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Passenger transport in Nigeria: Environmental and economic analysis with policy recommendations

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HIGHLIGHTS

- ▶ The life cycle environmental impacts of passenger transport in Nigeria estimated for 2003–2030.
- ▶ The tradeoffs between economic costs and environmental impacts discussed.
- ▶ Scenarios considered: business as usual; sustainable transport; high economic growth.
- ▶ Public transport is more sustainable than transport by cars and motorcycles.
- ▶ Ending gas flaring would improve substantially environmental, economic and social impacts.

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ABSTRACT

This paper presents the life cycle environmental impacts and economic costs of the passenger transport sector in Nigeria for 2003–2030. Four scenarios are considered: business as usual (BAU); increased use of public transport (buses) at the expense of cars (LOWCAR) and motorcycles (LOWMC), respectively; and high economic growth with increased car ownership and decline of public transport (HICAR). The findings show that for the BAU scenario the life cycle environmental impacts double over the period, despite the assumption of increased fuel and vehicle efficiency of 35% over time. The total fuel costs at the sectoral level increase three times, from US\$3.4 billion/yr in 2003 to US\$9.7 billion in 2030. Increasing the use of buses would reduce the environmental impacts on average by 15–20% compared to BAU; at the same time, the total fuel costs would be 25–30% lower. If the use of cars grows much faster due to a high economic growth as in HICAR, the environmental impacts and fuel costs would increase by 16% and 26%, respectively. These results demonstrate clearly that future transport policy in Nigeria should promote and incentivise public (bus) transport as a much more environmentally and economically sustainable option than transport by cars and motorcycles.

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1. Introduction

The transport sector was globally responsible for 62% of world oil consumption and 25% of total final energy demand in 2011 (IEA, 2011). In Nigeria, the oil consumption by the transport sector is even greater, consuming 80% of the total petroleum products (IEA, 2008) and making it the largest consumer of fossil fuels in the country. Road transport dominates, accounting for over 90% of all transport in terms of kilometres travelled (FOS, 2004; CFA, 2005; Oni, 2010). This is similar to the overall average for Africa, with road transport contributing to 80% and 90% of goods and passenger movements, respectively (UN, 2009). In Nigeria, this is due to a

decline in other transport sectors, especially rail. For example, the number of rail passengers declined from 14 million to less than 1 million between 1980 and 2005 while rail freight decreased from 3 million tonnes to less than 500,000 tonnes within the same period (AfDB, 2007). This has led to an enormous pressure on the already inadequate and deteriorating road infrastructure in the country. For instance, only about 15% of the total 193,200 km of roads are paved (AfDB, 2006).

The high consumption of petroleum products in Nigeria translates into the daily sales volumes of about 26 and 4.2 million litres of petrol and diesel, respectively (NNPC, 2008; Mitchell et al., 2008). However, the four (Government-owned) refineries operate at about 40% of their capacity so that petroleum products have to be imported to supplement the demand (NNPC, 2006). For example, in 2005, the Government imported about 69% of the petrol and 43% of the diesel consumed in the country (NNPC, 2006). Given that all

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the fuel imports are paid for at international prices and are then subsidised for local affordability, this represents a significant drain on the country's already stretched financial resources.

The consumption of fossil fuels (mainly petrol and diesel) in the transport sector contributes 25.4 million tonnes of CO₂ or 50% of the national emissions; almost all of this (99%) is from road transport (IEA, 2010). Gas flaring adds further CO₂ emissions – this is a significant issue for Nigeria, since up to 75% of the gas extracted together with oil is flared (ERA, 2005; Sonibare and Akeredolu, 2006). However, this amount is gradually reducing and gas flaring in Nigeria is set to end in the near future (Nzeshi, 2010).

The huge dependence on road transport and a lack of an effective regulatory framework have also led to other societal concerns. Notably, the increase of motor vehicles from 1.3 million in 2000 to 2.2 million in 2004, representing an annual increase of about 17% (AfDB, 2006), has led to congestion in urban areas as well as increased noise and air pollution (Adegbulugbe et al., 2008), contributing to a wide range of health impacts (Krzyzanowski et al., 2005). The increase in road accidents is also a major concern; for example, an average of 18,387 cases of road accidents per year were reported between 2003 and 2007 with the number of fatalities averaging 8672 (NBS Nigeria, 2009).

With a population of over 158 million people (IEA, 2011), depending heavily on fossil fuel based transport, it is important to understand fully the environmental and economic impacts of the current passenger transport sector in Nigeria as well as how these may change in the future as the sector develops. Therefore, this paper considers the life cycle environmental impacts and economic costs of the passenger transport sector over the period 2003–2030. For these purposes, scenario analysis is used to explore possible ways in which the sector could develop. In addition to 'business as usual', three further scenarios are considered: two are based on sustainable transport development promoting public transport by buses, with one assuming reduced use of cars and another decrease in the use of motorcycles; the final scenario assumes increased ownership and use of cars at the expense of public transport. While there are numerous studies of the passenger transportation sector in different parts of the world, they are rarely assessed on a life cycle basis and even if so, only energy use and greenhouse gas emissions are considered (e.g. Eriksson et al., 1996; Bouwman and Moll, 2002; McCollum and Yang, 2009; Chester et al., 2010; Ou et al., 2010; Akerman, 2011; Hao et al., 2011; Croft McKenzie and Durang-Cohen, 2012). No such studies have been found in literature for Nigeria. Thus, as far as the authors are aware, this is the first life cycle assessment study of the passenger transport sector in Nigeria providing a full picture of the sector's environmental impacts from 'cradle to grave', indicating 'hot spots' and opportunities for improvements over the whole life cycle. This is also the first study showing the trade-offs between the life cycle environmental impacts and economic costs for the sector, aiming to inform future transport policy in Nigeria.

The paper is structured as follows: Section 2 provides a description of the current transport system as well as the scenarios considered; the results are presented in Section 3 and the conclusions and policy recommendations in Section 4.

2. Methodology

The methodology developed and used in this research is outlined in Fig. 1. As shown, it consists of three main steps:

1. definition of the current passenger transport system and future scenarios;
2. system modelling using life cycle assessment and economic (fuel) costs;

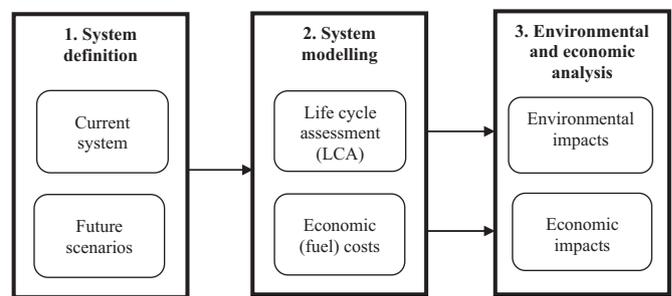


Fig. 1. The methodology used for environmental and economic analysis of the passenger transport sector in Nigeria.

3. estimation of life cycle environmental impacts and economic costs for the current passenger transport system and future scenarios.

These are described in more detail in the following sections.

2.1. System definition

The passenger transport system considered here is outlined in Fig. 2. The system boundary is drawn from 'cradle to grave', encompassing all activities from the extraction of crude oil to the production of petrol and diesel and use of the fuels for road and rail transportation. Both domestic and imported fuels are considered, as appropriate. Manufacture of vehicles and trains as well as the construction of roads, rail networks, pipelines, etc. are also included in the system boundary. The following sections provide more detail on the current transport system and the assumptions made in the definition of the scenarios.

2.1.1. Current passenger transport system

This study considers passenger transport within Nigeria and focuses on road transport as the major transportation mode in the country which, as mentioned earlier, contributes to over 90% of all passenger travel. Rail transport is also considered, although its contribution is small (0.25%). Domestic air and water transport are not considered due to a lack of data.

The characteristics of the current road and rail transport are summarised in Table 1, showing traffic volume, vehicle load factors and fuel intensities for different transportation modes and vehicles. Due to a limited data availability, the data from the ECN (2004, 2010) which refer to the year 2000 have been extrapolated to the year 2003 using the growth rate projections from the ECN. These data are considered fairly representative of the current Nigerian transport system as the overall characteristics of the sector have remained more or less constant over time (ECN, 2010). Some data on railway transport for the year 2003 have also been sourced from the FOS (2004). Therefore, for consistency and as a reference point for future scenarios, 2003 is considered as the base year throughout the work.

As shown in Table 1, the total number of passenger-kilometres travelled by road is 467 billion and 1.13 billion by rail. The large majority of travel is by bus (44.8%) and car (42.5%); motorcycle travel contributes 12.6% and rail only 0.24%. Intercity travel dominates in both bus and car transportation, contributing respectively 35% and 26% of all passenger travel. Over 61% of travel is by petrol vehicles and the rest by diesel.

The prices for the domestic and imported fuels used for the economic analysis are given in Table 2. As shown, the imported fuels are 35% more expensive but are subsidised by the Government to bring them in line with the domestic prices and so reduce

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