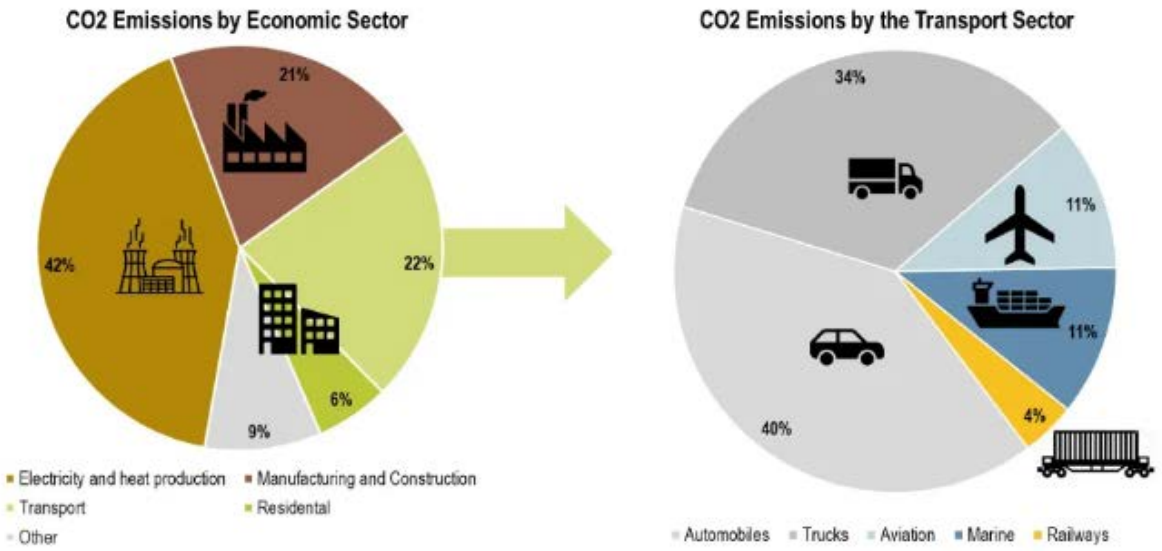

Figure 1.0 Global Greenhouse Gas Emissions by the Transportation Sector. (Rodrigue, 2020)

Historically, urbanization has become entangled with growing ecological footprints and in particular, the growing use of fossil fuels. So urban dwellers, people living in cities, currently account for more than 70% of the world global carbon emissions! It does not have to be that way. So I will say one of the problem with urbanization today is that 'we are not really tapping to the potential of building cities that will radically reduce carbon footprint while improving wellbeing'. We know we have a huge opportunity today because we will have over the next 30 years historical unprecedented growth of urban areas that almost double the current global population; and if we could get those cities right, it means we could create a lifestyle for people in cities that have very low carbon footprints. People can still have a better quality of life with greener cities, allows more physical exercise like biking, walking etc. and not having to drive 1ton of steal every time you're going somewhere, and people being able to use smart collective transport and ability to regain areas that have been previously occupied by cars and unwanted buildings. All the new urban areas need to be constructed with the best available technology and using the best urban practices.

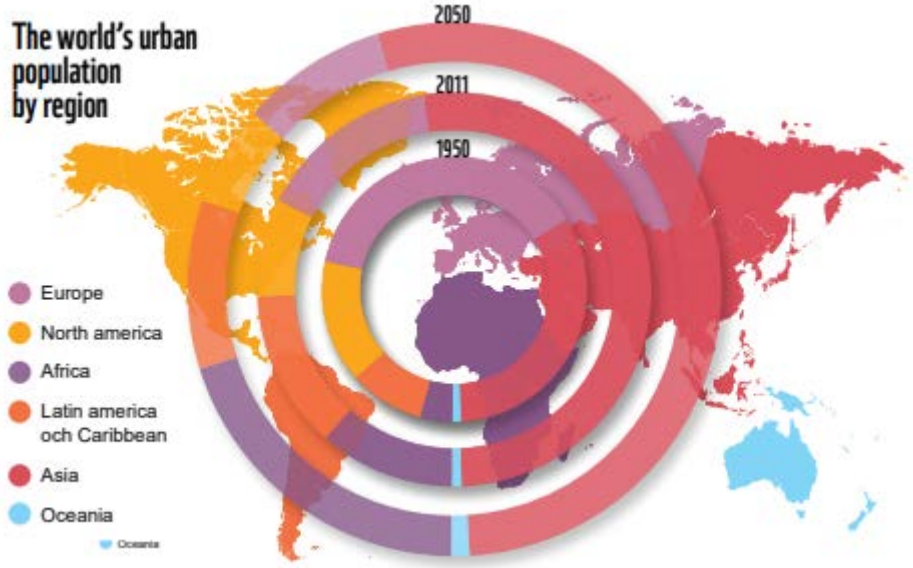

Figure 1.2 the world urban population by region. (WWF (world wild fund for nature), 2020)

One of the toughest environmental and social challenges of our time is managing the mobility of people and goods. By 2030, freight volume will grow by 70% globally and the number of vehicles on the road is expected to double by 2050. (World Bank Group, 2017). Having a long term perspective which focuses on sustainability is a defining factor in the future of mobility. The main focus of this research paper has been to use this material as a catalyst for the generation of innovative ideas and discussion points for new research in the area of sustainable mobility.

The world's cities are expected to grow by 65 million inhabitants per year between 2010 and 2025
(WWF (world wild fund for nature), 2020).

1.1 Public transport Interchange (PTI)

Public transport Interchange (PTI) can be defined as a purpose-built facility which offers the possibility and flexibility of passengers and goods to transfer from one mode of transport to another i.e. from the road to air, rail to bus, etc. as distinct from the conventional single-mode station facility with no capacity to interchange with other transport services. An interchange design may provide clear routes between services or modes to minimize the time and efforts involved in making a transfer. Passenger boarding routes have to be clearly and consistently identified. The use of visual aids, architectural treatments on the floors, walls, finishes, etc. can provide better "wayfinding information". However, interchange design may take care of accessibility requirements of impaired passengers for seamless travel. The general guidelines for interchange design are as follows:

- Need assessment of interchange in the transport network to fulfil its functions as per travel demand and mobility in different directions and areas.
- Location of interchange on existing line hauls where there is efficient access to the existing transport network. However, it may be located in places of high accessibility.
- Location of interchange be associated with public space
- Improvement of existing roads/construction of new roads
- Access modes in order of priority i.e. walk, bicycles, feeder services, intermediate Paratransit, etc.
- Size of interchange to meet expected peak demand
- Interchange facilities and services
- Perceptions and attitude towards the interchange
- Public awareness to encourage people for using of interchange
- Provision of automatic services at an interchange station
- Layout for seamless transfer with comfort, security and commuter's safety

(Pawan , S.Y.Kulkarni, & M. Parida, 2019).

The different modes of interchange can be categorized as follows

- Road-Road Interchange
- Road-Rail Interchange
- Road-Air Interchange
- Road-Water Interchange
- Road-Rail-Air Interchange
- Interchange Over space (different terminals located within the same building).
- Interchange over Distance (different terminals located at a considerable distance).

1.2 Sustainable Mobility

The concept of sustainable mobility clearly, has now become a major issue for transport. Transport is a key factor in attempts to increase the degree of sustainability in our societies which have a direct effect on all the negative impacts that can be measured i.e. environmental impact, social impact and economic impact. To better understand the concept of sustainable mobility, we must first understand 'sustainable development' and 'mobility' in its simplest thought. Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Mobility in the other hand simply means the seamless movement/transportation of people and goods from one point to another.

Therefore, sustainable mobility *is "a development that guarantees the movement/ transportation of people and goods from one point to another which is consummated through different modes i.e. road-rail, road-rail-air, road-water etc. created in a way that respects the safety and the environment, ensures the provision of life's material needs and guarantees fairness among individuals."*

For the transportation system to be sustainable, it should be socially equitable, support civil rights by allowing all people to gain access to jobs, education, training, and needs (Morency, 2013). Expenses in transportation should be minimal to support capital creation and augment integrated land use planning. Transportation should also improve the quality, liveability and character of communities and participation by all, including distressed communities. Essentially, a socially equitable transport system should meet the needs of the marginalised (African Development fund, 2013)

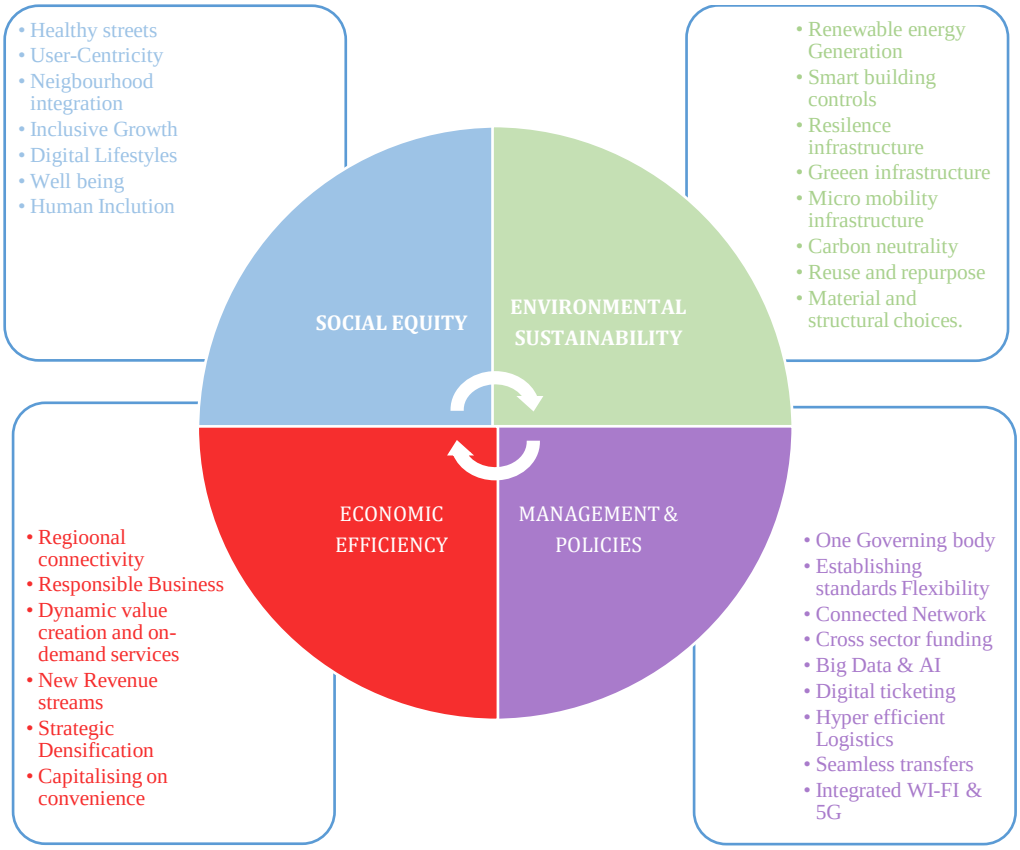

Figure 1.3 Desirable systems for sustainable Public Transport Interchange (PTI)

The diagram above is further explained in section 2.0 of this research paper.

1.3 Statement of Problem

Global passenger use of public transport is expected to increase by up to 300% by 2050, while the transport sector as a whole is already the fastest-growing contributor to climate emissions. Stations, as the gateway to mass transit, have a vital role to play in enabling the former and combating the latter.

1.4 Aims and Objectives

The aims and objectives for this research paper are as follows:

I. To create awareness to the ready of the possible harm of our current transport system and the need to be pro-active and adopt an agile approach toward mitigating the negative effect it could cause to our future existence.
II. To provide material of knowledge, as a catalyst for the generation of innovative ideas and discussion points for new research in the area of sustainable mobility.
III. This research works aims at proposing desirable systems that can be adopted into different mode and scale for the development of a sustainable interchange for now and the future.
IV. To explore different existing models of Public transport Interchange (PTI) and how it was used to solve mobility issues sustainably and efficiently to meet the needs of a growing urban population.
V. This research paper is aiming to provide guidance and recommendations for constructing, managing, operating and using an interchange to enable seamless mobility, travelling efficiency, user satisfaction and performance

1.5 Methodology

An exhaustive qualitative research approach was done to get relevant pieces of information for this topic. The European project City-HUB had as main objective to provide a model to develop new or enhanced interchanges. This research has carefully analysed two case studies namely: EcoFrota Programme (São Paulo, Brazil) and Metro-bus BRT System (Istanbul, Turkey) carried out by City-Hub in 2015 based on the analysis of the current practice.

2.0 Systems for sustainable mobility

The main focus of sustainable mobility is to find ways to facilitate the movement of persons and goods in agreement with a strategy of sustainable development. One of the greatest environmental challenges we face today lies in mobility. People need a seemingly infinite network of vehicles and transportation systems to uphold societies and economies. Cars. Busses. Trains. Trucks. And other modes of transport each leaving their indelible mark on the environment. Sustainable urban mobility requires a mind shift: where transport in private cars and trucking give way to different modes of public transport. Like bicycle and pedestrian lanes, electric vehicles, car-sharing and rail freight. More and more cities around the world are rising to the challenge. Creating solutions that ensure the vital flow of people, goods and services. While mitigating climate change and creating climate-safe cities (WWF (world wild fund for nature), 2020). In other to fully actualize a sustainable public transport interchange, we need to highlight four major systems for ensuring a successful sustainable mobility project. Figure 1.3 above, shows a clear description of these four desirable systems of sustainable mobility and strategies that could be adopted to actualize them.

a) **Social Equity**: Access to mobility is a basic need for all. However, If thoughtfully deployed, shared mobility solutions and extended public transit (and a smart combination thereof), can enable those who don't have access to a private vehicle to be mobile. This is a critical contribution as it facilitates social inclusiveness, such as finding and holding a job outside one's neighbourhood.
b) **Environmental sustainability:** Globally, we are depleting natural resources about twice as fast as they are generated. According to the International energy agency (IEA, 2017), transportation accounts for 58% of all energy consumed on planet Earth. According to the International energy agency (IEA), the amount of energy used by transportation is expected to drop by 39% by 2040 and represent 50% of global energy consumption then. This is still a sizable share. This very significant reduction requires a massive shift from internal combustion to electric powertrains. . Increased biking and walking for short distances instead of driving will go a long way in urban centres. It is also necessary to use less energy per km travelled by increasing the density of transportation (mass transit). This transformation can be actualized in time with a massive shift from fossil fuels to renewable energy sources and an aggressive campaign for building professionals to start designing and construction with reusable materials than can also be repurposed.
c) **Economic Efficiency:** Mobility solutions that deplete very little natural resources and increase social inclusiveness which in turn, do not have to be less worthy. Direct economic benefits include enabling more people to work, thus increasing tax revenue while reducing welfare costs. Sustainable mobility brings about efficient regional connectivity, new revenue streams, and responsible businesses and capitalizes on convenience. The implementation of congestion charges, carbon permits, EV credits or mobility-related taxes (fuel tax, toll, etc., to invest in our infrastructure) allows for a better representation of the total cost of a given mobility mode, thus enabling for modal decisions to progressively steer mobility towards sustainability. (Urban Mobility Company, 2019)
d) **Management and Policies:** Transport interchanges are one of the urban design challenges of our age. Just as the nineteenth century grappled with bringing railways and canals into cities, today we face the challenge of high-speed rail and integrated transport. Rather than see transport planning primarily as infrastructure provision, it is necessary today to view this within the wider embrace of sustainable development. Then social, economic and environmental considerations can help direct transport investment towards the most beneficial ends. Social regeneration can act as a partner to economic renewal if the right plans and policies are put in place. Government has a key role to play in directing investment and in ensuring some of its own space needs are met near interchanges. Institutionalizing a corporate body responsible for transportation matters for both local and national level, establishing codes and standard flexible enough to change with growing needs and incorporating big data and AI (artificial intelligence), digital ticketing, hyper-efficient logistics systems etc. can help to keep track of all transportation activities and suggest reports for future amendments to enable a continuous seamless transfers.

2.1 Functional Zones for Public Transport Interchange (PTI)

There are various factors associated with transport interchange; which includes but not limited to integrated management, the relevance of different typologies, essential and desirable features, and the different zones of the interchange. The kind of services provided is key to the success of the transport interchange and should meet with the growing needs of users and established policies based on research already done, to accommodate the space available. Three different zones can be identified within a transport interchange: the Access/Egress zone,

Facilities and Retail zones and the Transport/Transfer zone, each with a different focus of service. Figure 2.1 below clearly shows the different zones identified within an interchange and their relationships as well as possible services located in each zone.

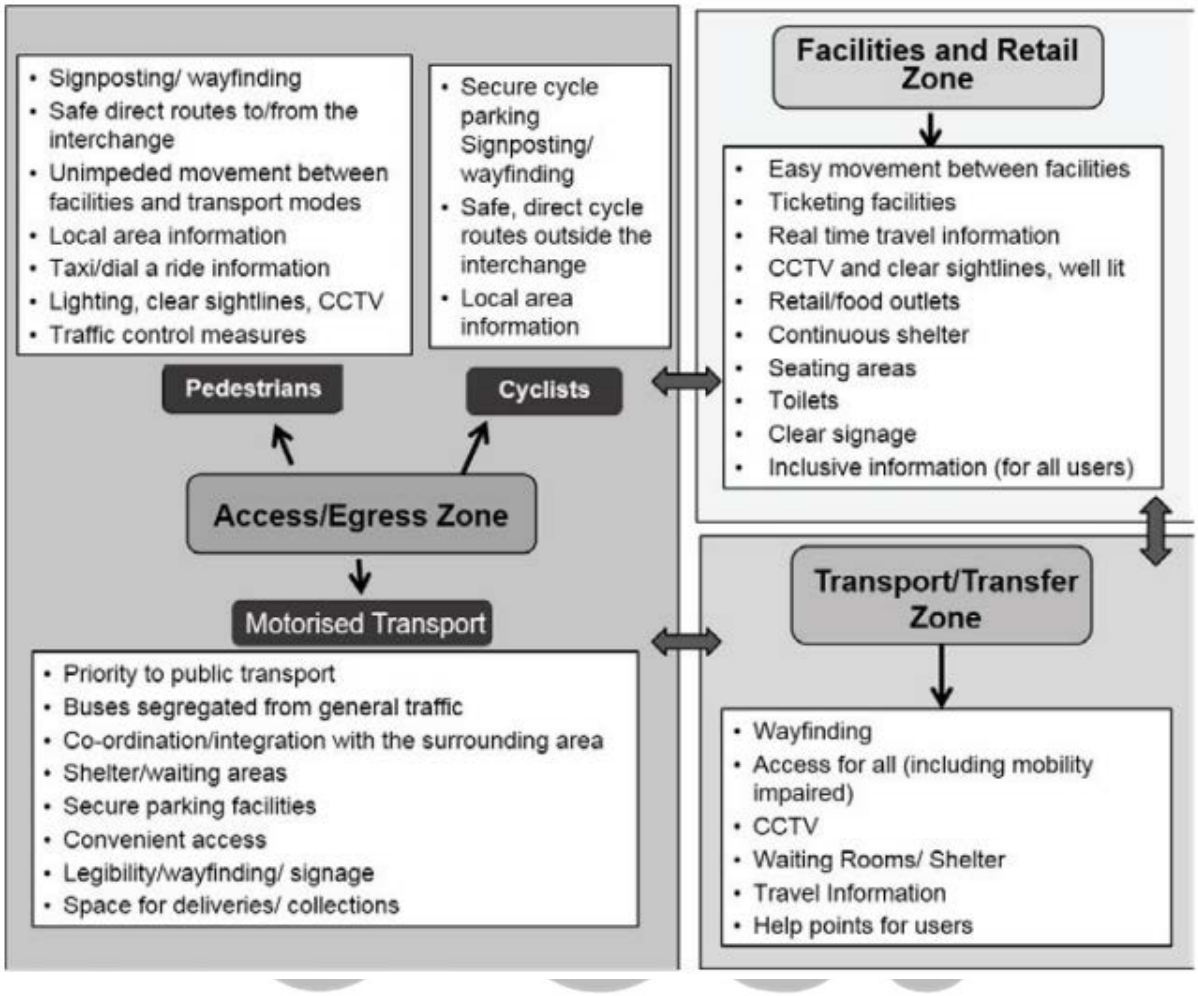

Figure 2.1 interchange zones showing relationships and possible facilities in each zone. (Andrés Monzón, Sara , & Florida, 2016).

a) Facilities and Retail Zone: This zone is more like a leisure area within the interchange where users have more time to spend while waiting. Activities such as shopping, eating, toileting, seating, seamless movements, all take place within this area. This zone also covers ticketing facilities and should provide real-time information's, transit, traffic and weather reports to ensure users are kept up to date with any delays or change to their travel request.

b) Transport/Transfer Zone: Hear, accessibility for all is a major concern. This can be best achieved by integrating good design and technology to ensure seamless transfer of users and goods between the different available modes. Waiting rooms and shelters fitted with CCTV for security should be available to travellers, with up to date travel information, signage and posters/banners should also be placed at strategic points for easy navigation.

c) Access/Egress Zone: this zone should provide facilities and services to accommodate different users arriving and leaving the interchange: pedestrians, rails, cyclists and motorised transport (such as taxi or kiss and ride). Key facilities such signposting and way-finding; direct routes for pedestrians and cyclist with traffic control measures (such as pedestrian crossings where necessary); and information about the local area. Technologies for assistive movement and traffic control should also be made available. Shelters for those waiting for public transport modes, and security for all parked vehicles, bicycles etc.

All these three zones are used by travellers but with different ends and requirements. Different type of users would have different priorities. The users are different according to their characteristics (age, professional activity, physical constraints), according to their trip (motives, mode, peak-time or not) and the use of the services and facilities at the interchange. All these should be also analysed and feed the business model of the interchange.

3.0 Case Studies

The European project City-HUB had as main objective to provide a model to develop new or enhanced interchanges. This research has carefully analysed two case studies namely: EcoFrota Programme (São Paulo, Brazil) and Metro-bus BRT System (Istanbul, Turkey) carried out by City-Hub in 2015 based on the analysis of the current practice.

3.1 EcoFrota Programme (São Paulo, Brazil): The Program "EcoFrota" had its origin linked to the objective of meeting the requirements of the Law 14.933/09 Climate Change in the City of São Paulo in June 2009. It recommends that the entire system of public transport in the city should operate with renewable fuel by 2018 and, from 2009, gradually reducing the use of fossil fuels by at least 10% each year. The technologies to achieve this goal are varied, including biodiesel, ethanol, sugar cane diesel, electricity-powered engines, hydrogen, hybrids and battery technologies. The diversity of technologies brings several advantages, such as the better distribution of the energy matrix, further development of technologies, the best option of choice due to the cost/benefit/use and, finally, lower costs due to competition. The Programme was launched in February 2011. By February 2012, the Ecofrota already had more than 1,600 buses, divided into 200 lines, which corresponded to 11% of the total fleet of the municipality (15,000 buses). During this period, there was a 6.3% reduction in emissions of pollutants and a 6.7% in CO2 emissions the changes thus far in energy usage bring benefits to the city's economy, the quality of life of its inhabitants and the preservation of its environment. (Pasquale, Adriano, & Michele, 2016).

3.2 Metrobus BRT System (Istanbul – Turkey): Istanbul is one of the largest cities in Europe with a population of over 14 million people who generate over 20 million trips per day. More than half of these journeys are made using motor vehicles, with 21% by private cars, causing significant levels of congestion during peak times. Like other megacities, Istanbul has to meet the challenge of satisfying a rising demand for accessibility within a context of growing sustainability concerns. Metrobus is a 24-hour BRT (Bus Rapid Transit) scheme, travelling from Beylikdüzü Tüyap in the west of the city to Söğütlüçeşme in the Anatolian area of the city. This 52 km journey (constructed in four steps), which initially took 180 minutes, now takes an average of 100 minutes, with a frequency of 30 seconds. The buses utilise hybrid technology to help reducing emissions and improving energy efficiency. Daily ridership is approximately 800,000 – the system is highly popular as it provides a high-frequency connection across Istanbul especially on the weather that doesn't allow using the waterway. Moreover, the integration with other transportation modes and the implementation of "distance-based fare" promoted the usage of the system. (Pasquale, Adriano, & Michele, 2016).

4.0 Conclusion and Recommendations

Beyond the obvious actions a city must take, citizens themselves must have to change the way they look at their cities and use that as a condition to build a more sustainable way to live. Adopting solutions to local conditions enables cities to provide transportation options to people in low-income areas, thereby setting up a whole chain of positive outcomes such as better access to services, as well as the local job markets.

From an economic perspective, is very much connected between transport growth and GDP growth. We can make both people and cities grow, as well as business and countries grow, but with a reduced CO^2 footprint and that's where sustainable transport solution comes in; where you can combine economic sustainability, environmental and social sustainability.

Stakeholders engagements are the key to success as we aim to significantly lower greenhouse gas emissions particularly in the area of sustainable urban mobility. We need to see engagement's at all levels and throughout society decision-makers who dare to implement bold public policies, innovative companies that contribute to the creation of people-oriented low carbon solutions.

References

Allan, A. (2014). Sustainability and the Design of Transport Interchanges. *Construction Management and Economics, 32*(3), 313. doi:10.1080/01446193.2013.877149

Andrés Monzón, Sara , H., & Florida, D. C. (2016). Efficient urban interchanges: the City-HUB model. *6th Transport Research Arena* (pp. 1124 – 1133). Barcelona, Spain: Transportation Research Procedia.

ARUP. (2020). *Future of stations.* London: Kingsbury Press.

European commision. (2016). *Final Report Summary - CITY-HUB (City-Hub).* Madrid, Spain: City-HUB.

MGS & Architecture. (2020). *interchange design for seamless travel*. Retrieved from Modern green structures and architecture: https://www.mgsarchitecture.in/building-materials-products/articles/444-interchange-design-for-seamless-travel.html

Mohieldin, M., & Vandycke, N. (2017, July 10). *Sustainable Mobility for the 21st Century*. Retrieved from the world bank group: https://www.worldbank.org/en/news/feature/2017/07/10/sustainable-mobility-for-the-21st-century

Morency, C. (2013, Febuary 12). *Sustainable Mobility: definitions, concepts and indicators.* Retrieved from Mobile Lives Forum: https://en.forumviesmobiles.org/video/2013/02/12/sustainable-mobility-definitions-concepts-and-indicators-622

Pasquale, G. D., Adriano, G. L., & Michele, T. (2016). Innovative public transport in Europe, Asia and Latin America: a survey of recent implementations. *6th Transport Research Arena* (pp. 3284 – 3293). Senigallia, Italy: Transportation Research Procedia.

Pawan , K., S.Y.Kulkarni, & M. Parida. (2019, December). *Interchange Design for Seamless Travel.* Retrieved from NBM & CW (Intra construction and equipment magazizne): https://www.nbmcw.com/tech-articles/others-article/18196-interchange-design-for-seamless-travel.html

Rodrigue, J.-P. (2020). Transport, Energy and the Environment. In J.-P. Rodrigue, *The Geography of Transport Systems* (p. 456 pages). New York: Routledge.

Urban Design Group. (2011). Transport Interchanges. *Urban Design Group Journal*, 12-20.

Urban Mobility Company. (2019, June 26). *The future of sustainable mobility: a three pillar approach*. Retrieved from Urban Mobility Daily: https://urbanmobilitycompany.com/content/daily/the-future-of-sustainable-mobility-a-three-pillar-approach

wwf (world wild fund for nature). (2020, 10). *sustainable mobility*. Retrieved from wwf.panda: https://wwf.panda.org/our_work/our_focus/projects/one_planet_cities/sustainable_mobility/

WWF (world wild fund for nature). (2020, 10). *sustainable mobility*. Retrieved from wwf.panda: https://wwf.panda.org/our_work/our_focus/projects/one_planet_cities/sustainable_mobility/