# Driving Side and Driving Side Change: An Overview of Costs, Benefits and Economic Implication

by

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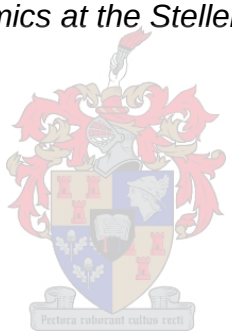


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**Declaration**

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the authorship owner thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining of any qualification.

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**Abstract**

The main goal of this study is to determine if there are any costs or benefits that can be associated with Right Hand Drive (RHD) countries and the Left Hand Drive (LHD) countries. This thesis first indicates world figures on driving side. This gives an overall view on how the world is divided between LHD and RHD countries. The research follows by focussing on countries that changed their driving side. The reason for changing driving side is investigated and assigned to either being economical, spatial or political of nature. Descriptive statistics on driving side are analysed (Gross Domestic Product (GDP), Gross Domestic Product per capita (GDP per capita), vehicle ownership and accident rates) to see if there is any difference in driving side with regards to economic indicators. The following chapter shifts to the African continent. Transport prices and costs in Africa are discussed, leading into final chapter. The final chapter considers the change of switching driving side for Rwanda and to make a possible recommendation.

The thesis concluded that most of the countries in the world are LHD. Countries that changed their driving side initially did so because of political reasons but change later became driven by spatial and regional integration reasons. The research shows that there are no statistical significant differences between the wealth of RHD and LHD countries in the world and that vehicle ownership increases at a diminish rate with GDP per capita. There is no indication that the driving side of a country will have an effect on its accident rate and vehicle ownership increases at a diminishing rate with GDP per capita. Africa is still largely divided and there seems to be no difference between LHD and RHD African countries with regards to economic indicators. Transport costs structures are very different to those of European countries and are more labour intensive. There are projects that aim to increase the efficiency of transport in Africa, but the research shows a lack of acknowledging different driving sides in the continent. The research for switching driving sides in Rwanda reveals significant cost savings with using RHD vehicles rather than LHD vehicles and switching driving side would be beneficial. If the decision to switch driving side is purely based on vehicle operating costs, switching from LHD to RHD vehicles will be economically beneficial for Rwanda.

**Opspomming**

Die hoofdoel van hierdie tesis was om vas te stel of daar enige kostes of voordele bestaan wat toegeken kan word aan ‘n land wat aan die linkerkant van die pad bestuur of ‘n land wat aan die regterkant van die pad bestuur. Hierdie tesis begin deur te kyk na die wêreld syfers met betrekking tot die stuurkant. Dit gee 'n geheelbeeld van hoe die wêreld verdeel is tussen linkerhand stuur (LHS) en regterhand stuur (RHS) lande. Die navorsing volg deur klem te plaas op lande wat hul stuurkant verander. Die rede vir die verandering in bestuurkant is ondersoek en toegeken as ekonomies, ruimtelik of politiek van aard. Beskrywende statistieke van LHS en RHS lande word (Bruto Binnelandse Produk (BBP), Bruto Binnelandse Produk per capita (BBP per capita), voertuig eienaarskap en ongeluksyfers) om te bevestig of daar enige verskil in die stuukant met betrekking tot ekonomiese aanwysers is. Die volgende seksie skuif na die Afrika kontinent. Afrika word gesien as die verdeelde kontinent met betrekking tot stuurkant. Die laaste gedeelte van die tesis handel oor die moontlikke verandering van stuurskant vir Rwanda en gee ‘n moontlikke aanbeveling daarop.

Die navorsing het getoon dat meeste van die lande in die wêreld LHS is. Lande het aanvanklik hulle stuurkant verander weens politieke redes, maar verandering in stuurkant is later gedryf deur ruimtelike en plaaslike integrasie. Die navorsing toon dat daar geen statistiese beduidende verskille tussen die rykdom van RHS en LHS lande in die wêreld is nie en dat voertuig eienaarskap toeneem teen ‘n verminderende koers in vergelyking met BBP per capita. Daar is ook geen aanduiding dat stuurkant ‘n invloed op ongeluksyfers het nie. Afrika is steeds grootliks verdeel en die data dui aan dat daar geen verskil, in terme van ekonomiese aanwysers, tussen LHS en RHS Afrika lande is nie. Vervoerkostestrukture is baie anders as dié van die Europese lande en is meer arbeidsintensief. Daar is projekte wat daarop gemik is om die doeltreffendheid van vervoer in Afrika te verhoog, maar die navorsing toon 'n gebrek aan erkenning dat daar verskille in stuurkant is. Die navorsing wat gedoen is oor die moontlikheid van stuurkant verander in Rwanda dui daarop dat daar wel koste besparings is met die gebruik van regterhand stuur voertuie. As die besluit om stuurkant te verander gegrond word op die besparing in voertuigloopkoste, sal Rwanda ekonomiese voordeel trek om van stuurkant te verander.

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**Acknowledgements**

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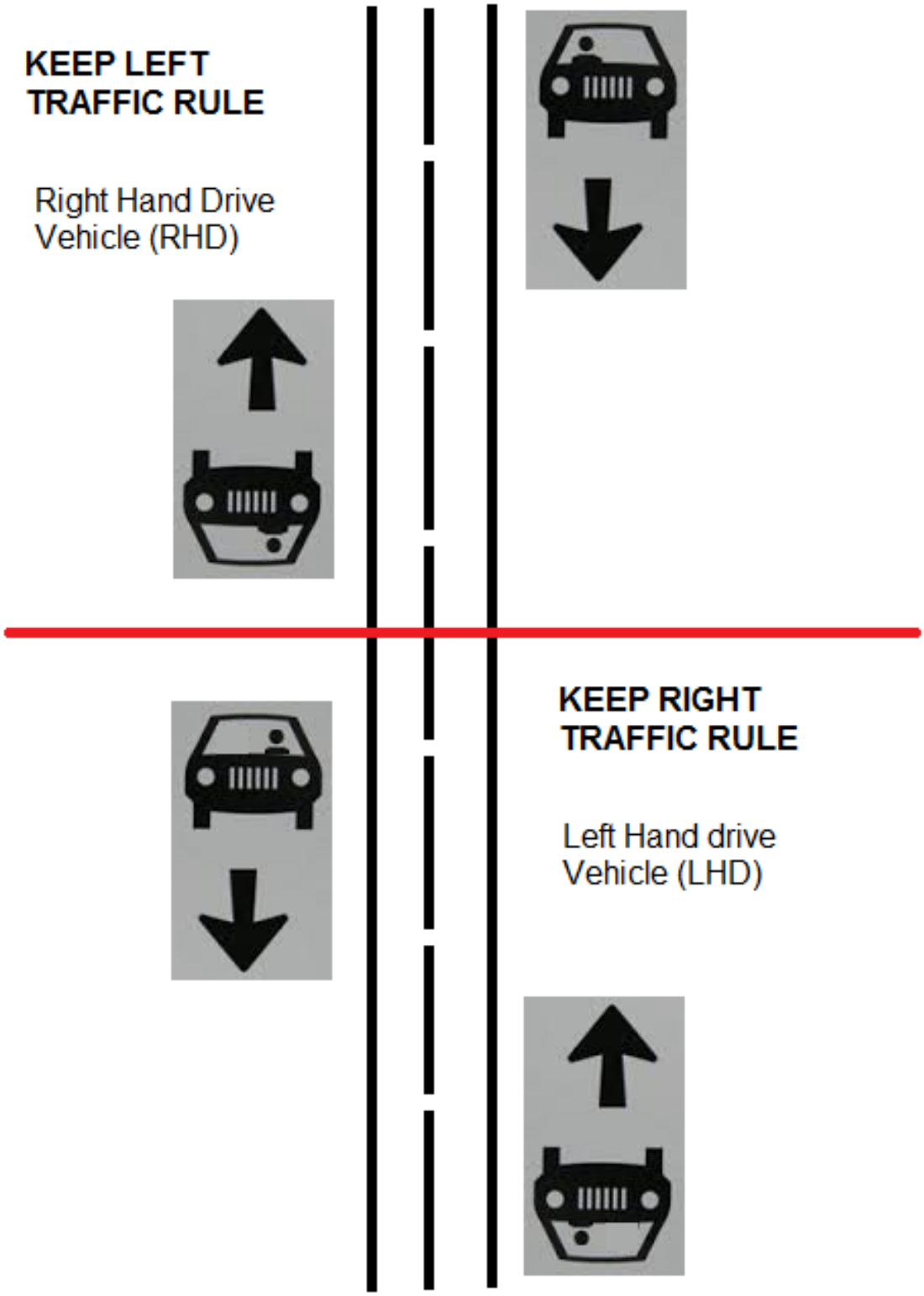


**Figure 1: Illustration of road use and driving side**

# Chapter 1: Introduction and Overview

This Chapter briefly discusses the history behind driving side, the current division of driving side in the world and some clarification on left side traffic and right side traffic. The chapter concludes with a discussion of the remaining chapters and research findings. Figure 1 on the previous page was designed by the author to illustrate the different driving terminology used in the study.

The overall purpose of this research is to identify if there are any cost and benefits associated with driving side in the world. This research aims to identify costs and benefits between Left Hand Driving (LHD) and Right Hand Driving (RHD) countries, specifically focussing on Rwanda. Research surrounding driving side is becoming increasingly important and more research into this subject must be considered worldwide. Changing the driving side of a country may hold significant economic benefits for a country, and if so, it should be considered. Research in this field is lacking information. Only a few credible sources could be found which indicates multiple uses of single sources.

## 1.1 Historic Overview: Driving side

There are many speculations of why some countries use the keep-left traffic rule and some countries use the keep-right traffic rule. South Africa has always used the keep-left traffic rule. Most of the literature point to North America for pursuing the keepright traffic rule and the British Colonies for endorsing the keep-left traffic rule. It was in the middle of the 19$^{th}$ century that the world started to predominately switch to the keep-right traffic rule (Hiskey, 2010).

The anecdotal evidence regarding the driving side rule often relate left or right driving side to left or right handedness. In the Middle Ages, roads where not particularly safe places to be and meeting people coming the other way on the road was something best done defensively. Hiskey (2010) mention that historians believe the keep-left rule was adopted because, on a horse, if a person were right handed and met some unsavoury company on the road, this person could draw his or her weapon, typically attached to his or her left side, with his or her right hand and bring it to bear quickly against the person who is going the opposite way of you on your right; all the while, controlling the horse's reigns with his or her left hand. And in the case that you meet a friend on the road, your right hand would be free to greet him. People of the era riding horseback ruled the streets and soon everyone followed in their steps.

The first physical signs of driving side discovered by archaeologists came from the ancient Roman Empire. In 1998 archaeologists discovered a road that was used to move stone to and from a rock quarry in Swindon, England. They observed that when moving *away* from the quarry, the tracks on the left had deeper groves in the ground, made by added stone weight on the carriages (Hiskey, 2010).

The keep-left rule was very common and even in 1300 AD Pope Boniface VIII ruled that all peasants moving to and from Rome should abide by the keep-left rule. This rule was practice widely across the Western World until the late 1700's. In the 18th century, the teamsters (known as a driver of a group of animals) of the United States, who drove big wagons with teams of horses, started to shift from the keep-left rule. These big wagons dominated the road networks of the United States and forced others to abide by their rules. They did not have a seat for the driver and the driver would typically sit on the rear left horse, when the driver was right handed. Such a seating position allowed them to easily drive a whole team of horses with a lash in their right hand. Oncoming traffic was therefore required to pass on the left side to ensure that no collisions took place. Sitting on the left rear horse, it was much easier to enforce a keep-right set of rules (Hiskey, 2010).

**Figure 2: Teamster of horse and carriage**

Source: Pinterest.com, 2016

This keep-right rule also spread through Europe, seemingly starting with the French. The reason for the French to switch to the keep-right rule rather than using the traditional keep-

left rule was not completely clear. Hiskey (2010) suggested that the French Revolutionists rebelled against the rules of the Pope while others suggest that the French wanted to differentiate from England. Some even suggest that Napoleon enforced the keep-right rule. There are no evident reasons present for if Napoleon was the main enforcer and why he would do so. Whatever the case may be, Napoleon enforced the keep-right rule in the countries he conquered and even after he was defeated, most of those countries decided to keep the keep-right rule. One important country which Napoleon conquered was Germany, which later on in the 20$^{th}$ century, also enforced the keep-right rule over the countries they conquered (Hiskey, 2010).

England never adopted this method primarily because the big wagons which became common in the United States did not work well on narrow streets which were common in London and other English cities. They kept the classical keep-left rule of the road that had endured for hundreds of years before and by 1756, this was actually made an official law in Britain. As the British Empire expanded the keep-left rule spread throughout the world (Hiskey, 2010).

## 1.2 Keep-Left vs Keep-Right Traffic Rule: Country Distribution

Table 1 and 2 lists the countries driving on the left and on the right. Figure 3 shows the international spatial distribution of left-side driving countries (blue) and the countries driving on the right side (red). Seventy-six countries in the world drive on the left side of the road and 167 countries drive on the right side of the road. Around 65% of the world population live in countries that drive on the right side of the road. Considering the total distance of roads (road length), 90% carries traffic that drives on the right with only 10% of traffic driving on the left (Stack Exchange.com, 2014).

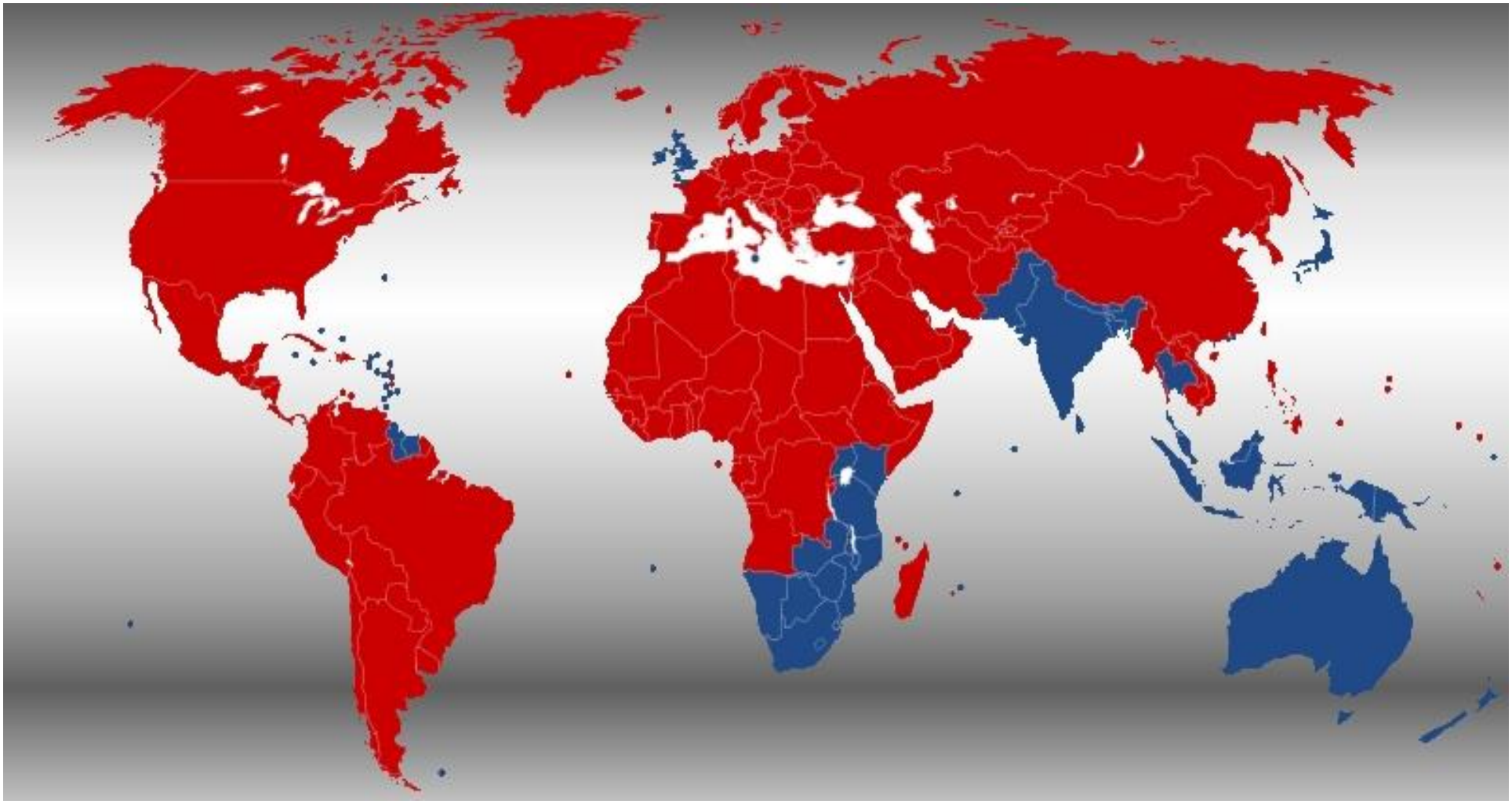

**Figure 3: World Map of Left Hand Driving(Red) and Right Hand Driving(Blue) Countries, 2015**

Source: Sine nomine, 2015

**Table 1: Countries that drive on the right side of the road with left hand drive (LHD)**

| | | | | | |
|---|---|---|---|---|---|
| Afghanistan | Chile | Germany | Liberia | Oman | Sweden |
| Albania | China | Ghana | Libya | Palau | Switzerland |
| Algeria | Colombia | Gibraltar | Liechtenstein | Panama | Syria |
| American Samoa | Comoros | Greece | Lithuania | Paraguay | Taiwan |
| Andorra | Congo | Greenland | Luxembourg | Peru | Tajikistan |
| Angola | Congo (Former Republic of Zaire) | Guadeloupe | Macedonia | Philippines | Togo |
| Argentina | Costa Rica | Guam | Madagascar | Poland | Tunisia |
| Armenia | Croatia | Guatemala | Mali | Portugal | Turkey |
| Aruba | Cuba | Guinea | Marshall Islands | Puerto Rico | Turkmenistan |
| Austria | Czech Republic | Guinea-Bissau | Martinique | Qatar | Ukraine |
| Azerbaijan | Denmark | Haiti | Mauritania | Reunion | United Arab Emirates |
| Bahrain | Djibouti | Honduras | Mayotte | Romania | United states |
| Belarus | Dominican Republic | Hungary | Mexico | Russia | Uruguay |
| Belgium | Ecuador | Iceland | Micronesia | Rwanda | Uzbekistan |
| Belize | Egypt | Iran | Midway islands | Saint Barthelemy | Vanuatu |
| Benin | El Salvador | Iraq | Moldova | Saint Martin | Venezuela |
| Bolivia | Equatorial Guinea | Israel | Monaco | Saint Pierre and Miquelon | Vietnam |
| Bosnia & Herzegovina | Eritrea | Italy | Mongolia | San Marino | Wake island |
| Brazil | Estonia | Ivory Coast | Montenegro | Sao Tome e Principe | Wallis and Futuna Island |
| British Indian Ocean Territory | Ethiopia | Jordan | Morocco | Saudi Arabia | West Bank |
| Bulgaria | Faroe islands | Kazakhstan | Myanmar | Senegal | Western Sahara |
| Burkina Faso | Finland | Korea, North | Netherlands | Serbia | Yemen |
| Burundi | France | Korea, South | Netherlands Antilles | Sierra Leone | |
| Cambodia | French Guiana | Kosovo | New Caledonia | Slovakia | |
| Cameroon | French Polynesia | Kuwait | Nicaragua | Slovenia | |
| Canada | Gabon | Kyrgyzstan | Niger | Somalia | |
| Cabo Verde | Gambia, The | Laos | Nigeria | Spain | |
| Central African Republic | Gaza strip | Latvia | Northern Mariana islands | Sudan | |
| Chad | Georgia | Lebanon | Norway | Svalbard | |

**Table 2: Countries driving on the left side of the road with right hand drive (RHD)**

| | | | |
|---|---|---|---|
| Anguilla | Guyana | Mozambique | Suriname |
| Antigua and Barbuda | Hong Kong | Namibia | Swaziland |
| Australia | India | Nauru | Tanzania |
| Bahamas, The | Indonesia | Nepal | Thailand |
| Bangladesh | Ireland | New Zealand | Timor-Leste |
| Barbados | Isle of Man | Niue | Tokelau |
| Bermuda | Jamaica | Norfolk island | Tonga |
| Bhutan | Japan | Pakistan | Trinidad and Tobago |
| Botswana | Jersey | Papua New Guinea | Turks and Calicos islands |
| Brunei | Kenya | Pitcairn Island | Tuvalu |
| Cayman Islands | Kiribati | Saint Helena | Uganda |
| Christmas Island | Cocos Islands | Saint Kitts and Nevis | United Kingdom |
| Cook Island | Lesotho | Saint Lucia | Virgin islands (British) |
| Cyprus | Macau | Saint Vincent and the Grenadines | Virgin Islands (US) |
| Dominica | Malawi | Samoa | Zambia |
| East Timor | Malaysia | Seychelles | Zimbabwe |
| Falkland islands | Maldives | Singapore | |
| Fiji | Malta | Solomon Islands | |
| Grenada | Mauritius | South Africa | |
| Guernsey | Montserrat | Sri Lanka | |

Considering Figure 3, the map indicating the driving side of each country, some spatial relation seems to surface:

1. Left hand drive countries dominate the map.
2. Most of the countries that drive on the left side of the road (RHD) are in the southern hemisphere
3. There is roughly 35% of LHD countries in the northern hemisphere and around 65% of LHD countries in the southern hemisphere.
4. North America seems to be the only continent completely driving on the right side of the road (LHD).
5. Africa is divided in terms of driving side.
6. All of the left hands driving nations are either coastal or next to a coastal country.
7. Right hand drive countries completely dominate the Southern and Eastern hemisphere.

### 1.2.1 Driving Side: Traffic Regulations

In the case of Right Hand Drive (RHD) countries, most vehicles have the driving seat on the right. On roads without a footpath pedestrians may be advised to walk on the right. All traffic is generally required to keep-left unless overtaking. Oncoming traffic is seen coming from the right and right-turning traffic must cross oncoming traffic. Most traffic signs facing motorists are on the left side of the road. When referring to Left Hand Drive (LHD) countries, most of the vehicles have the driving seat on the left. Pedestrians are advised to walk on the left side of the road. All traffic generally keeps to the right and oncoming traffic to the left. Traffic turning left must cross-oncoming traffic. Most driving signals facing motorists are on the left right side of the road. Figure 4 and 5 illustrates left side and right side traffic.

**(a) Left side traffic (RHD):**

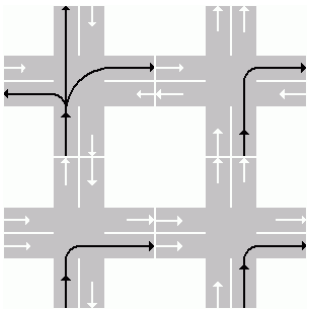

**Figure 4: Illustration of left side traffic**

**(b) Right side traffic (LHD):**

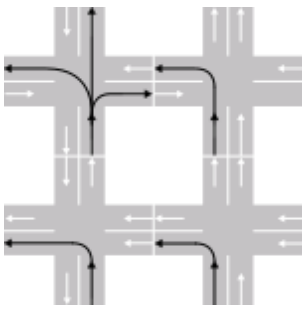

**Figure 5: Illustration of right side traffic**

Source: Stack Exchange.com, 2014

### (c) Traffic Safety

According to Leeming and Mackay (1969), keep-left countries have a much lower collision rate than keep-right countries. The source of his data and method for establishing this finding is unclear. This statement will be investigated later in this study to establish if there is any validity to Leeming's statement. It is thought the reason behind this is that most people's right eye is their dominant eye. The right eye in keep-left traffic is the one closest to oncoming traffic and so should reduce collisions. Another theory as to why this might be is that most people are right handed, so when driving a manual transmission car in a keep-left country, most people's dominant hand is on the steering wheel; this could help in a person's ability to manoeuvre accurately. Most horse riders and cyclists will naturally mount the horse or bike from the left hand side. In the cyclist's case, this is why most bike chains and gears are on the right side of the bike so that the rider can walk along on the left side of the bike and not worry about getting pants or shoe laces caught in the gearing while walking beside the bike (Sine nomine, 2015).

## 1.3 Other modes of transport and other driving facts

International regulations for preventing collisions at sea decree that all water traffic should *keep to the right* when two vessels pass one another going opposite directions. The reason for this was that historically the steering oar for ships was on the right hand side of the boat. Thus, by passing each other they would protect the steering oars from colliding as this would not have been possible had they adopted a keep-left rule (Hiskey, 2010).

In aviation, the "rule of the road" is to *keep right* when passing oncoming air traffic. Interestingly, in dual-control airplanes, the captain always sits on the left side of the plane as you might expect, but in helicopters, the captain sits on the right hand side. In the case of rail transport and rail networks, there is no specific convention for keeping left or keeping right when they pass one another (Hiskey, 2010). Rail traffic generally runs to one side of a double track line, not always the same side as road traffic. Double-track railways may use each track exclusively in one direction.

While modern vehicles are either left or right, that was not always the case. Car manufactures began putting the seat on one side or the other. Some chose to put it on the side closest to the curb so that people could more easily avoid scraping buildings, curbs, etc. Other car manufactures would put it on the opposing traffic side to help reduce car to car collisions, which would tend to be more deadly. Many early American motorized vehicles actually placed the steering wheel on the right hand side of the car, even though America

used the keep-right rule. This practice was finally put to an end by Henry Ford. He preferred the left side steering wheel. Ford cars thus adopted the left hand side steering wheel. Due to the popularity of Ford, this effectively squashed the right hand steering wheel cars in America (Hiskey, 2010).

### 1.4 Outline of Discussion

The outline of this thesis transcends from an international perspective, to a continental perspective and a country perspective. Chapter one introduces the history of driving side. This chapter also gives an international view on which countries drive on the left side or the right side of the road. Chapter 2 provides an overview of the research methodology and goal of the research. This chapter also describes the data collection techniques used in this research study. Chapter three discusses the literature review of all the countries that changed their traffic rule, starting with Finland in 1858. This chapter also discuss the reasons for changing driving side. Chapter four delivers a macroeconomic perspective on costs and benefits associated with driving side. Chapter four further focusses on the descriptive statistics of all the LHD and RHD countries in the World. It provides an overview of the GDP, GDP growth, accident figures and the vehicles per 1000 people in each country to establish if there is any relevance between these characteristics and driving side. Chapter four also includes some accident figures of LHD and RHD countries in the world.

Chapter five focuses on Africa. Africa remains the divided continent when driving side is concerned. This chapter aims to distinguish between the RHD and LHD countries in Africa and how their economic indicators differ. This chapter also discuss the African transportation market in terms of prices and costs. Trade and transport infrastructure in Africa that can be influenced by driving side are also discussed, such as the Road Side Station (RSS) project in the Northern African transport corridor and the use of transport development as a tool for improving regional integration and trade. Chapter five also presents some, albeit limited, information with regards to the difference of RHD and LHD vehicle manufacturing in South Africa.

Chapter six will look at the microeconomic evaluation of switching driving side in terms of vehicle operating cost. Rwanda is currently considering switching their driving side. This chapter discusses some findings of recent research that considers the costs and benefits of road side change. This chapter also discuss data collected by the CSIR (Council for Scientific and Industrial Research) for the RTDA (Rwanda Transport Development Agency) in 2014. This gives a microeconomic indication on vehicle operating cost if switching from LHD to RHD will be economically beneficial.

## Chapter 2: Research Questions, Objectives and Methodology

The main goal of this study is to determine if there are any costs or benefits that can be associated with countries driving on the left side of the road (RHD) and the countries driving on the right side of the road (LHD). Would changing driving side lead to economic benefits or bring about mainly financial costs and what are these benefits and costs? Analysing some macro and microeconomic characteristics of different LHD and RHD countries may assist to potentially identify possible benefits or costs.

The objectives of the research is (a) to explore the history of driving side, (b) identify countries that changed their driving side and the reason for this change, (c) provide descriptive macroeconomic indicators for different LHD and RHD countries, and (d) to undertake a microeconomic analysis to determine costs and benefits for changing driving side. The latter will make use of data collected in Rwanda who is considering changing driving side.

These objectives, and ultimately the main goal, can be achieved by answering the following questions:

1. What is the history surrounding driving side? How did countries first decide to adopt either the LHD or the RHD traffic rule?
2. How does the world look now in terms of driving side? Which countries are LHD and which countries are RHD?
3. Are there countries that have changed driving side? If so, why and when did they change their driving side?
4. Are there any macroeconomic indicators that distinguish the LHD and RHD countries from one another and are there a significant change in these indicators for the countries that changed their driving side?
5. Are there any costs and benefits associated with driving side change? What are these microeconomic factors that would provide costs and benefits?

Research will mostly be collected from secondary literature and data sources. Peter Kincaid (1986) provides arguably the foremost reference on driving side in his book *The Rule of the Road* (1986). Supporting literature, where available, will be used to support Kincaid's' statements. Analysing macroeconomic indicators will make use of secondary data obtained from The World Bank and the World Health Organisation (WHO). Studies conducted by the Rwanda Ministry of Infrastructure and data collected by the Council for Scientific and Industrial Research (CSIR) for the Rwanda Transport Development Agency (RTDA) in 2014

will help to analyse microeconomic cost and benefit factors for switching driving side. A questionnaire set up by the CSIR can be found in Appendix C. Original Equipment Manufacturers (OEM's) and other professionals in the motor industry in South Africa can provide insight into the production cost of different LHD and RHD vehicles and if there is any benefits that could be obtained from standardizing vehicle type. The questions are formulated in such a way that OEM's do not need to provide any sensitive information that would deter them from partaking in these questions. Information from them can be obtained by asking somewhat unassuming questions. These questions and answers can be found in Section 5.3. These qualitative data collection techniques are often time consuming and costly and data is usually collected from smaller samples than in quantitative data collection techniques.

Investigating countries that have changed their driving side throughout history will give insight into how, when and why they chose to change driving side. These factors that influenced driving side change can be categorised and the main reason(s) for change can be identified.

To analyse LHD and RHD countries in terms of economic indicators, research should be conducted on which countries in the world drive on the left and which countries drive on the right. Correlating the split of countries with data obtained from The World Bank and WHO will form the base for analysing LHD and RHD countries from a macroeconomic perspective. Macroeconomic indicators such as Gross Domestic Product (GDP), Gross Domestic Product per capita (GDP per capita), accidents figures from the World Health organisation (WHO) and vehicle ownership figures will be investigated to conclude if there is any difference in Left Hand Drive (LHD) and Right Hand Drive (RHD) countries in regards to these indicators.

Gross Domestic Product is one of the main economic indicators that indicates the health of an economy and also provides a guideline for indicating the standard of living for a country (Investopedia, 2003). Performing a t-test on the difference in GDP for LHD and RHD countries will provide insight to the health of LHD and RHD economies, and if there is any difference between the two. Gross Domestic Product per capita is essentially GDP divided by the total population of a country. Gross Domestic Product per capita may, by comparing LHD and RHD countries, establish the relative performance of each group. Gross Domestic Product per capita growth normally reflects an increase in productivity in countries (Investopedia, 2003). Paired with vehicle ownership figures, it is possible to identify when people are tend to buy vehicles as GDP per capita increases. These macroeconomic indicators can be attributed to African countries to establish if there is any difference

between LHD and RHD African countries and to see if a change in driving side affected GDP. Macroeconomic indicators will be discussed in Chapter 4.

To evaluate any African country for a driving side change, it is important to understand the transport market and economic environment. A paper by The World Bank titled *Transport Prices and Costs in Africa: A Review of the Main International Corridors* (World Bank, 2009), will assist in identifying the prices and costs of road transport in Africa. This will help to determine which costs are most likely to differ with LHD and RHD vehicles. Reiterating the importance of a road side change in a country like Rwanda can be supported by emphasising current and future road infrastructure projects. These projects are aimed to increase regional trade and boost the economy, which is a clear indication that road transport infrastructure plays a big role in trade facilitation. Increasing trade through transport development may be achievable with changing driving side.

Evaluating the studies by both the Rwanda Ministry of Infrastructure and the RTDA will provide insight into economic costs and benefits. These two studies should be assessed individually and compared with one another to establish which costs and benefits would be most fitted to evaluate a driving side change.

It was found that the literature on driving side is, somewhat surprisingly, source limited and does not address all of the objectives. Virtually no written case studies exist of countries changing driving side. The absence of formal articles and literature made the research challenging but also interesting. The research questions and objectives should be adequately answered by following the suggested research methodology alongside available sources as outlined in this Chapter. The lack of available research, however, did pose a challenge to answer the research questions.

# Chapter 3: Literature review

## 3.1 Research surrounding driving side

Despite the potential costs, benefits and social impact of driving side and driving side change, there is very little research done on the topic. Surprisingly little information was available on case studies and the comparison of left versus right side driving. While several countries have changed driving side, very few documented their change.

Changing driving side is an important topic when considering the economic benefit it may produce. As trade agreements and trade relationships become increasingly important, facilitating trade and transport uniformity becomes more relevant. Changing driving side, however, is not always seen as a method for adding economic benefit in a country, but more as a sign of independence. Driving side rules in a country is very seldom questioned by the citizens of the country. Many citizens just accept the current side without question. If there is any inherent benefit for a country and its citizens to switch driving side, it surely should be considered.

Ultimately the question is if there are any benefits or costs that can be attained or avoided by using one side of the road rather than the other. Peter Kincaid (1986) provides arguably the foremost reference on driving side in his book *The Rule of the Road* (1986). He describes the *history* of countries driving side, *when* countries decided to change driving side and *how* these decisions came about. Finding supporting evidence to support Kincaid's statements, however, proved extremely difficult and ultimately emphasises the lack of research surrounding this topic. Additional available information to support Kincaid's statements was used to supplement the text.

## 3.2 Countries that changed road side use in the last century

This section considers the most recent changes in driving side. Since the early 1800's driving side changes have been made along political and strategic reasons. Figure 6 shows the countries that have changed their driving side since 1858.

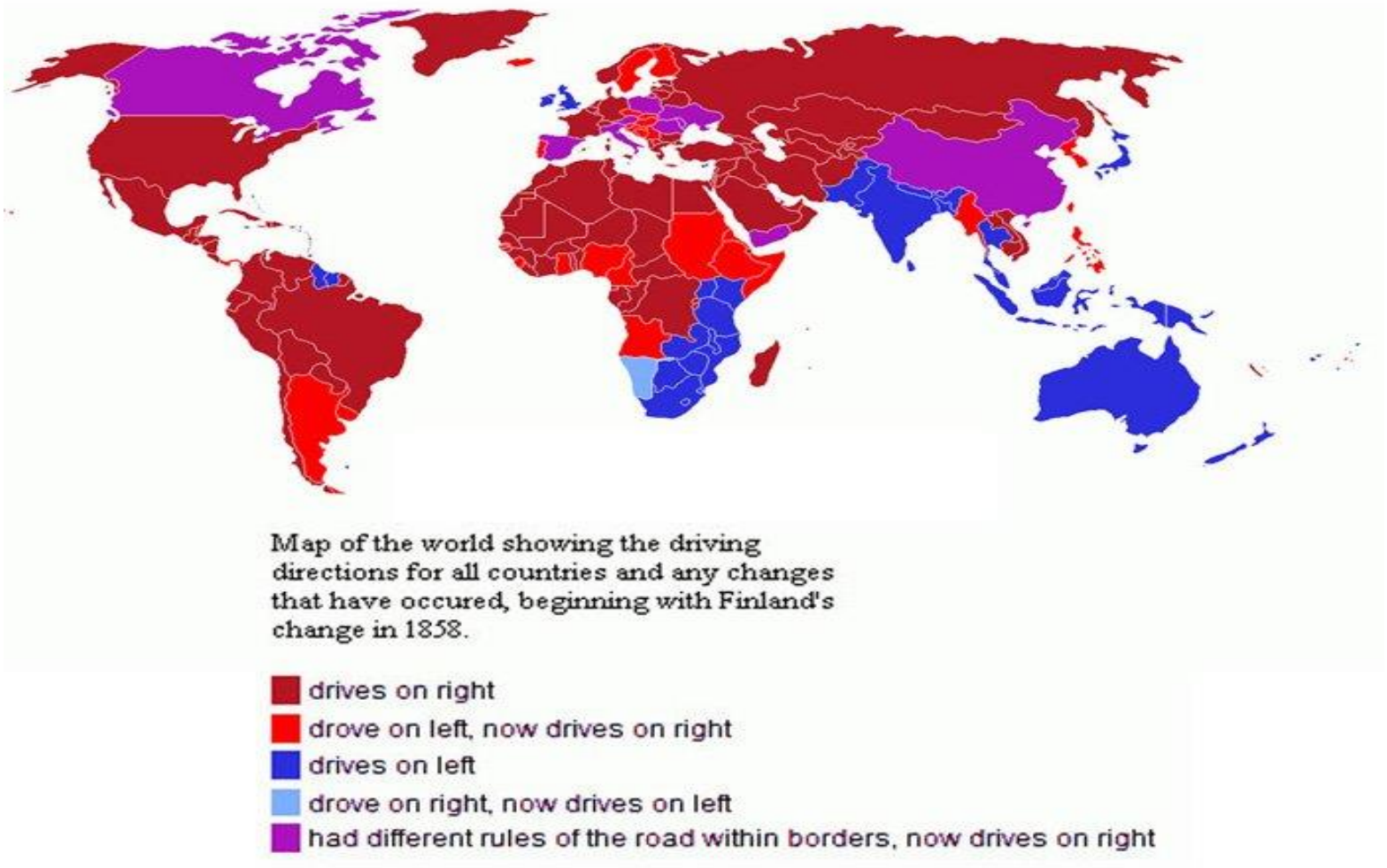


**Figure 6: Map of Countries that Changed Driving Side Rule Since 1858**

Source: Star, 2000

**Table 3: Change in Driving Side of Countries since 1858**

| (i) | | (ii) | (iii) |
|---|---|---|---|
| **Drove on left, now drives on right.** | | **Drove on right, now drives on left.** | **Had different rules within borders, now drives on right.** |
| Angola | North Korea | (b) Namibia (1915) | Austria |
| (e) Argentina, 1945 | (g) Philippines, 1945 | (r) Samoa (2009) | Canada |
| (m) Burma (Myanmar), 1970 | Serbia | | China |
| (i) Cameroon, 1961 | (n) Sierra Leone, 1971 | | Italy |
| (c) Czech Republic, 1939 | Slovakia | | Moldova |
| Djibouti | Slovenia | | Poland |
| (j) Ethiopia,1964 | (s) Somalia | | Romania |
| (a) Finland, 1858 | South Korea | | Spain |
| (k) Gambia, 1965 | (p) Sudan, 1973 | | Switzerland |
| (q) Ghana, 1974 | (l) Sweden (1967) | | Ukraine |
| (d) Hungary, 1941 | (h) Taiwan (1946) | | Yemen |
| Montenegro | (f) Uruguay (1945) | | |
| New Caledonia | | | |
| (o) Nigeria, 1972 | | | |

Source: Star, 2000

Table 3 list the countries that (i) changed from driving on the left to driving on the right, (ii) changed from right to left and (iii) those countries which had different rules within their borders but now drive on the right side. The date when the country changed driving side, indicated in brackets, was not available for all the countries due to the lack of available information. The following section provides a brief overview of the decision to change for selected countries. Most of the information was obtained Peter Kincaid's book, *The Rule of the Road* (1986).

**(a) Finland**

Since the medieval times, Finland was part of Sweden. Increasing Swedish influence on Finland had them adopting the Swedish language, which today is still spoken widely in southern Finland. France and Russia signed the Treaty of Tilsit in 1807. Sweden, who was very anti-Napoleon, went to war against Russia. They eventually lost and were forced to

hand over Finland to Russian control. While under Russian administration, the preferred language and culture in Finland was Swedish. During the 1890's Russia tried to Russianize Finland by introducing a Russian postal and monetary system, which intensified until 1914 (Kincaid, 1986:98). On 6 December 1917, Finland declared independence from Russia when the Bolsheviks took over. The traffic rule of Finland while under Swedish power is said to be keep-left, but in modern times it has always been to keep right. The change is said to have happened along with the Russianization period (1858), as the Russian rule of the road is to keep-right (Kincaid, 1986:99).

**(b) South West Africa (Namibia)**

At a time when European countries scrambled to take sovereignty over the unclaimed parts of Africa, Namibia came under German administration on 16 August 1884. Walvis Bay, annexed to South Africa on 12 March 1878, was still under British occupancy. On 9 July 1915, the South African militant forces defeated the rebels and the Germans. Namibia then came under the military law of South Africa and was administered under the League of Nations mandate. The rule of the road in Namibia is the same as in South Africa, keep left, but it was keep-right in the times of German occupancy. This makes Namibia one of a few known countries that moved from the keep-right to the keep-left rule of the road. The exact time of change is unknown, but it is speculated that it happened during the occupation of Namibia by South Africa (Kincaid, 1986:156).

**(c) Czechoslovakia, Czech Republic and Slovakia**

When Czechoslovakia was still part of the Astro-Hungarian Empire, it used the keep-left traffic rule. This rule was uniformly enforced through the whole Astro-Hungarian Empire. On 28 October 1918 Czechoslovakia was given independence, but still used the keep-left rule as stipulated by the Czech Highway Code in 1938(Kincaid, 1986:89). It was agreed by Britain, France and Italy to let Germany occupy Czechoslovakia, in turn changing the road rule to keep-right on 15 March 1939. Peter Kincaid published his book in 1986 and the separation of Slovakia and Czech Republic happened in 1992 (Wilde, 2016). According to the information from Star (2000) both these countries still drive on the right side of the road. This indicates that the separation of these countries did not affect this traffic rule.

**(d) Hungary**

Hungary was part of the Austro-Hungarian Empire who had always used the keep-left rule of traffic. Germany sided with the Austro-Hungarian Empire in a war against the Triple Entente (France, Britain and Russia) as excuse to initiate ambitious plans. The Empire however did

not survive the war and some of the countries within the Empire were granted independence before the end of the war. The German parts of Austria declared themselves a republic and so Hungary became independent (Kincaid, 1986:114). The change in the rule of the road in Hungary came with the German expansion during and before the Second World War. The changeover took place in two stages. All of Hungary, except Budapest and approximately a 30km border around Budapest changed to the keep-right traffic rule on 6 July 1941 at 03H00. The rest of Hungary only changed on 9 November 1941 at 03h00, the reason being that the preparations in Budapest took a lot longer and was more complex (Kincaid, 1986:115).

**(e) Argentina**

Before 1945, Argentina drove on the left side of the road. They switched to the right side of the road in 1945. Argentina's economy started experiencing growth in the latter part of the nineteenth century. Protectionist policies in the United States resulted in trade barriers against Argentine goods, which lead Argentina to form a strong relationship in trade with Britain. The country experienced a large volume of British investment through the development of railways and other transportation systems. (Kincaid, 1986:44)

The United Kingdom became weak in the 1930's and Argentina started contemplating their independence from British colonialism. In 1943 Juan Péron came into power as president. He favoured a relationship with the United States over the UK. In this year, Péron decided to change the rule of the road. This decision was also heavily influenced by the Pan American Union to harmonize the transport of Latin American countries, endorsed by Argentina and the other two Latin American countries using the left side rule of the road, Uruguay and Panama. All three countries decided to change relatively close to the end of the war, as transport shortages made change easier. Argentina subsequently changed their rule of the road on June 10, 1945 at 06h00 in the morning (Kincaid, 1986:45).

**(f) Uruguay**

In the late nineteenth century, most investment in infrastructure was from Britain. British influences was rejected by most Uruguayans during the 1920's and 1930'sAmerican economic influence. Initial keep-left rule of traffic in Uruguay in the early 20$^{th}$ century can be attributed to the British influence in Uruguay and neighbouring country, Argentina. The rule of the road in Uruguay was changed at 04h00 on 2 September 1945. One of the main drivers for this change was the pressure by the Pan American Highway to enforce a uniform rule of the road. One unusual aspect of the change was that there where rehearsals before implementation of the change. The change was relatively smooth, with no major incidents.

On the Monday, the day after the change, traffic flows was smooth but slow (Kincaid, 1986:178-181).

**(g) Philippines**

The Philippines came under U.S. occupation in 1898 after the Spanish-American war. The U.S. governed the Philippines up until 1916, enforcing wide spread education to teach English to the formerly Spanish nation. Philippines became a Commonwealth nation in 1935, becoming fully independent in 10 years. The Philippines was surrendered to the Japanese in 1942, forming an Independent Philippines Republic but was returned to a Commonwealth nation in October 1944. The Philippines, like Panama, adopted the keep-left rule for traffic since most of its neighbouring countries used the same rule (Kincaid, 1986:148). Throughout American occupation, it still kept the keep-left traffic rule, but when it became independent, the Philippines became the first country to change to the keep-right rule in a region dominated by the keep-left rule. The change took place on 10 March 1945, but was said to have started even a bit earlier (Kincaid, 1986:149).

**(h) Taiwan**

In 1894 China and Japan went to war over the control of Korea. When Japan won the war, Taiwan was succeeded to Japan in 1895 and stayed under Japanese occupation for the next 50 years. In 1943 the Cairo declaration of the allied powers assured China that Taiwan would be restored to Chinese powers after the war. In 1945, Japan was defeated and Taiwan was returned under Chinese administration. The rule of the road was keep-left under Japanese administration. After 1945, under Chinese administration, Taiwan changed the rule of the road to keep right. The exact date that Taiwan changed is not clear, but China changed on 1 January 1946 (Kincaid, 1986:162).

**(i) Cameroon**

After being under German control, Cameroon was taken over by France and Britain in 1914 and 1915. It was split up in 1922 into six territories, one sixth being under British control and the rest under French control. The northern British territory was divided into three parts, two strips adjacent to Nigeria and one along the coast, and was largely governed by Nigerian authorities (Kincaid, 1986:53). British Cameroon used the keep-left traffic rule, said to be adopted from Nigeria. French Cameroon used the keep-right traffic rule. After the Second World War, French and British territories became trust territories under the United Nations. In 1960, the British Cameroons passed a legislation asking if they wanted to join Nigeria or French Cameroon. The two strips adjacent to Nigeria voted to become part of Nigeria and

the coastal part joined French Cameroon. The two northern strips already adhered to the keep-left rule of Nigeria and only changed to the right side with the whole of Nigeria on 2 April 1972. The specific date of change for French Cameroon is not yet discovered but is believed to be around 1961, the year of the union (Kincaid, 1986:54).

**(j) Ethiopia**

For Ethiopia, the change of driving on the left side of the road to driving on right side of the road happened on 8 June 1964. This change was accompanied by a lot of confusion and a lot of accidents with some fatalities on the day. The initial use of the keep-left rule in Ethiopia remains unexplained, as Ethiopia was politically independent until it was occupied by Italy from 3 October 1935 until 1941. After Italy was forced out by the Allies, Ethiopia became largely under the control of British administration. British influence during the period after 1941 may be the reason for the use of the keep-left rule. In 1953, Ethiopia signed a defence treaty with the United States, which may be the main factor influencing the change from keep-left to keep-right traffic in 1964 (Kincaid, 1986:97).

**(k) Gambia**

Gambia is a small stroke of land, surrounded by Senegal in West Africa. Senegal was a French colony, using the keep-right traffic rule, whilst Gambia used the keep-left traffic rule as it was a British colony. Gambia became the last British colony in West Africa to become a republic within the Commonwealth in 1966 (Kincaid, 1986:102). The pressure on Gambia to change its rule of the road was great, adding the inconvenience of travelling through Senegal inland. On 1 October 1965 Gambia switched from the keep-left traffic rule to the keep-right traffic rule. The transition was said to have gone smoothly, without incident (Kincaid, 1986:104).

**(l) Sweden**

On the 3 September 2017, Sweden will celebrate 50 years of driving on the right side of the road. As many countries, in the early 1700's, Sweden used the left road side rule, most probably due to the "sword hand" rule that most horse riders followed in that period. It was only in 1916 that the Swedish parliament acknowledged the left side road use law but every year between 1920 and 1936 whether they would switch from the left to the right. At this point, all of Sweden's neighbouring countries, including Norway and Denmark, were using the right side rule, but nothing happened. In 1955 a national referendum was held with strong arguments for both cases. The people lobbying for the right side use used the argument of safer overtaking while the left side users played on the nation's emotions and

stating their argument that using the left side is part of their history and heritage. The people voting for the left side driving rule won, obtaining 83% of the votes. Regardless of this outcome, there was still strong lobbying for changing to the right side. This eventually led to parliament stating in 1963 that the road side use will switch from left to right in 1967. Sweden also formed the Swedish National Traffic Safety Board during this period (Volvoclub.org.uk, 2015).

On the third of September 1967 at 04:50 in the morning, the country's traffic stopped for ten minutes as the transition ensued. Traffic was allowed to continue on 05:00 on the right side of the road, and has been ever since. Roads, crossings, roundabouts and flyovers were already redesigned and somewhat 360,000 road signs were changed during the night. The change was also preceded by an intensive national campaign. On the day, there was also a temporary speed limit of 30kph in built up areas and 50kph in all other areas in Sweden. On the day, there were only 150 accidents reported. The change worked very well and cost Sweden around €64 million, almost worth €500 million in 2015 (Volvoclub.org.uk, 2015).

**Figure 7: Photo taken on the day Sweden changed the rule of the road**

Source: Dagen, 2014

**(m) Burma (Myanmar)**

After the eruption of sporadic nationalistic and anti-British sentiments, Burma became independent from India in 1937. Throughout British occupation and years after, Burma enforced the keep-left rule in traffic. It appears that in 1970, they changed to the keep-right rule. No response was given to why they chose to change driving side in 1970 (Kincaid, 1986:52). Some sources seem to think that it was the superstitious nature of General Ne Win was the cause for change. After the General seized power in 1962, he relied on the advice given to him by his astrologers and numerologists. The rule of the road change is

said to have happened because one of the General's astrologists suggested that he had moved too far left in political terms (Selth, 2014).

**(n) Sierra Leone**

After slavery was abolished by the British Parliament in 1807, Sierra Leone became a heaven for freed slaves. Sierra Leone became independent in 1961 and became a republic in 1971 and is part of the Commonwealth. The rule in Sierra Leone always was to keep-left but became under the same pressures than other British West African colonies. The decision to change the road of the rule was not one of independence, but happened on the same day as they became a republic. The change took place at 06h00 on a Monday 1 March 1971. There was very little resistance from the public to change, accompanied by only a small number of minor accidents. The change also prohibits the registration of right hand drive vehicles (Kincaid, 1986:153).

**(o) Nigeria**

After the establishment of the United Africa Company by Sir George Goldie in the early 1880's, the obtainment of a charter changed the company into the Royal Niger Company, administering trade in the northern parts of what is now Nigeria (Nwanze, 2014). Pressure from surrounding territories required governance that can only be administered by a higher power. On 1 January 1900 Nigeria became administered under the Crown. Nigeria became independent on 1 October 1960 and a Republic within the Commonwealth in 1963. At 06h00 on 2 April 1972, Nigeria changed their rule of the road to keep right. The reason for this is the same as many British colonised West African countries. During the civil war from 1966-1970 road construction came to a halt, which lead to the unsophisticated change of roads in 1972. The approach to change that Nigeria took was to recognize that the longer the wait for change become, the more complex change will be (Kincaid, 1986:139).

**(p) Sudan**

As part of the Ottoman Empire, Egypt was historically in control of Sudan. It was only in 1882 that Britain occupied Sudan. Sudan became independent outside of the Commonwealth in 1956 and the rule of the road changed from keep-left to keep-right in August of 1973. There are two reasons for the change. The first reason is that Sudan wanted to conform to its neighbouring countries' rule of the road. Secondly, most second hand cars that were available to the Sudanese people were made for right-hand traffic, so it would make it easier to use these vehicles on the road if the rule was changed (Kincaid, 1986:156-158).

**(q) Ghana**

Becoming the first Sub-Saharan Colonial country to do so, Ghana gained independence from Britain on 6 March 1957 (Kincaid, 1986:104). While it was still under British administration, Ghana used the keep-left traffic rule. Ghana, Nigeria, Sierra Leone and Gambia were the only four West African countries driving on the left at that stage. All their neighbouring countries inland used the keep-right rule for traffic. After the United Nations West African Transport Conference of 1961 the conference held by the United Nations Economic Commission for Africa in 1964, the harmonization of transport rules was set and most West African countries changed to the keep-right rule(United Nations Economic Commission for Africa, 1961) . Ghana was the last of the four countries to change side on 4 August 1974, after becoming independent on 6 March 1957 (Kincaid, 1986:105). The change in Ghana happened due to great pressure from Nigeria and cross-border traffic to the North also increased (Kincaid, 1986:106).

**(r) Samoa**

On the 7th of September 2009 at 06:00, the people of Samoa had to stop their cars and start driving on the left side of the road. This change ensued total road rage between road commuters. The main reason for the switch was that Samoa's main neighbouring countries, Australia and New Zealand, both drive on the left side of the road and that it would be easier for the somewhat 170,000 poor Samoans to acquire cheap second-hand cars from their neighbouring countries. Prime ministers, Mr Tuilaepa Sailele Malielegaoi also added that the people would be able to escape more tsunamis if they had cars (Barta, 2009).

Some outsiders and critics suggested that the switch from the keep-right to the keep-left traffic rule would change Samoa's already dangerous roads into disaster zones as many may forget that they have switched. There were also extra costs, for example adding new doors to busses so that people can exit these vehicles safely. Extra costs components like these are difficult for a country that is already reliant on foreign aid. The value of left hand drive cars were also set to decrease significantly as it become less desirable even though it is still allowed on the Samoan roads (Barta, 2009).

**(s) Somalia**

Somalia was founded in 1960 by merging British and Italian Somaliland. The rule of the road in British Somalia was to keep left. Peter Kincaid was informed by a resident of Mogadishu, in 1986, that they used the keep-right rule for traffic. It seemed that the rule has changed at

some point but at the stage of publication of his book, it was not clear if and when it happened (Kincaid, 1986:154-155).

**(t) Asia and the Middle East**

Japan passed the left side rule in 1924. Under the control of the U.S. during 1945-1972, Okinawa drove on the right side of the road but changed back to the left after it was returned to Japan. China passed the right side rule by law in 1946. After WWII, Korea shifted to the right side rule under influence of the US and Russia. In the 1960's, Pakistan considered shifting to the right side use rule but no change was made. The argument against this was that camel trains that went on through the night was trained to keep to the left and it is difficult to learn old camel's new tricks (Sine nomine, 2010).

The review on the countries that changed driving side reveals some interesting facts. One of the major recurring themes throughout is occupancy and independence. Most of these countries where at one time or another occupied by another country that enforced a keep-left or keep0right traffic rule in the occupied country. Some of these countries changed their driving side as sign of independence and other decided to keep their traffic rule. Most changes in driving side happened before 1980, except for Samoa who changed their driving side most recently in 2009. Another interesting fact is that except for the Czech Republic, Slovakia and Hungary, the rest of the countries that was reviewed are all coastal countries. These countries all have ports and are open to international trade. As stated earlier, international trade and transport uniformity is becoming increasingly important and if for instance transport uniformity in a continent like Africa would be achieved, starting with coastal countries would be a more efficient way of achieving uniformity.

### 3.3 Driving Side Change

The countries that have changed driving side since 1858, which side they changed to and why they changed are permuted in Table 4. Reasons for change can be categorised into three interrelated categories, namely economic and trade reasons, spatial reasons and political reasons. These reasons are often independent and they are discussed in the following sub-sections.

#### Category 1: Economic & Trade relationship reasons

Economic and trade reasons include financial and economic benefits and cost savings that can be attained by changing road side use. Smaller, trade dependant countries may change sides to gain trade integration benefits. For example, one of the main reasons for Samoa to change driving side was to obtain cheaper second hand vehicles from Australia and New Zeeland. A Study conducted on the possibility of switching driving side in Rwanda shows that possible benefits can stem from reduced time at border crossings, reduced maintenance and cost of parts and lower purchase and import cost of vehicles (Republic of Rwanda Ministry of Infrastructure, 2009). These benefits accrue mainly to the owners and operators of motor vehicles. There are no specific studies that quantify benefits for the whole economy with regards to changing driving side. The study done for Rwanda is discussed in greater detail in Chapter 6.

#### Category 2: Spatial and Regional Integration reasons

Spatial reasons for change usually occur when a country is surrounded by countries driving on the other size. These countries are most likely to be encouraged by neighbouring countries to harmonize transport activities. This happened in South America and West Africa. Their underlying reason may also be economical, but it is accepted as being a spatial reason. One example of this is Gambia where the pressure to change its rule of the road was great, adding the inconvenience of travelling through Senegal inland (Kincaid, 1986:104).

#### Category 3: Political reasons

Political reasons mostly includes war, where countries where invaded and usually forced to abide by the rules the occupying country. In most cases, the adoption of independence also leads to the change in road side use. Most African countries that was formerly colonised by the British decided to change their road side rule when they became independent. Nigeria is one such a country. It seems that up until the 1970's political reasons was very important in changing driving side. Over the last couple of decades, however, the focus seems to be on

category 1 and 2. This is important given the focus of the new world order. It is apparent that historically, most countries have changed their rule of the road due to political reasons.

All African countries shifted as because of political or spatial reasons. Only Sudan and Samoa changed partially because of the vehicle trade opportunity, which is making it easier to acquire vehicles.

From the literature it seems that more recent driving side changes are due to spatial and regional integration reasons. Earlier changes seem to have been more motivated by political reasons, which include occupation and war. Table 4 presents the countries and their dominant category of change.

**Table 4: The dominant reason for change in traffic rule**

| KEEP-LEFT TRAFFIC RULE | YEAR/CHANGE | KEEP-RIGHT TRAFFIC RULE | DOMINANT CATEGORY CHANGE |
|---|---|---|---|
| Finland | 1858 → | Finland | 3 |
| Namibia | ← 1915 | Namibia | 3 |
| Czech Republic | 1939 → | Czech Republic | 3 |
| Hungary | 1941 → | Hungary | 3 |
| Argentina | 1945 → | Argentina | 2+3 |
| Uruguay | 1945 → | Uruguay | 3 |
| Philippines | 1945 → | Philippines | 3 |
| Taiwan | 1946 → | Taiwan | 3 |
| Cameroon | 1961 → | Cameroon | 3 |
| Ethiopia | 1964 → | Ethiopia | 3 |
| Gambia | 1965 → | Gambia | 2 |
| Sweden | 1967 → | Sweden | 2+3 |
| Myanmar (Burma) | 1970 → | Myanmar ( Burma) | 3 |
| Sierra Leone | 1971 → | Sierra Leone | 2 |
| Nigeria | 1972 → | Nigeria | 2 |
| Sudan | 1973 → | Sudan | 2+1 |
| Ghana | 1974 → | Ghana | 2 |
| Samoa | ← 2009 | Samoa | 2+1 |

### 3.4 Macroeconomic indicators

Investopedia (2003) defines microeconomics as a study of economics that includes the behaviour of the economy as a whole. Segments of the economy that is examined in macroeconomics include national income, inflation, unemployment and Gross Domestic Product (GDP). Economic indicators are economic data that are usually macroeconomic of nature. Economic indicators help to assess the overall health of an economy (Investopedia, 2007b).

The descriptive macroeconomic statistics that was used in this research includes Gross Domestic Product (GDP), GDP growth, Gross Domestic Product per capita (GDP per capita.), vehicles per 1000 of the population and the estimated fatality rate per 100 000 people of the population as a result of vehicle accidents. As stated earlier, GDP is one of the main economic indicators that indicates the health of an economy and also provides a guideline for indicating the standard of living for a country (Investopedia, 2009). Gross Domestic Product per capita is essentially GDP divided by the total population of a country. Gross Domestic Product per capita may, by comparing LHD and RHD countries, establish the relative performance of each group. Gross Domestic Product per capita growth normally reflects an increase in productivity in countries (Investopedia, 2003).

### 3.5 Economic evaluation of Benefits and Costs

Whenever people are faced with options, they immediately think of the possible benefits or costs they might receive or incur with one option to another. This may sometimes prove difficult as most people do not perceive benefits and costs correctly. Economic evaluation focuses on including total benefits and costs (tangible and intangible) when making a decision. One way of comparing costs and benefits in economic terms is by using a Cost-Benefit Analysis (CBA).

Cost-Benefit Analysis is a method of making business and economic-based decisions. It can be used to evaluate a single option or to compare multiple options. This method aggregates all the costs of a certain option and compares it to all the benefits of the option. Costs and benefits may be tangible (monetary value) and/or intangible costs (morale, utility and disutility). Another cost factor to include in in the CBA is opportunity cost. As the CBA is more widely used in the evaluation of governmental policies and economic projects, individuals subconsciously partake in a CBA every day of their lives. (Investopedia, 2007a) Investopedia (2007a) outlined the CBA process in two simplified steps:

1. Listing all possible costs and benefits of a decision or project. Benefits should include all forms of revenue and intangible benefits or positive utility. Costs should include

opportunity costs, all indirect and all direct costs as well as risk. It is important to quantify these costs and benefits in the same monetary measurement.

2. Compare benefits and costs and if the benefits exceed the costs, the rational decision would be to move forward with the option, or the option that yields the highest benefit-cost ratio.

Most people perceive costs and benefits to have different measurements, but they are in fact very similar. Benefits are measured by an individual's willingness to pay to receive a positive utility or benefit. Costs are measured as the total compensation amount that is required to offset negative disutility (Portney, 2016). When determining the economic value of a cost or benefit it is important to use shadow prices. Shadow price is defined as the opportunity cost to society resulting from a project or activity. Shadow prices are used where the actual monetary value is not known or where the actual monetary value does not reflect the real value to society (BusinessDictionary.com, 2016).

## Chapter 4: Macroeconomic Statistics

The aim of this chapter is to determine if there is any relationship between macroeconomic indicators and the driving side of a country. Indicators considered include Gross Domestic Product (GDP), GDP per capita, GDP growth, Vehicles per 1000 of the country's population and traffic accident statistics. Most of the data used in this chapter was collected by The World Bank and is available from The World Bank[1]. The raw data was the reworked into usable spreadsheets for analysis.

### 4.1 Descriptive statistics on driving side

Of the 243 countries in the world, 167 countries drive on the left and 76 countries drive on the right. Data on macroeconomic indicators was only available for 131 LHD countries and 53 RHD countries. As mentioned in Chapter 2, GDP is one of the main economic indicators that indicates the health of an economy and also provides a guideline for indicating the standard of living for a country (Investopedia, 2003). Gross Domestic Product per capita may, by comparing LHD and RHD countries, establish the relative performance of each group (Investopedia, 2003).

**Table 5: Gross Domestic Product of LHD and RHD countries in 2013**

| | Driving on the Right (LHD) | Driving on the Left (RHD) | Total |
|---|---|---|---|
| **Number of Countries** | 131 | 53 | 184 |
| **Average GDP** | US $456 Billion | US $271 Billion | US $721 Billion |

Source: World Bank, 2014a

To test if the difference in LHD GDP and RHD GDP is statistically significant, a simple t-Test (two-sample assuming unequal variances) was calculated. The result of the t-Test is presented in Table 6.

[1] All of the data was analysed in Microsoft Excel. The data was accessed from The World Bank on 15 June 2015

**Table 6: t-Test (two-sample assuming unequal variances) for GDP**

| | *GDP LHD Countries* | *GDP RHD Countries* |
|---|---|---|
| **Mean** | US $453 Billion | US $271 Billion |
| **Variance** | 3.01985E+24 | 6.38273E+23 |
| **Observations** | 131 | 53 |
| **Hypothesized Mean Difference** | 0 | |
| **df** | 180 | |
| **t Stat** | 0.974074782 | |
| **P(T<=t) one-tail** | 0.165663309 | |
| **t Critical one-tail** | 1.653363013 | |
| **P(T<=t) two-tail** | 0.331326618 | |
| **t Critical two-tail** | 1.973230823 | |

For the test to indicate statistical significant results in the difference of the GDP's of LHD and RHD countries, the t-statistic should be smaller than the t Critical two tail value and the P(T<=t) two-tail value must be smaller than 0.05. The result of the test indicates that there is *no statistical significant difference* between differences in GDP's for the respective driving sides.

**Table 7: Gross Domestic Product Per Capita for LHD and RHD Countries in 2013**

| | **LHD Countries** | **RHD Countries** |
|---|---|---|
| **Number of Countries** | 130 | 53 |
| **Average GDP Per Capita (USD)** | US $13,835.61 | US $13,424.69 |

Source: World Bank, 2014a

To test if the difference in GDP per capita for LHD and RHD has any significance, a simple t-Test (two-sample assuming unequal variances) was calculated. The results of the t-Test are presented in Table 8.

**Table 8: t-Test (two-sample assuming unequal variances) for GDP Per Capita**

| | *GDP Per Capita LHD* | *GDP Per Capita RHD* |
|---|---|---|
| **Mean** | $13 836 | $13 425 |
| **Variance** | 419110698 | 370890388 |
| **Observations** | 130 | 53 |
| **Hypothesized Mean Difference** | 0 | |
| **df** | 102 | |
| **t Stat** | 0.128527598 | |
| **P(T<=t) one-tail** | 0.44899227 | |
| **t Critical one-tail** | 1.659929976 | |
| **P(T<=t) two-tail** | 0.897984541 | |
| **t Critical two-tail** | 1.983495259 | |

For the test to indicate statistical significant results in the difference of the GDP's of LHD and RHD countries, the t-statistic should be smaller than the t Critical two tail value and the P(T<=t) two-tail value must be smaller than 0.05.Table 8 reveals that there is *no statistical significant difference* in LHD or RHD countries' GDP per capita. It seems that the economic performance and health of LHD and RHD countries does not differ significantly.

**Table 9: Top Ten Populated Countries**

| # | Country | 2000 | 2010 | 2015 | 2050 | Driving side |
|---|---|---|---|---|---|---|
| | | Population | Population | Population | Expected | |
| 1 | China | 1,268,853,362 | 1,330,141,295 | 1,361,512,535 | 1,303,723,332 | LHD |
| 2 | India | 1,004,124,224 | 1,173,108,018 | 1,251,695,584 | 1,656,553,632 | RHD |
| 3 | USA | 282,338,631 | 310,232,863 | 321,362,789 | 439,010,253 | LHD |
| 4 | Indonesia | 213,829,469 | 242,968,342 | 255,993,674 | 313,020,847 | RHD |
| 5 | Brazil | 176,319,621 | 201,103,330 | 204,259,812 | 260,692,493 | LHD |
| 6 | Pakistan | 146,404,914 | 184,404,791 | 199,085,847 | 276,428,758 | RHD |
| 7 | Nigeria | 123,178,818 | 152,217,341 | 181,562,056 | 264,262,405 | LHD |
| 8 | Bangladesh | 130,406,594 | 156,118,464 | 168,957,745 | 233,587,279 | RHD |
| 9 | Russia | 146,709,971 | 139,390,205 | 142,423,773 | 109,187,353 | LHD |
| 10 | Japan | 126,729,223 | 126,804,433 | 126,919,659 | 93,673,826 | RHD |
| ∑ | **Total** | **3,618,894,827** | **4,016,489,082** | **4,213,773,474** | **4,950,140,178** | |

Source: Internetworldstats.com, 2015

Table 9 indicates the top ten highest populated countries and their driving side. It is interesting to note that the highest populated countries in the world shift between LHD and RHD. China, United States, Brazil, Nigeria and Russia are all LHD countries and the rest are RHD countries. In 2015, the top 5 LHD had a combined population of 2,133,085,034, accounting for 29.36% of the total world population. The total population of the top 5 RHD countries is 2,002,652,509, accounting for 27.57% of the total world population. It is forecasted, however, that in 2050 the split will be more even with LHD countries making up 48% of the total world population and RHD countries making up 52%.

Gross Domestic Product (GDP) and GDP per capita both share some interesting facts. The average GDP of LHD countries in 2013 is almost double that of the RHD countries, but the GDP per capita is on average only slightly more in favour of LHD countries (see Appendix B). The average GDP per capita does not indicate any significant difference between LHD and RHD countries.

**Table 10: Average Real GDP growth for LHD and RHD countries (2001-2015)**

| | AVERAGE REAL GDP GROWTH LHD (%) | AVERAGE REAL GDP GROWTH RHD (%) |
|---|---|---|
| **Minimum** | -4.29% | -0.76% |
| **Average per Year** | 3.97% | 3.63% |
| **Maximum** | 11.03% | 9.98% |

Source: World Bank, 2014a

Table 10 presents the average annual GDP growth each year for the period of 2001-2015 was 3.63% for RHD countries and 3.97% for LHD countries.

Figures 20 and 21, Appendix B, indicate the countries that have changed their driving side (green bars) at some point in history (discussed in Chapter 3) and the red bars indicate the average GDP per capita growth per driving side respectively. Countries that changed their driving side indicate a GDP growth that is evenly split, with half of them performing below average and the other half performing above average. All of the countries that have changed their driving side indicate positive average GDP growth.

It is apparent that there is no difference between the GDP or GDP per capita of LHD and RHD countries, but did a driving side change had any influence on GDP and GDP per capita for countries that changed driving side? Table 11 and 12 illustrates GDP per Capita and

GDP growth for 4 countries that most recently changed their driving side. The Tables indicate GDP per capita and GDP growth before, after and during driving side change.

**Table 11: GDP Per Capita before, after and during driving side change**

| Country | Ghana (LHD) | | Nigeria (LHD) | | Samoa (RHD) | | Sierra Leone (LHD) | | Sudan (LHD) | |
|---|---|---|---|---|---|---|---|---|---|---|
| GDP Per Capita (USD) | Year | GDP Per Capita | Year | GDP Per Capita | Year | GDP Per Capita | Year | GDP Per Capita | Year | GDP Per Capita |
| | 1969 | $ 234 | 1967 | $ 99 | 2004 | $ 2,351 | 1966 | $ 159 | 1968 | $ 128 |
| | 1970 | $ 258 | 1968 | $ 97 | 2005 | $ 2,588 | 1967 | $ 145 | 1969 | $ 137 |
| | 1971 | $ 274 | 1969 | $ 121 | 2006 | $ 2,794 | 1968 | $ 135 | 1970 | $ 151 |
| | 1972 | $ 233 | 1970 | $ 224 | 2007 | $ 3,130 | 1969 | $ 165 | 1971 | $ 160 |
| | 1973 | $ 264 | 1971 | $ 160 | 2008 | $ 3,376 | 1970 | $ 173 | 1972 | $ 168 |
| | Average | $ 252 | | $ 140 | | $ 2,848 | | $ 156 | | $ 149 |
| | **1974** | **$ 301** | **1972** | **$ 209** | **2009** | **$ 3,174** | **1971** | **$ 164** | **1973** | **$ 202** |
| | 1975 | $ 286 | 1973 | $ 252 | 2010 | $ 3,531 | 1972 | $ 179 | 1974 | $ 252 |
| | 1976 | $ 276 | 1974 | $ 402 | 2011 | $ 4,066 | 1973 | $ 217 | 1975 | $ 298 |
| | 1977 | $ 313 | 1975 | $ 437 | 2012 | $ 4,257 | 1974 | $ 239 | 1976 | $ 359 |
| | 1978 | $ 354 | 1976 | $ 555 | 2013 | $ 4,180 | 1975 | $ 246 | 1977 | $ 434 |
| | 1979 | $ 381 | 1977 | $ 534 | 2014 | $ 4,172 | 1976 | $ 211 | 1978 | $ 455 |
| | Average | $ 318 | | $ 398 | | $ 3,897 | | $ 209 | | $ 333 |

Source: The World Bank. 2014a

**Table 12: GDP Growth before, after and during driving side change**

| Country | Ghana (LHD) | | Nigeria (LHD) | | Samoa (RHD) | | Sierra Leone (LHD) | | Sudan (LHD) | |
|---|---|---|---|---|---|---|---|---|---|---|
| GDP Growth (%) | Year | % Growth | Year | % Growth | Year | % Growth | Year | % Growth | Year | % Growth |
| | 1969 | 3.8 | 1967 | -17.6 | 2004 | 4.0 | 1966 | 0.3 | 1968 | -1.0 |
| | 1970 | 7.2 | 1968 | -3.4 | 2005 | 3.5 | 1967 | -1.4 | 1969 | -1.6 |
| | 1971 | 2.5 | 1969 | 21.4 | 2006 | 1.3 | 1968 | 0.5 | 1970 | 2.8 |
| | 1972 | -5.2 | 1970 | 22.2 | 2007 | 5.6 | 1969 | 6.9 | 1971 | -0.8 |
| | 1973 | 0.0 | 1971 | 11.6 | 2008 | 0.3 | 1970 | 6.8 | 1972 | -7.9 |
| | Average | 1.6 | | 6.9 | | 3.0 | | 2.6 | | -1.7 |
| | **1974** | **4.0** | **1972** | **0.9** | **2009** | **-5.5** | **1971** | **1.7** | **1973** | **-2.4** |
| | 1975 | -14.5 | 1973 | 2.8 | 2010 | -0.2 | 1972 | -0.9 | 1974 | 8.0 |
| | 1976 | -5.4 | 1974 | 8.3 | 2011 | 5.0 | 1973 | 0.3 | 1975 | 12.1 |
| | 1977 | 0.6 | 1975 | -7.8 | 2012 | -0.4 | 1974 | 1.5 | 1976 | 12.9 |
| | 1978 | 6.8 | 1976 | 5.9 | 2013 | -2.7 | 1975 | -0.4 | 1977 | 2.8 |
| | 1979 | -4.3 | 1977 | 2.9 | 2014 | 0.4 | 1976 | -2.5 | 1978 | -9.0 |
| | Average | -2.1 | | 2.2 | | -0.6 | | -2.5 | | 4.1 |

Source: World Bank, 2014a

Table 11 indicates that these five countries had a higher average GDP per capita for the ongoing years after they implemented their driving side change (year of change included) than the years before the change was implemented. Samoa and Sierra Leone was the only

two countries that experienced a dip in GDP per capita during the year of driving side implementation. The overall trend is that GDP per capita did increase in the 10 years indicated in Table 11. It is not clear that exponential growth in GDP per capita can be attribute to a change in driving side, but there is evidence that suggest that a driving side change might influence GDP per capita in that specific year.

Table 12 indicates that four out of these 5 countries experience lower average GDP growth for the ongoing years after the implementation of a driving side change (year of change include). It is apparent that Ghana and Sudan is the only two countries that experienced improved GDP growth in the year of change and Sudan is the only country with higher GDP growth for the ongoing (year of change included). It is not indicative that a driving side change has a direct influence on GDP Growth as these figures do not appear to follow any trend.

When driving side change is considered, the vehicles per capita are also of importance. Vehicles per capita indicate how great the impact of driving side change will have on motor vehicle owners. The impact of replacing a LHD or RHD vehicle is less where ownership is low. Following is some general statistics on vehicles per capita for both LHD and RHD countries in the world. Table 13 indicates that there is a great difference in vehicle ownership between LHD and RHD countries. The data shown in Table 13 will be used to analyse vehicle ownership in the next section. Data on vehicle ownership was only available for 32 LHD countries and 73 RHD countries.

**Table 13: Vehicles per 1000 people for LHD and RHD countries (2011)**

| | LHD countries | RHD Countries |
|---|---|---|
| **Number of Countries** | 32 | 73 |
| **Min** | 5 | 3 |
| **Max** | 842 | 708 |
| **Average** | 331 | 259 |

Source: World Bank, 2014b

Left hand drive countries have higher GDP and GDP growth which would indicate higher ownership as seen in Table 13. Countries with higher ownership would most likely incur higher vehicle replacement cost than those countries with lower ownership, when switching driving side.

### 4.2 Driving side and vehicle ownership

To establish if there is a relationship between GDP per capita and the number of vehicles per thousand of the population, the two indicators can be correlated to identify any possible trend. Figures 8 to 10 shows the relationship between GDP per capita and vehicles per 1000 of the population. GDP per capita (2011) is used in this analysis and was obtained from The World Bank (The World Bank, 2014b). Plotting the relationship between GDP per capita and vehicle ownership may provide an indication if driving side has any impact on vehicle ownership. If driving side influences GDP per capita, it may also indirectly influence vehicle ownership. Figures 8-10 displays the log-linear relationship between GDP per capita and vehicle ownership. The $R^2$ value shows how well the log-linear equation fits the plotted data, with a value of 1 being a perfect match.

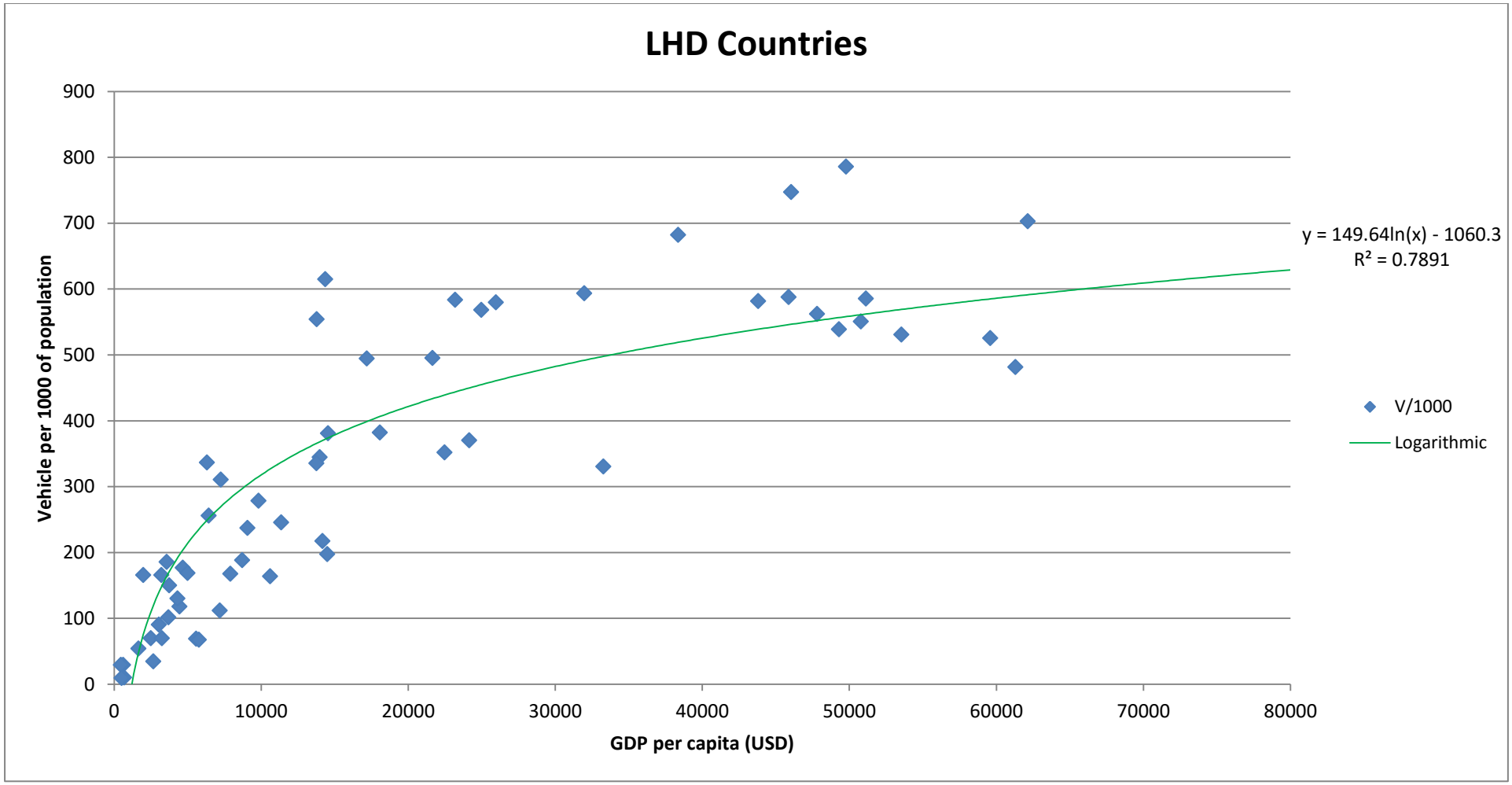


**Figure 8: GDP and Vehicles per 1000 of the Population: LHD countries (2011 Data)**

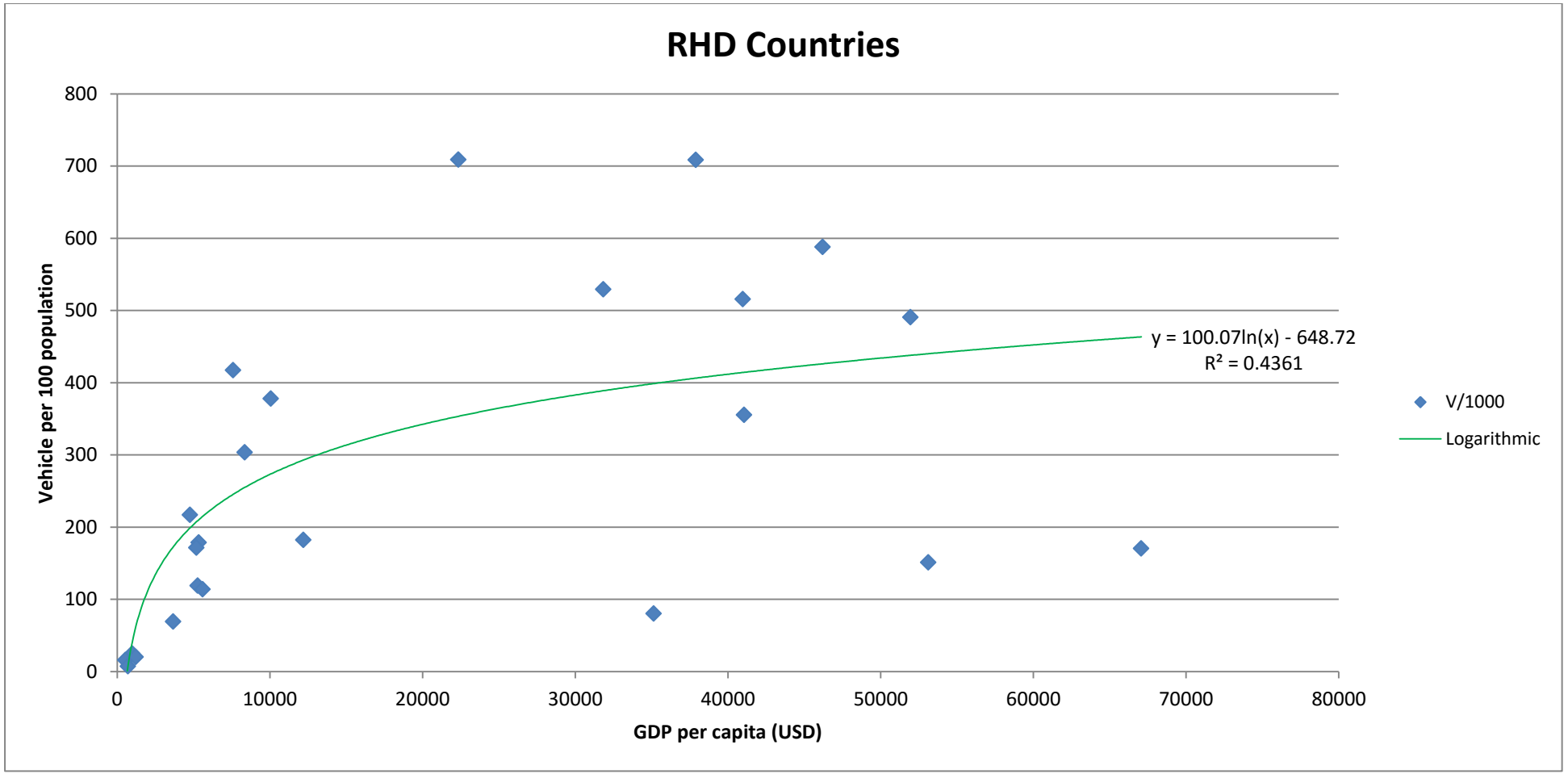


**Figure 9: GDP and Vehicles per 1000 of the Population: RHD countries (2011 Data)**

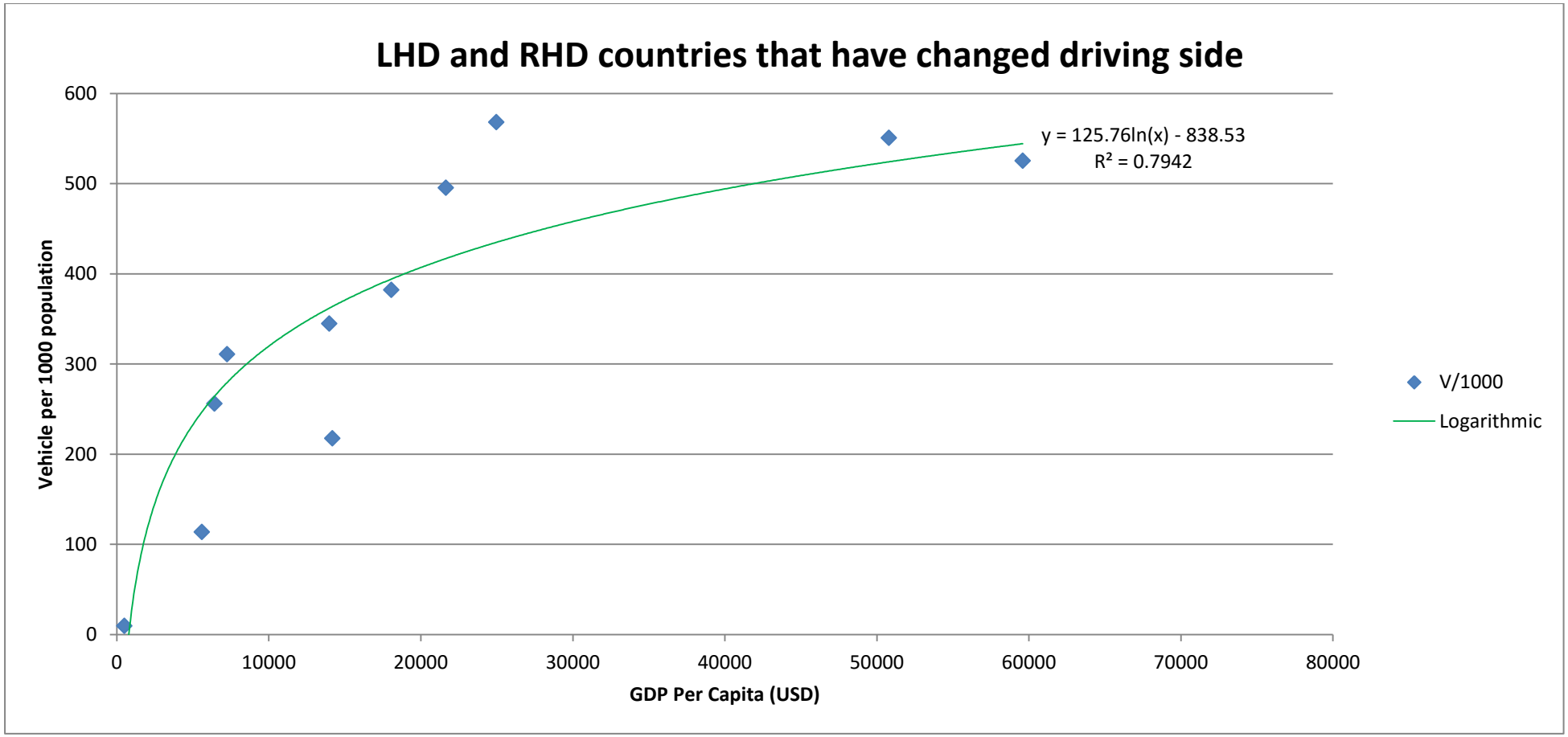


**Figure 10: Relationship of GDP and Vehicles per 1000 of the Population of All Countries that Changed their Driving Side (2011)**

The *dependent variable (y)* represents vehicle ownership per 1000 of the population and the *independent variable (x)* represents GDP per Capita. The Logarithmic trend line shows an $R^2$ value of 0.7891. This indicates a fit of 78.9%. From this we can see that for LHD countries, their relationship between GDP per capita and vehicle ownership per 1000 of the population can be defined by the following equation:

Equation: $y=149.64\ln(x) - 1060.3$ (1)

Change in GDP per capita will not have a constant change in vehicle ownership. Initially, vehicle ownership will increase significantly. As GDP per capita increases further, vehicle ownership will increase at a diminishing rate. Table 14 illustrates this more clearly.

**Table 14: Logarithmic relationship between GDP per capita and Vehicle ownership in LHD countries (2011)**

| GDP per capita | Vehicle ownership | Increase in vehicle ownership |
|---|---|---|
| $10,000 | 318 | - |
| $20,000 | 421 | 104 |
| $30,000 | 482 | 60 |
| $40,000 | 525 | 43 |
| $50,000 | 558 | 33 |

Using the same $R^2$ identification technique the most suitable equation to define the relationship between GDP per capita and vehicle ownership per 1000 of the population for RHD countries can be established. The same technique is used for countries that changed their driving side. For RHD countries, the logarithmic trend line indicates the highest $R^2$ value of 0.4361. This $R^2$ value is quite low and does not indicate a good fit, but is the best out of the three possibilities. The relationship between GDP per capita and vehicle ownership in RHD countries can be defined by the following equation:

$y=100.07\ln(x) - 648.72$ (2)

As in Equation 1, there is no constant relationship between the two variables. Initially, vehicle ownership will increase significantly but will also increase at a diminishing rate.

If we look at the countries that have changed driving side, the logarithmic trend line indicates a good $R^2$ value of 0.7942. Thus, the relationship between GDP per capita and vehicle ownership of countries that changed their driving side can be defined by the following equation:

Equation: y=125.76ln(x) – 838.53 (3)

The relationship between the dependent and independent variable also indicates, as with the other two equations, a positive relationship and initially, vehicle ownership will increase significantly but will also increase at a diminishing rate.

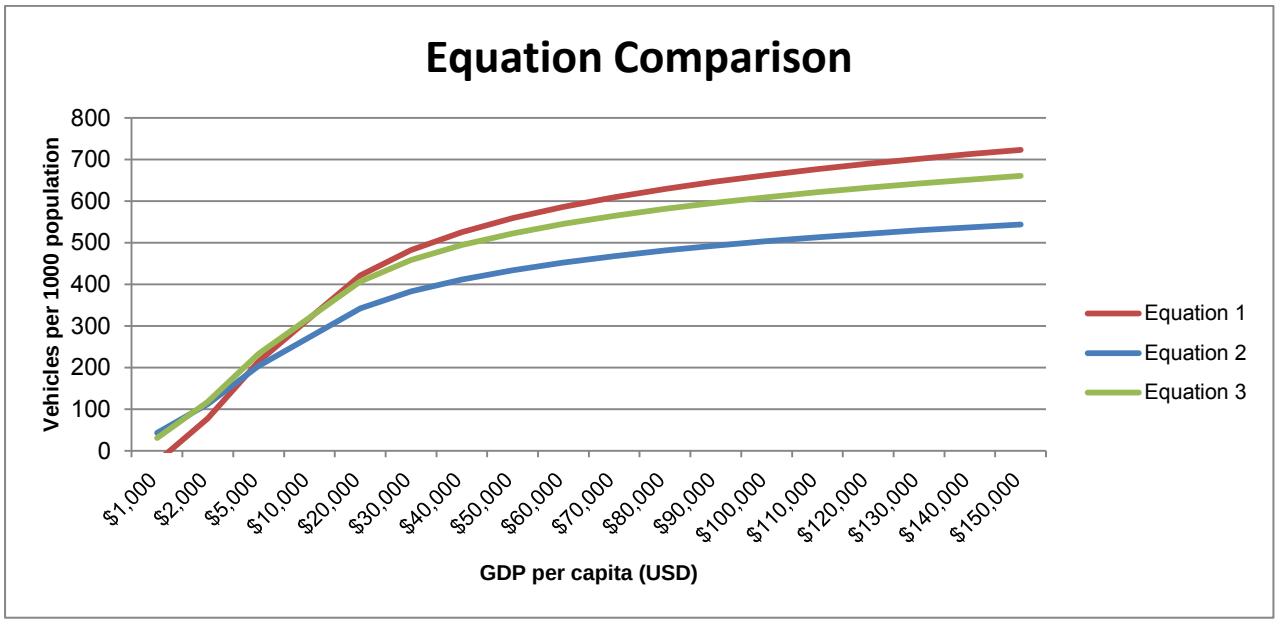


**Figure 11: Comparison of equations**

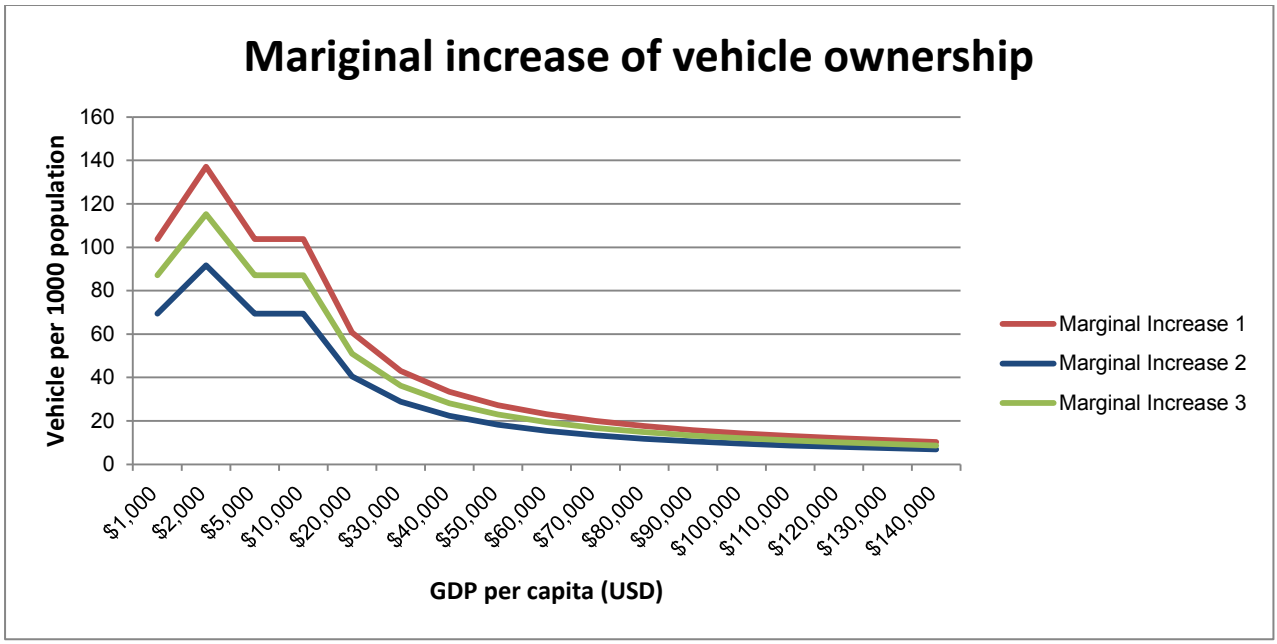


**Figure 12: Marginal increase of vehicle ownership per 1000 of the population**

Figure 11 and 12 help to illustrate the diminishing increase of vehicle ownerships per 1000 of the population as GDP per capita increases. The figures indicate that vehicle ownership in

LHD countries has a stronger, positive relationship with GDP per capita compared to RHD countries. This relationship, however, is only valid when GDP per capita exceeds $5000. The relationship is reversed for countries with a GDP per capita of less than $5000. Countries that changed driving side also have a higher increase in vehicle ownership associated with a GDP per capita increase. In the majority of cases the change in driving side is anecdotal with RHD and LHD switch. It can be concluded that LHD countries will see a larger increase in vehicles per 1000 of population with GDP per capita increase.

### 4.3 Accidents in LHD and RHD countries

Data obtained from the WHO (World Health Organisation) shows the estimated number of road traffic deaths for all countries in 2010 (World Health Organization, 2015). The world countries have been divided into LHD and RHD categories to compare the two sides in terms of estimated number of road traffic deaths and estimated road traffic death rate (per 100 000 population). This is presented in Table 15.

**Table 15: Accident statistics for LHD and RHD countries in 2010**

| | | **Estimated number of road traffic deaths in 2010** | **Estimated road traffic death rate (per 100 000 population) in 2010** |
|---|---|---|---|
| **LHD Countries** | Min | 0 | 0 |
| | Max | 970 | 42 |
| | **Average** | **419** | **16** |
| **RHD Countries** | Min | 1 | 2 |
| | Max | 892 | 68 |
| | **Average** | **164** | **16** |
| **Countries that changed Driving side** | Min | 30 | 3 |
| | Max | 908 | 34 |
| | **Average** | **489** | **17** |

Source: World Health Organization, 2015.

The average estimated number of road traffic deaths is much higher in LHD countries, which is largely due to the larger population of LHD countries. Considering the estimated Road Traffic deaths per 100 000 of the population, both LHD and RHD countries have an estimated average of 16 deaths per 100 000 of the population. This indicates that, at least for the year 2010, there is no indication that driving one or the other side leads to more

accidents. Even for countries that changed their driving side, the estimated average road deaths per 100 000 of the population is not significantly higher.

To conclude on this chapter, it is clear that there is a positive relationship between GDP per capita and vehicles per 1000 of the population. However, it is apparent that there some level of relationship between the *driving side* of a country and its *number of vehicles per 1000 of the population*. Even though the level of vehicle ownership between LHD and RHD differ, the trends between them are identical. The only difference between LHD and RHD countries with regard to driving side and vehicle ownership is the level of vehicle ownership.

Neither GDP nor GDP per capita is in any way statistically different between LHD and RHD countries. There seems to be no concrete evidence that GDP per capita and GDP growth is significantly influenced by the change in road side use. If there was a significant influence on GDP and GDP per capita, one could conclude that it would influence vehicle ownership rates in relation to these indicators. For instance, if a driving side change could be attributed to higher GDP per capita, vehicle ownership would increase and trade in motor vehicle industry would experience growth. This chain of possible economic effects may indicate that driving side change can result in macroeconomic benefits. The 2010 accident data show that there is no difference in average deaths per 100 000 of the population for LHD and RHD countries, which indicates that the level of deaths caused by accidents involving RHD and LHD vehicles are the same.

## Chapter 5: Africa: The divided continent

This chapter focus on driving side, transport cost and transport integration in Africa. Transport prices and costs are structured differently than in Europe. Africa has a higher variable cost component in relation to fixed cost, where in Europe transport cost is split more evenly between fixed and variable cost (The World Bank, 2009). The impact on driving side change will be different for African and European countries. There are some projects in Africa (Northern Corridor Road Side Stations, 2015.) that are already looking at making it easier to undertake long distance and cross-border transport activities. Driving side change should also be considered in these projects. The aim of this chapter is to distinguish between LHD and RHD countries in Africa, analyse the African transport environment and investigate the use of transport as a tool for economic development.

Africa is the only continent that is still largely divided between LHD and RHD nations. Out of 54 African countries 13 countries drive on the left side of the road (Right hand driving) and 41 countries drive on the right side of the road (Left hand driving). The GDP and GDP growth figures show that African countries are experiencing significant GDP growth. It is apparent that Africa is becoming the new centre for growth and opportunity for trade and Africa should look at improving its regional trade infrastructure to ensure economic growth and efficient trade integration.

One problem that should receive attention is the transport division of African countries. Harmonizing the driving side could have significant potential economic benefits. The scope of benefits are include economies of scale in vehicle production, leading to a decrease in vehicle purchasing price, maintenance costs and the cost of parts for these vehicles. These are all factors that strongly influence transport costs and prices. Transport cost and price will be discussed in detail later in this chapter. To harmonize transport in Africa would mean switching to a single driving side throughout the continent. The question being, which side is the best to drive on? The majority of countries drive on the right of the road so one could argue that would be the easiest route to follow.

**Table 16: GDP of LHD and RHD African countries**

| | Right Hand Drive | Left Hand Drive |
|---|---|---|
| Number of Countries | 13 | 41 |
| Total | $546,453,529,852 | $1,774,162,813,293 |
| Average | $42,034,886,912 | $46,688,495,087 |
| Minimum | $1,268,018,738 | $310,684,636 |
| Maximum | $350,630,133,297 | $521,803,314,654 |

Source: The World Bank, 2014a

Table 16 shows that the average GDP is very similar for LHD and RHD countries. Transport costs and prices in Africa may have an impact on the economy when a driving side change is considered. The following section will discuss transport costs and prices in Africa as reported by The World Bank. The cost and prices of transport are based on fixed and variable costs that can be influenced by switching driving side.

### 5.1 Transport Prices and Costs in Africa: A Review of the International Corridors

This section will provide a brief overview of the transport environment in Africa, the costs and the prices of transport. Transport prices and costs are based on the trucking transport sector along major transport corridors in the different African regions. The purpose of this section is to provide a base knowledge on the cost structure, transport operating cost, of African countries, based on the trucking sector. Transport cost can be defined as the monetary value of resources a transport provider must pay to provide a product to the user of transport (Transportationeconomics.org, 2015). *Transport cost* is divided into fixed and variable cost. *Transport price* can be defined as the monetary measure of what the user of a transport product has to pay the *transport provider* to make use of the transport provider's service. Transport prices are the negotiated monetary value for moving a passenger or cargo unit from a specific origin to a destination (Transportationeconomics.org, 2015).

#### 5.1.1 The African Transport Environment

Africa is generally characterised by low wages. This should imply low transportation cost and low transportation prices, since the transport industry is highly labour intensive (The World Bank, 2009:4). The truth is that transport prices are very expensive, especially in Central Africa, and is accompanied with poor service delivery. High profit mark-ups are responsible for this. Transport costs, on the other hand, are low in comparison to other countries. Figure 13 gives an outline of how transport prices and costs are determined (The World Bank, 2009:4).

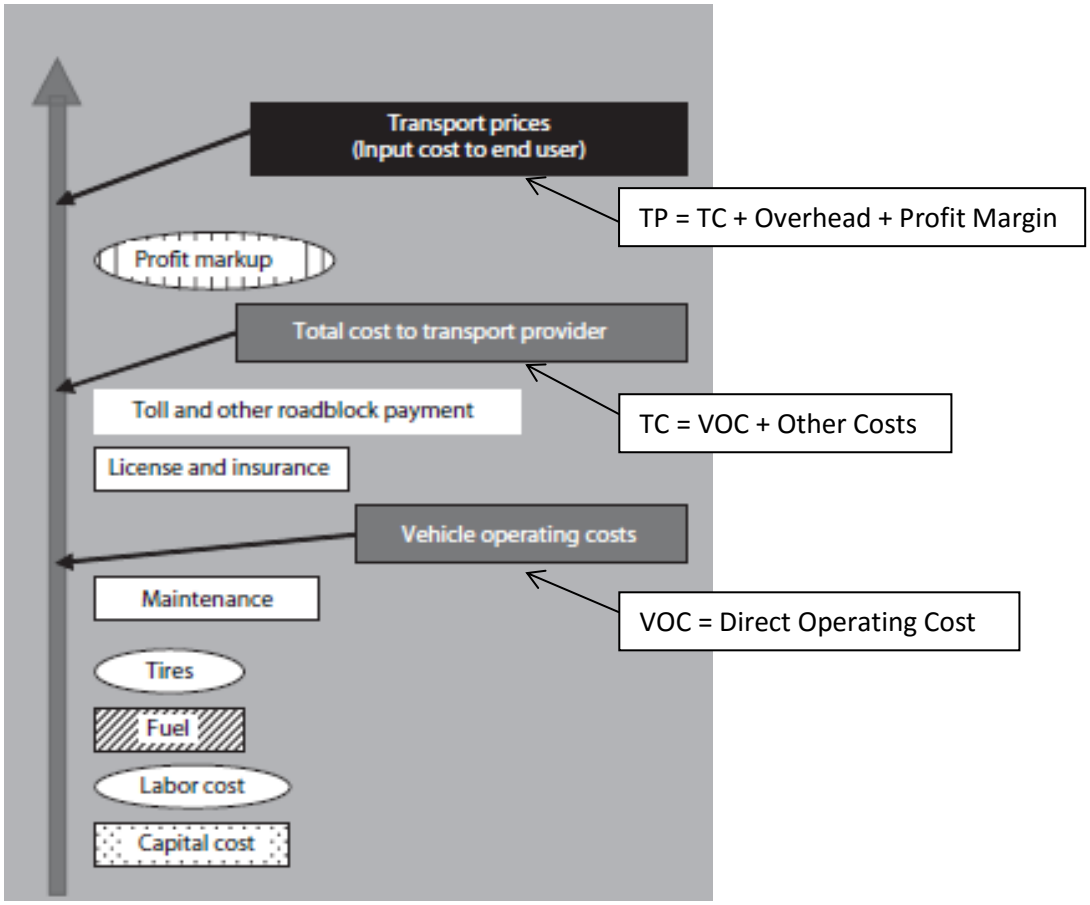


**Figure 13: Various Cost Components of Transport**

Source: The World Bank, 2009

- Transport Prices (TP) = Transporter Costs (TC) + Overhead + Profit margin
- Transporter Costs (TC) = Vehicle Operating Cost (VOC) + Other Indirect costs (insurance, licences, road toll, etc.)
- Vehicle Operating Cost (VOC) = Direct Costs of operating a Vehicle (tires, fuel, labour, maintenance and capital costs)

Vehicle operating cost will be affected the most by changing driving side, lowering capital and maintenance cost in standardised vehicles. Lower direct vehicle operating cost will lead to lower transport prices, making transport more accessible. Barriers to market entry like customs regulations, access restrictions and technical restrictions bring forth extra logistical costs. Another barrier exists with rent seeking[2] activity like cartels, corruption and inefficient trucking services. Logistics in Africa are more susceptible to rent seeking activities. Rent seeking activities and other barriers cause fragmentation of the supply chain, preventing

[2] The expenditure of resources in order to bring about an uncompensated transfer of goods or services from another person or persons to one's self as the result of a "favourable" decision on some public policy (Johnson, 2005)

seamless supply chains that are much needed. Some countries fall into the vicious cycle of inefficient transport operations and high prices (The World Bank, 2009:4). Freight sharing schemes are a big problem in central and West Africa as it harbours corruption. Freight sharing schemes usually favour the use of large fleets that consists of old and inefficient trucks. The import duties on large, new trucks are around 10 percent (The World Bank, 2009:5). The only reason why truckers decide to operate with an old fleet is because the regulatory systems in practice cap's the business operator's revenue and in return deter them of investing in new trucks (The World Bank, 2009:6). Furthermore, the only way to obtain large shares in freight contracts is to bribe freight bureaus and officials. Freight sharing schemes also eliminate direct contracting, which is the best way logistical contracts should be handled (The World Bank, 2009:5).

Cartels can provide low service quality and charge above normal tariffs for transport services. In these conditions, trucking companies in the cartel operates at high tariffs but underutilize their transporting capacity. One would expect new market entrants with high tariffs, but cartels make it nearly impossible for new service providers to enter the market.

In East Africa the transporting market is more competitive and more mature, while Southern African corridors prove to be the most advanced due to deregulation. There are two strategies, from a transport capacity, for preventing the underutilization of trucking capacity in Africa. The first strategy is to use second-hand trucks. The second is to overload the truck. Overloading causes a lot of damage to the road surface and is an important issue worldwide. Attempts at regulating the over loading of trucks in Africa have not been successful due to the fact that most stakeholders have interest in operating with overloads (The World Bank, 2009:6).

Africa is seen as having some of the worst roads in the world, attributing to the high variable costs of the transport operation. The study conducted by The World Bank (2009) however does not indicate that the poor road conditions in some sub-Saharan African countries attribute a lot to operating costs. The results of the Highway Development and Maintenance Model 4 (HDM-4) shows mixed results. For Central and West African countries, if the roads are fairly well paved, with low traffic conditions on international corridors, an improved road surface does not yield significant operating cost decreases[3] (The World Bank, 2009:7). The upgrading of road capacity and road surface quality in some East African countries, operating with a newer fleet, will have a significant impact on reducing operating costs. In

[3] The increase in operating cost as a result of using an old fleet of trucks is much higher than the additional operating cost stemming from poor road conditions. The extra operating cost incurred from poor road conditions will be much higher with a new fleet of trucks.

general, the capital cost in African countries is low while the operating cost high. Operating cost is influenced by road conditions and the price of fuel. The following table will give some insight into the different transport cost structures of African countries.

**Table 17: The fixed and variable transport costs of African transport operators**

| | Fixed Costs % | Variable Costs % |
|---|---|---|
| Central and West Africa | 30 | 70 |
| East Africa | 40 | 60 |
| Southern Africa | 32 | 66 |

Source: The World Bank, 2009

In contrast, developed countries such as France have a more even split (Table 17). France has a variable to fixed cost ratio of 45:55. Overall, in all the transport corridors in Africa, the highest variable cost item is lubricants and fuels, contributing up to 40% of total vehicle operating cost. Tires are also a big cost factor and bribes are far less of a cost impact than initially perceived. (The World Bank, 2009:7). Central and West Africa is predominantly LHD and East Africa is mostly RHD.

### 5.1.2 Overview of *Transport Prices* in Africa

Transport prices in Africa vary from region to region. For example, transport prices in Southern Africa are on average two to three times cheaper than in Central Africa. Central Africa is categorised by a wide spread of transport prices where some transporting companies subcontract activities to other truckers at lower rates. Some informal truckers operate at low prices, with trucks in bad conditions and with a low service quality. Central Africa is the most expensive in terms of transport prices, followed by East and West Africa, both of which has similar prices. Southern Africa has the lowest transport prices. Transport prices and transporting times give a good indication of service delivery quality. Southern and West Africa has the highest delivery speeds from port to hinterland destination while Central Africa has the worst (The World Bank, 2009: 37-38).

### 5.1.3 Overview of *Transport Costs* in Africa

Changing road side use in Africa will have a great impact on the cost of transport. The change will in effect force some road users to replace their entire fleet with either RHD or LHD vehicles. This will have a significant cost implication with regards to start-up costs, but may reduce the long term cost of maintenance and parts. Homogenising transport may also have a positive effect on transport. Since all the trucks and cars are of same driving orientation, quantities of vehicles bought will increase. As the law of economies of scale indicate, the higher the quantity, the lower price becomes. Inadvertently, vehicle purchasing

prices will most likely decrease, and maintenance cost will decrease with it as parts become more available. As seen in Table 17, the transport cost composition for the different African Regions is different. Other variable costs may not be influenced by road side change, for instance road and traffic conditions. In parts where cheap, old and second hand vehicles are used, fixed cost will be largely unchanged.

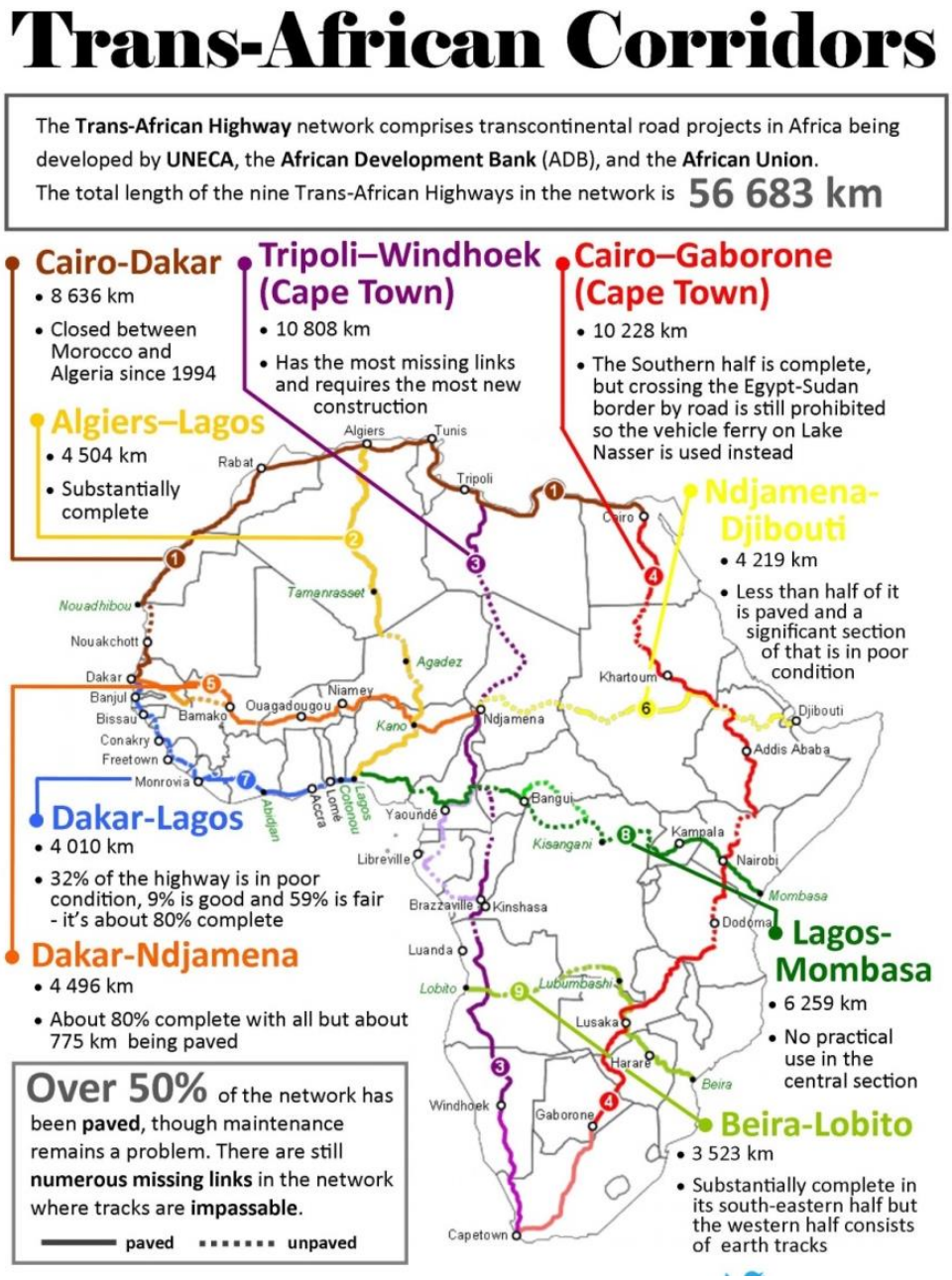


**Figure 14: Major Trans-African Transport Corridors**

Source: Sidler, 2014.

In Figure 14 we can see that major transport corridors in Africa move between countries with LHD and RHD. The transport costs also differ between these countries. The Lagos-

Mombasa route is a great example of a route that travels through LHD and RHD countries. Along major African corridors, variable transport cost per kilometre is on average between US$1.22 and US$1.31, with the exception of high variable cost on the Ngaoundéré – Moundou route and low variable cost on the Mombasa - Kampala route. Daily fixed cost per day in Africa can vary from US$21 to US$73, which is very small in comparison to the fixed costs observed in the United States and Europe (The World Bank, 2009:64). The following Table illustrates the typical cost structure of a trucking company In Africa compared to Europe

**Table 18: Transport Cost Composition in Africa and Europe compared (%)**

| Cost | France (LHD) | Chad (LHD) | Kenya (RHD) |
|---|---|---|---|
| **Fuel** | 25 % | 50% | 21% |
| **Maintenance** | 9% | 22% | 10% |
| **Depreciation and insurance** | 12% | 8% | 24% |
| **Toll roads/User charges** | 5% | 11% | 1% |
| **Staff costs** | 35% | 6% | 19% |
| **Admin and Overheads** | 14% | 3% | 25% |
| **Total** | 100% | 100% | 100% |

Source: The World Bank, 2009

Fuel remains a big variable cost item in all three countries, where in Central Africa (Chad) it is as high as 50%. Labour costs in the more developed countries are higher, up to 35% in France. Toll charges in Chad are the highest, while it seems in East Africa tolls are fairly an unused concept. From this Table 18 we can see that in different African countries, the transport cost compositions vary. If a change is implemented with regards to harmonising driving side, could these compositions become more similar? In short, it is highly unlikely. The reason is that the changes in transport cost are influenced by factors that might be external and more complex than the side of the road which they might be driving on (The World Bank, 2009:64). Factors such as staff costs, admin and overheads, depreciation and insurance and toll roads cannot be influenced by purely changing driving side. As mentioned earlier, economies of scale can be attained that will eventually lean towards lower purchasing and maintenance cost of vehicles.

### 5.2 Projects in Africa that may influence Driving side

One of the latest projects in Africa is the adoption of the Japanese Michi-no-Eki (Road Side Stations) along East African corridors. The main goal of these Road Side Stations is to aid the trucking and transport sector by providing much needed refuelling and maintenance

services. The Road Side Station (RSS) will be implemented along major transporting routes in East Africa, including Kenya, Uganda, Rwanda, Burundi, Sudan and the Democratic Republic of the Congo (DRC). The main functions of the RSS are listed below:

- Restaurants, Shops, Health clinic, Bank/Bureau office, Car workshops: In roadside stations dedicated to cars;
- Trucks Cleaning repairs and inspection services;
- Fuelling Petrol station, Public information area/Administrative services,
- Local community markets for crafts& local produce;
- Service for trucks (repairs);
- Supermarkets;
- Parking spaces providing secure parking yards for transit vehicles as well as rest facilities, restaurants, information centres, and outlets for amenities needed by truck crews, long distance passengers and, in some cases, the local communities (Road Side Stations, 2015).

From these functions one can see that not only will the RSS play a functional role in aiding the trucking and transportation sector by providing much needed refuelling and maintenance centres, it will also create a business environment for local entrepreneurs and producers of services and goods, in return providing much needed employment opportunities. Another important factor to consider is that it would be frequent enough on major routes to provide assistance for short road side stops as well. Some companies require their drivers to stop every 2 to 3 hours for a quick rest and this will be made easier with the RSS concept.

There are three types of RSS designs, small, medium and large. A Spanish consulting firm, TYPSA, has identified 144 RSS locations throughout these previously mention countries in 2014, but only 67 of these locations are economic viable. Along the 2000km road network, with the extensions into South Sudan and The DRC, Kenya will have 22 RSS's, Uganda 27, the DRC and Rwanda both will have seven and Burundi and Sudan will have two each (African Development Bank, 2014). The three RSS stations that will be implemented will be shown in the following figures.

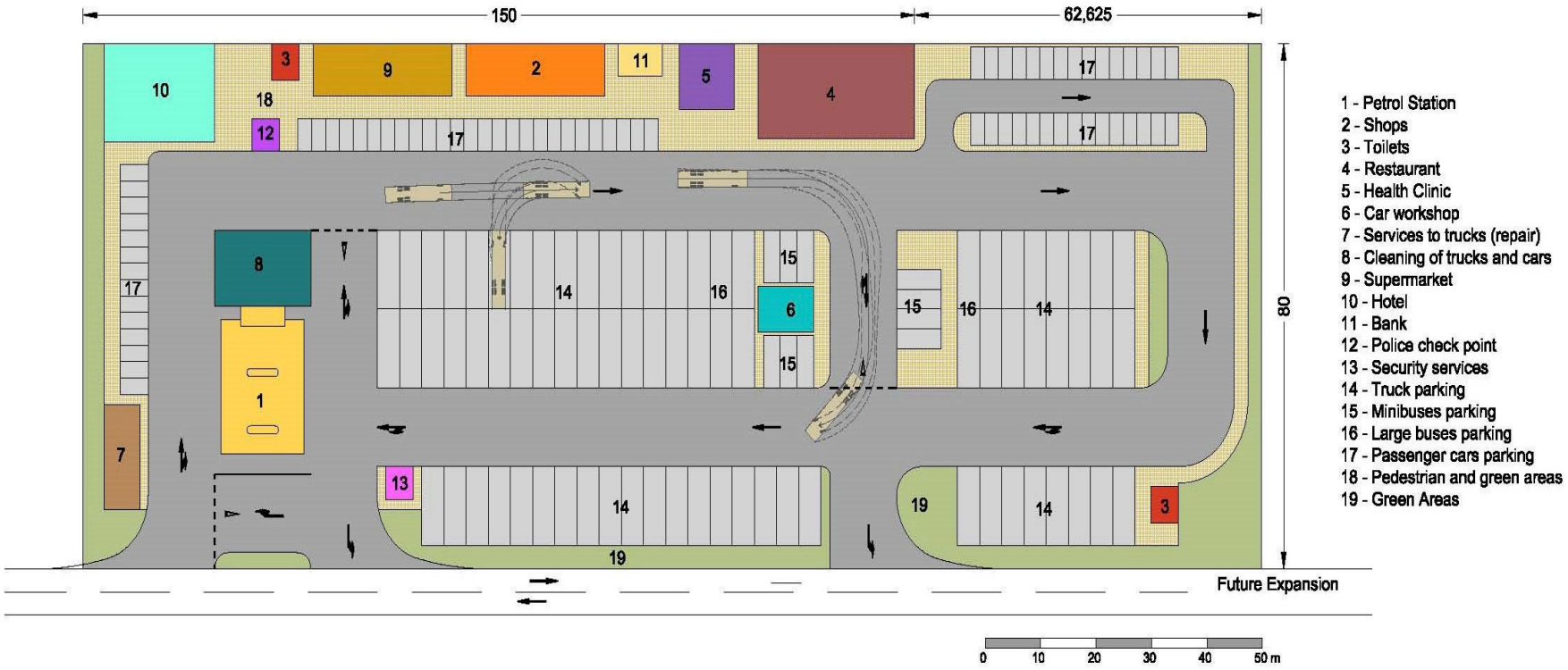


**Figure 15: Large RSS (RHD)**

Source: Northern Corridor Road Side Stations, 2015

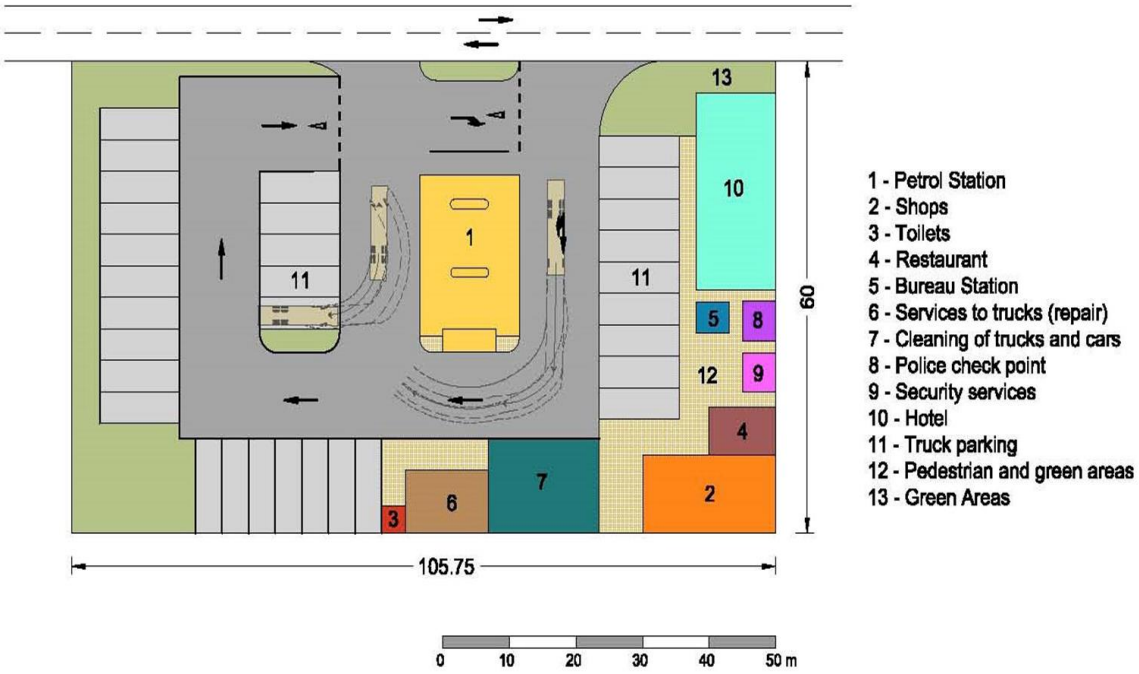


**Figure 16: Medium RSS (RHD)**

Source: Northern Corridor Road Side Stations, 2015

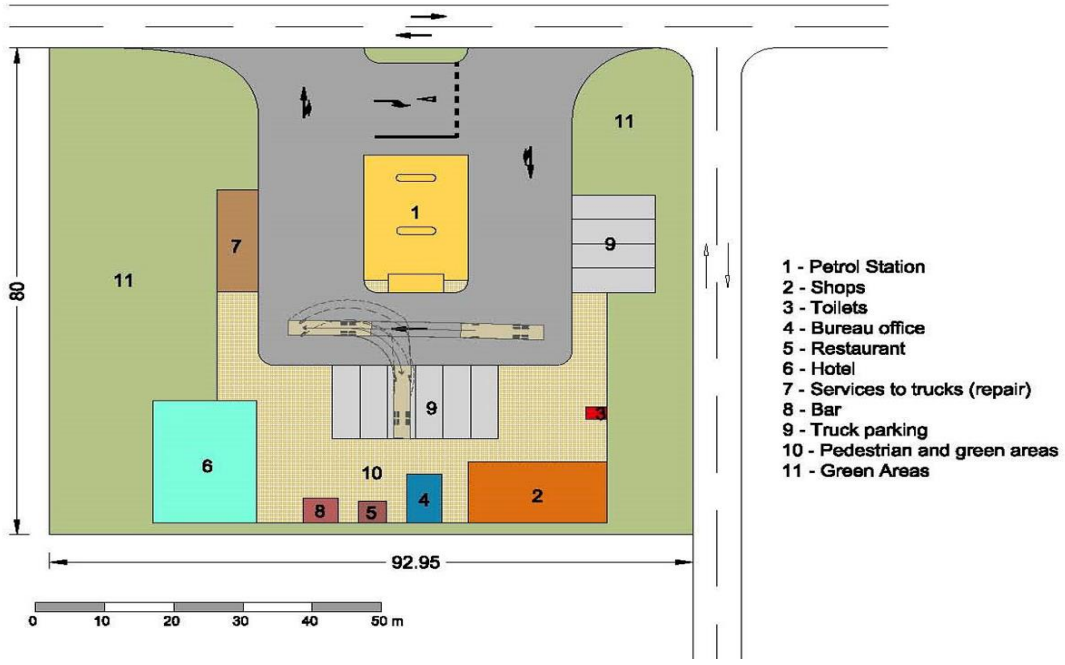


**Figure 17: Small RSS (RHD)**

Source: Northern Corridor Road Side Stations, 2015

**Table 19: Number of Small, Medium and Large Facilities in each Country**

| Country | Total | Small | Medium | Large | Driving Side |
|---|---|---|---|---|---|
| *Kenya* | 22 | 6 | 9 | 7 | RHD |
| *Uganda* | 27 | 8 | 12 | 7 | RHD |
| *Rwanda* | 7 | 4 | 3 | 0 | LHD |
| *DRC* | 7 | 0 | 4 | 3 | LHD |
| *Burundi* | 1 | 1 | 0 | 0 | LHD |
| *South Sudan* | 2 | 2 | 0 | 0 | LHD |

Source: Northern Corridor Road Side Stations, 2015

Large facilities are more extensive with a lot more complementary services, including healthcare. From the services and the size of the large RSS facility, the conclusion can be drawn that these facilities will be placed far apart from one another, closer to areas where these facilities would be needed. Only the small RSS facilities do not have police check points. The small and medium facilities both have banks/bureau offices, which indicate that their placement would be closer to border posts. All of these facilities have the basic functions of providing a resting, maintenance and refuelling function, which is the main aim we would come to expect from such a station. From Table 19 it is apparent that medium facilities are the most popular facility size chosen along these corridors. They provide all round service, with ample size to accommodate relatively large demand zones.

When considering the layout of the three RSS stations, it is apparent that the layout only accommodates a RHD traffic configuration. This is troublesome as four of the countries along the Northern transport corridor are LHD countries. It would be difficult and cumbersome for these vehicles (either LHD or RHD) to access RSS facilities in LHD countries from the right side of the road. Vehicles would have to cross over the lane of oncoming traffic to access the facility, making it dangerous for normal traffic and the trucks and increasing congestion at these sites. After close examination of both volumes one and two of the final reports for the RSS project, there seems to be not one design for LHD countries. Implementing the RHD design on LHD roads will not be feasible. It is an indication that the LHD and RHD dilemma is not always considered in regional integration initiatives.

On June 22 2016 the African development Bank (AFBD) approved a USD 245 million in loans and grants to the Uganda and Rwanda government to finance a project that is aimed at improving regional integration and trade. Along with trade integration, the project is aimed at decongesting traffic between Kampala (Uganda) and Mpigi (Rwanda). Uganda and

Rwanda is both land locked countries and are highly dependent on road transport for economic trade and growth. Rwanda will be responsible for investing USD 94 million in rehabilitating a 208km stretch road (Kagitumba-Kayonza-Rusumo) in Eastern Rwanda, while Uganda will be responsible for investing USD 151 million in the construction of a 23.7 km expressway. These two roads will form vital links in support of regional integration and trade facilitation in the East African Community (EAC). This project is said to help reduce poverty across Uganda, Rwanda and Tanzania. The project will also facilitate the development of cross-border markets and assist in the training of women traders and entrepreneurs (African Development Bank, 2016).

The main beneficiaries of this project are the traders and transporters along these corridors, as well as the some 2.14 million inhabitants of this region. Co-investors include the AFBD, the Japan International Cooperation Agency, the European Uninion (EU) and the governments of Rwanda and Uganda (African Development Bank, 2016).

This specific project, alongside the RSS project, clearly indicates that the EAC is focussed on relieving poverty and increasing trade through regional integration, driven by transport infrastructural projects. This indicates that transport is a powerful tool that can be used to gain positive economic benefits for the stakeholders involved. Changing the driving side may also be one such tool that can be used to achieve the goals set out by the EAC.

### 5.3 Vehicle manufacturing in South Africa

In an attempt to see if there are any production cost differences in the manufacturing of LHD and RHD vehicles five of the largest Original Equipment Manufacturers (OEM's) in South Africa were contacted. They were requested to provide and answer on three questions, listed below:

Question 1:

Are there any manufacturing / production cost differences between left and right hand drive personal use vehicles?

Question 2:

If there are any significant cost differences, what is the nature of these costs differences? (i.e. are they related to possible economy of scale benefits or are there technological benefits associated with one side or the other?)

Question 3:

Are there, in your opinion, any benefits to be gained by standardizing driving side?

The aim here was to use this information to determine the possible costs savings of switching driving side and the possible economic benefit of such a standardization. Unfortunately, no response was received from OEM's and alternative avenues were perused. The technical editor for Car Magazine in South Africa, Nicol Louw, was contacted and asked for his professional opinion on this matter. His answers are presented in Box 1:

Box 1

1. *"Definitely. Even during design and development the potential markets of the vehicle need to be known as the left/right hand drive impacts on packaging and even crash performance. Because of the engine/gearbox layout in a front-engined car is rarely symmetrical (especially front wheel drive applications with transverse engine layout), the position of the steering column can cause interference. That is for example the reason why we do not get a Mercedes-Benz E63 S AMG all-wheel drive in South Africa as the four-wheel-drive system interferes with right-hand drive. Some models are only produced in left-hand drive as this is the biggest market and it may not be financially viable to produce a right-hand drive version. This was the case with Ford Mustang in the past but Ford has at least overcome the issues/costs and we will get a right-hand-drive version later this year."*
2. *"Both. The build process is more complicated with both RHD and LHD versions on the same production line. This also leads to more parts (different part numbers etc) that leads to a cost increase. From a technical point of view the packaging in the engine bay of a front-engined vehicle will be a lot simpler if only one steering location is chosen."*
3. *"For sure there will be benefits. The problem is the cost to change all the road signs etc and public perception. I am sure the accident rate will be high after switch-over! I believe this was done successfully in a few countries for instance Sweden" (Louw, 2015).*

Africa remains the only really divided continent considering driving side. There seems to be no significant difference between the GDP per capita of LHD and RHD African countries. The transport environment differs greatly from European nations, characterised by higher variable costs and poor road conditions on major transporting corridors. Although there are great innovative projects on improving transport in Africa, the possibility of harmonizing transport conditions throughout the continent is still not mentioned. Current and future projects in Africa, however, reiterates the important role transport plays in improving economic conditions within a country, especially for landlocked countries that are highly dependent on road transport for trade and economic growth.

# Chapter 6: Microeconomic Analysis of Switching Driving side

The previous chapters considered driving side from a macro-economic perspective. This chapter will consider driving side from a micro-economic perspective. An attempt will be made to quantify the economic potential benefits associated with driving side for individual vehicle owners.

## 6.1 Case Investigation: Ministry of Infrastructure (MININFRA) 2009: Final Report on the Study on the Possibility of Switching Driving Side in Rwanda

When the ban of importing right hand drive vehicles in Rwanda was constituted in 2005, the maintenance cost of vehicles and the purchase costs increased significantly. This is attributed to the high import rate of second hand Japanese vehicle, which is mostly right hand drive, much cheaper and less reliable than European vehicles (Republic of Rwanda Ministry of Infrastructure, 2009:1). With the exception of the Democratic Republic of the Congo (DRC) and Burundi, Tanzania, Kenya and Uganda are the main neighbouring countries of Rwanda driving on the left side of the road. Especially with the ports of Mombasa in Kenya and Dar Es Salaam in Tanzania. Rwanda trades highly with these countries. Harmonizing the rule of the road throughout the East African Community (EAC) would prove beneficial for these countries.

The Rwanda Ministry of Infrastructure's study has thus aimed to report on the possible outcomes of a do nothing (DN) and do something (DS) scenarios for Rwanda changing from the keep-right to the keep-left rule of the road. The impact on the consumers and public operators are very important. Public operators are already heavily invested in left hand drive (LHD) fleets. Should the ban on importing RHD vehicles be lifted consumers that bought expensive LHD vehicles will be quite unimpressed with the reversal of the ban. Aggregating the individual benefits and costs should provide an indication of the overall benefits and costs of potentially switching driving side for the country.

The purpose of the Rwandan Ministry of Infrastructure report is to analyse all the relevant factors that will be influenced by the change in road use side. These factors include vehicle purchase and maintenance costs, the trade and business relationships between other neighbouring countries and Rwanda and traffic safety after switching the rule of the road. The first issue to discuss is the review of the driving laws in Rwanda and neighbouring countries.

### 6.1.1. Driving Laws in Rwanda and Neighbouring Countries

The road network in Rwanda was developed for the use of LHD vehicles, but up to the ban in 2005 most of the cars on their roads was RHD. One dangerous effect this had that the disembarking of taxi passengers occurred to the side where traffic was and not the safe side of the road shoulder. Multiple incidents of unsafe road use practises contributed to the implementation of a Presidential Order in 2005. The Presidential order can be referenced in Appendix A.

This Presidential order makes it clear that only LHD vehicles can be operated in Rwanda from the 16$^{th}$ of October 2009. All RHD vehicles have a 4 year period, from 2005 to 2009, to convert to LHD. The DN scenario in the study was based on the current law as described above in articles 1 to 4. Since the ban was introduced, a mere 15% of RHD vehicles converted to LHD. This may be attributed to the high costs of converting vehicles (Republic of Rwanda Ministry of Infrastructure, 2009: 6).

### 6.1.2 Determination of monetary costs and benefits for DN and DS scenarios

When evaluating the possibility of changing the road use side in Rwanda, the possible costs and benefits that may result from change should be the base for decision making. In this case, the costs and benefits for both DN and DS scenarios should be evaluated. Evaluating two options (DN and DS) can be referred to in the context of a Benefit-Cost analysis (CBA) as discussed in Section 3.5. Cost-Benefit Analysis is a method of making business and economic-based decisions. It can be used to evaluate a single option or to compare multiple options. This method aggregates all the costs of a certain option and compares it to all the benefits of the option (Investopedia, 2007a).

Some benefits already exists in the importation of cheap RHD vehicles, lower maintenance and repair costs and seamless cross border transit operations with neighbouring countries like Kenya and Tanzania. Some intangible costs and benefits prove difficult to evaluate in monetary terms. The economic evaluation of possible benefits and costs under these different scenarios for vehicle importation, maintenance and operation and accident costs will give insight into the decision making process (Republic of Rwanda Ministry of Infrastructure, 2009:43).

When evaluating costs from an economic point of view, it is important to note that an economic evaluation uses shadow prices of services and goods. This means that it uses the true resource cost of an item, rather than its market tradable value. Thus, the true resource cost will be reflected by the market price, subtracting levies, taxes and duties. MININFRA used conversion factors to establish economic costs and benefits, found in Table 20 below.

**Table 20: Economic conversion factors used by MININFRA**

| Cost Component | Taxes, Charges | Ratio | % Cost of Works | Weighted Coefficient |
|---|---|---|---|---|
| Drivers/Crew | 8% | 0.92 | 20% | 0.18 |
| Skilled Mechanics/Workers | 30% | 0.70 | 10% | 0.07 |
| Vehicles | 20% | 0.80 | 35% | 0.28 |
| Fuel | 45% | 0.55 | 10% | 0.06 |
| Imported Spare Parts | 15% | 0.85 | 15% | 0.13 |
| Administrative Expenses | 30% | 0.70 | 10% | 0.07 |
| Overall Economic Coefficient of Capital Cost* | | | | 0.79 |
| *30% weighting for new vehicles and 15% for spares | | | | |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

The report done by MININFRA found that the average import cost of the various RHD vehicles was 16% to 49% cheaper compared to LHD. This may be attributed to the fact that the Japanese car market exports second hand LHD vehicles at a low cost, because strict environmental laws makes it too expensive to dispose. This shows a significant opportunity for potential cost savings over the evaluation period of the year 2009 to 2028. According to MININFRA, the maintenance and operating of the different RHD vehicles were 5.5% to 38.5% cheaper than those of LHD vehicles over the same evaluation period. Mass produced LHD vehicles from Thailand and Japan increases the availability of parts at lower costs, which brings down the price of these parts. The savings in maintenance costs of RHD vehicles is rounded to a net benefit of $2.7 billion over the evaluation period (Republic of Rwanda Ministry of Infrastructure, 2009:44). The cost of road accidents was evaluated by using the Human Capital Approach. The Human Capital Approach is based on the loss to the economy as a whole due to the premature injury or death of a person.

Another important cost factor to consider would involve the cost of converting the current vehicle fleet to RHD. MININFRA used the conversion from RHD to LHD in the four year term since the ban to illustrate the future cost of conversion from 2009 to 2028. From vehicles that changed driving side, the minimum conversion rate is found in motorcars (7.8%). The maximum conversion rate is found with trailer trucks (31.3%). The weighted average conversion rat of all vehicles was 15%. One reason for this may be that the cost for the consumer to convert his/her vehicle is in relation much higher than for a trucking company. Although the cost for trucking companies is much higher, additional cost can be recovered by spreading it through different business activities. From Table 21 we can see the different

costs incurred by converting vehicles (Republic of Rwanda Ministry of Infrastructure, 2009:46).

**Table 21: Cumulative Conversion Percentage rate and Financial Costs for converting from RHD to LHD until May 2009**

| Vehicle Type | Cumulative % Conversion | Cost (USD) per vehicle |
|---|---|---|
| Car | 7.80% | $ 401 |
| Pickup | 14.70% | $ 354 |
| Jeep | 17.30% | $ 2,843 |
| Minibus | 13.80% | $ 613 |
| Bus | 11.80% | $ 3,000 |
| 2 Axle Truck | 23.70% | $ 2,832 |
| 3 Axle Truck | 23.70% | $ 2,833 |
| Articulated Truck | 31.30% | $ 3,000 |
| Trailer Truck | 31.30% | $ 3,000 |
| **Weighted Average** | **15.00%** | **$ 1,599** |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

Under DN scenario, the number of LHD vehicles will be 54%. This will lead to a lower economic cost of converting a vehicle and will generate a cost of around $5.66 million. The consumer will thus experience a higher negative value of benefit under a DS scenario than under a DN scenario. The average GDP per capita for Rwanda in the past ten year was approximately USD 550, which makes it very difficult for the average citizen to pay the USD 401 to convert his or her vehicle to LHD. Switching from LHD to RHD vehicles may prove to be more beneficial as RHD vehicles prove to cost less.This may indicate why it the conversion rate is so low. Next we take a look at the possible advantages switching driving side would have for transporters at Rwanda border posts (Republic of Rwanda Ministry of Infrastructure, 2009:46).

When a truck arrives at one of the eight border posts to enter Rwanda, it is taken of the road for inspection. After inspection it is allowed to continue into Rwanda, just making sure it stays to the correct side of the road. Truck drivers usually do not drive directly through a border post, as they need to switch to the other side of the road. This procedure does not allow for any time savings at any of border posts along the Rwanda border. However, if the implementation of a one stop border control and customs clearance system could materialize, switching the side of road use could lead to significant time and costs savings

(Republic of Rwanda Ministry of Infrastructure, 2009:46). This can be achieved by switching to the keep-left traffic rule in Rwanda.

The Republic of Rwanda Ministry of Infrastructure analysed the trucks crossing at the eight different borders, classifying them into vehicles registered within Rwanda, and foreign vehicles crossing border posts. They found that of all the vehicles crossing the Rwandan borders, 65.9% of these vehicles are RHD. Of all the Rwandan vehicles crossing borders, with the exceptions of the Gatuna and Kagitumba borders, 57.6% of all Rwandan vehicles that crosses the border are RHD. The share of RHD vehicles amongst foreign vehicles is even higher at 69%. This indicates that significant time savings at border posts is possible by switching road side use in Rwanda. (Republic of Rwanda Ministry of Infrastructure, 2009:47).

Assuming that 5 minutes can be saved by not having to change lanes in a one stop border crossing scenario, MININFRA estimated that there is a potential for increased saving of $0.68 million when a one stop border control system is integrated together with switching road side use. It is apparent from the MININFRA study that most of the vehicles crossing Rwandan borders are both RHD and from foreign origin. Can the switch in road side use increase the competitiveness of Rwandan transporters? By the Presidential Order in 2005, foreign RHD vehicles are allowed to be operated in Rwanda for a period not exceeding 3 months, where after special permission from the Minister of Transport is needed to continue vehicle operations (Republic of Rwanda Ministry of Infrastructure, 2009:47).

From the data collected by MININFRA, it is apparent that of all vehicles carrying passengers and goods across Rwanda borders, 72% of them are foreign, of which 69% is RHD. This indicates that since the Presidential Order in 2005, rather than converting to LHD vehicles, transporting vehicles was registered in foreign countries and operated in Rwanda under special permission. Adding to this, the highest volume of international trade by Rwanda was transported by foreign registered vehicles. It is clear that there are true benefits with the change of the road use and also some costs that can be attributed to vehicles. The change of road signs can also proof to be costly with the change of road use (Republic of Rwanda Ministry of Infrastructure, 2009:48).

The Republic of Rwanda Ministry of Infrastructure mentioned that Rwanda was going to undertake the installation of a modern road signage system under an ongoing signage project. The experts on the project said that if there was a decision made to switch from LHD to RHD, the incremental investment cost would not be significantly high. The current system is very old and rudimentary and upgrading is evidentially necessary, whether the decision to change road side use was made or not. According to The Republic of Rwanda Ministry of Infrastructure, if the decision to change side was made, the main additional costs would be

the conversion of 10 signalised junctions in different cities, which would cost around $2.5 million. A lump sum of $1.27 million should be set aside for institutional and operational costs involved in switching sides. The breakdown of the costs can be noted in Table 22 below (Republic of Rwanda Ministry of Infrastructure, 2009: 50)

**Table 22: Economic and financial costs of Operational Modalities, Signage, Signals and Furniture under a DS scenario**

| Parameter | Financial Cost (Million USD) | Economic Cost (Million USD) |
|---|---|---|
| Operational and Institutional cost for switching | $ 0.13 | $ 0.10 |
| Costs conversion of signalised junctions | $ 2.58 | $ 2.04 |
| Additionla costs for Road signs and Furniture | $ 0.04 | $ 0.03 |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

#### 5.1.2.1 Techno-Economic viability of switching sides

The Republic of Rwanda, Ministry of Infrastructure, used economic profitability indicators to evaluate the techno-economic viability of switching road side use. Financial impacts are also important and will be discussed in the next sub-section. The Republic of Rwanda, Ministry of Infrastructure, did the economic evaluation, as stated earlier, for the evaluation period from 2009 until 2028 on the different DN and DS scenarios. All benefits and costs for the DN scenario have been computed for each year during the evaluation period and were directly compared with similar costs and benefits under a DS scenario for the same time period. A discount rate of 12% was used, as this is the value used to represent opportunity cost of capital used in Rwanda for the evaluation of public economic projects (Republic of Rwanda Ministry of Infrastructure, 2009:51). A more detailed version of cost streams can be found in Appendix-A of the 2009 MININFRA report. Despite for some minor sources of negative benefits resulting from accident costs, costs associated with the conversion of vehicles and the costs of signage change, the figures indicate an overall net benefit of $2.9 billion over the evaluation period of 2009 until 2028 as seen in Table 23 (Republic of Rwanda Ministry of Infrastructure, 2009:51).

**Table 23: Net Economic Value from witching road use at a 12% discount rate (million USD)**

| Vehicle Import Cost | Vehicle Operation & Maintenance | Vehicle Conversion Cost | Benefit at Border Crossings | Accident Cost | Road Furniture and Signage cost | Total NPV ($ Million) |
|---|---|---|---|---|---|---|
| 162.33 | 2715.97 | -5.66 | 0.68 | -0.1 | -0.13 | 2873.09 |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

The next step MININFRA took with the techno-economic evaluation was to compile a sensitivity analysis on the economic evaluated costs and benefits. The reason for this is that in reality, the costs and benefits estimated is most likely to vary for the DN and DS scenarios. MININFRA thus conducted a sensitivity analysis by altering the various costs and benefits for the DN and DS scenarios to establish the robustness of the economic viability of switching road side use. In an attempt to do this, various scenarios distorting costs and benefits of the DN scenario in relation to the DS scenario has been created. The following scenarios were included:

a) 15% increase in both benefits and costs of the DS scenario;
b) 15 % decrease of benefits and costs of the DN scenario;
c) (a) and (b) together;
d) 20% cost increase and 20% benefit decrease of DS scenario;
e) 20% cost decrease and 20% benefit increase of DN scenario;
f) (c) and (d) together (Republic of Rwanda Ministry of Infrastructure, 2009:52).

**Table 24: Sensitivity analysis on Economic evaluation factors of DN and DS scenarios**

| | Cost in Million USD | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | Vehicle Import Cost | Vehicle Operation & Maintenance | Vehicle Conversion Cost | Benefit at Border Crossing | Accident Cost | Road Furniture and Signage cost | Total NPV ($ Million) |
| NPV Base | 162.33 | 2715.97 | -5.66 | 0.68 | -0.1 | -0.13 | 2873.09 |
| Test-A | 53.96 | 1893.84 | -9.99 | 0.26 | -0.13 | -0.46 | 1937.48 |
| Test-B | 29.61 | 1486.44 | -9.14 | 0.36 | -0.11 | -0.44 | 1506.72 |
| Test-C | -78.77 | 664.32 | -13.47 | -0.06 | -0.14 | -0.76 | 571.12 |
| Test-D | 17.83 | 1619.8 | -11.43 | 0.12 | -0.14 | -0.56 | 1625.62 |
| Test-E | -14.63 | 1076.6 | -10.3 | 0.25 | -0.12 | -0.54 | 1051.26 |
| Test-F | -159.13 | -19.57 | -16.07 | -0.31 | -0.16 | -0.97 | -196.21 |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

Table 24 shows the results from the sensitivity analysis for scenario (a)-(f). It is apparent that for all the scenarios, except (f), the total NPV stays positive and would lead to a beneficial situation when road side is changed. Only in the most extreme situation, situation (f), will the change in road side lead to a negative NPV. To conclude, the implementation of a DS scenario would have a beneficial outcome. Table 25 below uses optimistic and pessimistic vehicle growth rates within the sensitivity analysis. Under pessimistic growth, NPV drops by 55% but still stays positive. Under optimistic growth, NPV increase by 140%, indicating the robustness of the economic evaluation for the DS scenario (Republic of Rwanda Ministry of Infrastructure, 2009:52).

**Table 25: Sensitivity analysis of Economic evaluation factors for DN and DS scenarios under Pessimistic and opportunistic growth scenarios.**

| Scenario | Vehicle Import Cost | Vehicle Operation & Maintenance | Vehicle Conversion Cost | Benefit at Border Crossings | Accident Cost | Road Furniture and Signage cost | Total |
|---|---|---|---|---|---|---|---|
| Low Growth (NPV in Million $) | -37.07 | 1323.7 | -4.36 | 0.42 | -0.11 | -0.13 | 1282.45 |
| High Growth (NPV in Million $) | 786.41 | 6099.66 | -6.95 | 1.24 | -0.1 | -0.13 | 6880.13 |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

### 5.1.2.2 Financial impacts of switching driving side

When assessing the financial impact of changing road side use, MININFRA took a look at the financial impact it will have on government revenues. These revenues include import duties and fuel levies. MININFRA used a 9-step process for calculating the taxes and duties for importing vehicles, set out as follows:

1. Determine the Free on Board (FOB) cost of the imported vehicle;
2. Based on weight, determine the cost of freight;
3. Determine combined FOB and cost of freight, represented by A;
4. Calculate the cost of insurance, (3% of A) represented by B;
5. Calculate Cost, Insurance and Freight (CIF), represented by C=A+B;
6. Calculate import duty at a rate of 30% of C, represented by D
7. Calculate the income tax on total cost, 15% of C+D, represented by E;

8. Calculate VAT on F=C+D+E at a rate of 18%;
9. Calculate withholding tax at 5% of C (Republic of Rwanda Ministry of Infrastructure, 2009:54).

Using the steps described above, the tax revenues for both the DN and DS scenarios was calculated and discounted net cash flow at 2009 prices was estimated for the evaluation period of 2009-2028. As stated by MININFRA, the average import cost of RHD vehicles are 16 to 49% cheaper, and the government will lose a substantial amount of revenue by switching sides. It is estimated that the revenue loss will amount to US $88.99 million. Table 26 gives an insight to the projected discounted net cash flow at 12% for both DN and DS scenarios over the evaluation period (Republic of Rwanda Ministry of Infrastructure, 2009: 54).

**Table 26: Net cash flow discounted at 12% for DN and DS scenarios predicted over the evaluation period at 2009 prices**

| | Million USD | | | |
|---|---|---|---|---|
| **Parameter** | **DN** | **DS** | **NPV** | **% Difference** |
| Government revenue from vehicle import | 544.17 | 455.18 | -88.99 | -16.35% |
| Government revenue from fuel levy | 2985.61 | 3568.2 | 582.59 | 19.51% |
| Vehicle importers' cost | -1442.29 | -1177.68 | 264.61 | 18.35% |
| Drivers and operators' vehicle operation cost | -10375.7 | -6937.78 | 3437.94 | 33.13% |
| Vehicle conversion cost | -29.36 | -36.53 | -7.17 | -24.39% |
| Switching operation, road furniture and signage cost | -2.58 | -2.75 | -0.17 | N/A |
| Damage only accident costs | -0.03 | -0.09 | -0.06 | -164.02% |
| Net cash flow | -8320.2 | -4131.45 | 4188.75 | 50.34% |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

Another source of government revenue that can be affected is fuel levies. The implementation of a DS scenario has led to a loss in vehicle import tax revenue. In the case of fuel levies the opposite is true. With the change of road side use, there will be an extra $582.59 million will be generated by fuel levies over the evaluation period. This is an additional 19.51% over the DN scenario. This is attributed by the fact that under a DS scenario, the total number of vehicle would increase by 14% because decreased vehicle prices would increase its demand. The net revenue of the total levies and taxes that would be generated under a DS scenario would amount to $493.6 million. Table 25 gives an

overview of the taxes and levies on one litre of fuel in Rwanda (Republic of Rwanda Ministry of Infrastructure, 2009:55).

**Table 27: Composite of fuel levies for one litre in Rwanda**

| Description Of Cost | FRW/litre | USD/litre |
|---|---|---|
| CIF KIGALI | 417.02 | 0.74 |
| CIF REF. DOUANE | 184.14 | 0.35 |
| Redevance at 3% | 5.61 | 0.01 |
| Import duty at 30% | 56.14 | 0.1 |
| Taxe Conso at 37% | 93.7 | 0.17 |
| Sub Total port Duties and Taxes | 155.45 | 0.28 |
| *CHECK: CIF plus Subtotal taxes* | 572.47 | 1.01 |
| Road Fund | 60.23 | 0.11 |
| VAT | 112.24 | 0.2 |
| Total Taxes and Duties | 327.92 | 0.56 |
| PUMP PRICE | 796 | 1.34 |

Source: Republic of Rwanda Ministry of Infrastructure, 2009

As shown Table 26, the overall net cash flow for Rwanda during the evaluation period will be close to $4.8 billion, which will make a substantial contribution to the balance of payment for the government. To finish of the report done by MININFRA, we will take a look at the conclusions drawn from the study and the recommendations the MININFRA suggests.

### 6.1.3 Conclusion & Recommendations on MININFRA report

This section will give a brief overview of the conclusions MININFRA drew from their study and what they recommend under a DS and DN scenario. The first conclusion they drew was the fact that the ban introduced in 2005 drastically reduced the percentage of RHD vehicles from 99% to 49%. The combined share of these RHD vehicles (70%) was made in India and Japan. When the study was done, the figures show that in 2008, only 9% of all vehicles imported were new and around 70% was older than 10 years. The weighted import costs of RHD vehicles were 17%-49% cheaper and operating costs were 6%-39% cheaper on RHD vehicles (Republic of Rwanda Ministry of Infrastructure, 2009:61). The high demand for importing second hand RHD vehicles introduces the possibility increasing trade with the net exporters of second hand RHD vehicles such as japan and Thailand.

The majority perception of drivers (68.4%) believes that incremental accident rates are lower with RHD vehicles and the majority also believe that driving a RHD vehicle on LHD roads are not a constraint. As seen in Chapter 4, the accident rates in LHD and RHD countries does not indicate any difference between the two, which indicates a misperception of the Rwandan locals with regards to vehicle accidents of LHD and RHD vehicles. The extra generated traffic (16%) under a DS scenario, however, might lead to an increase in vehicle accidents. The DS scenario will also bring negative benefits with conversion costs. At border

crossings, there would be a $0.68 million savings in time savings under a DS scenario. Under a DN scenario, non-tariff barriers will lead to increased transport costs in Rwanda. There would be an overall net economic benefit of around $2.9 billion over the evaluation period when converting from LHD to RHD vehicles and using the keep-left traffic rule. A positive net cash flow of almost $4.9 billion will also be achieved under a DS scenario, strengthening the government's balance of payment. In the public's opinion, 54% of them voted for changing road side use from right to left (LHD to RHD), 32% were opposed to change and the rest was indifferent to change. In all questionnaires collected by MININFRA, the majority vote went to changing road side use (Republic of Rwanda Ministry of Infrastructure, 2009:61).

Although the economic benefits of changing road side use prove to be beneficial, practical issues concerning consumers cannot be overlooked. For instance, the ban on RHD vehicles in 2005 forced consumers to buy or convert vehicles to LHD. If the law was now to be reversed, these consumers must be compensated in some or another way for the financial loss they would again suffer. The low GDP per capita in Rwanda along with the high conversion costs of motor vehicles also makes it difficult for the people to afford. This effect can be multiplied in the public transporting sector. The ban also led to RHD vehicles being in the minority, leading to increased safety concerns under a DS scenario (Republic of Rwanda Ministry of Infrastructure, 2009:62).

To help in deciding between a DS and DN scenario, MININFRA recommends these guidelines as course for action under each scenario:

*Under a DN scenario:*

i. Greater efforts should be made to implement the Presidential Order of 2005 and the time frame to convert public transport vehicles from RHD to LHD should not exceed 2 years.
ii. As odd heavy goods vehicles (HGV) vehicle are responsible for many accidents in Rwanda, it should be enforced that foreign HGV's should fit a close proximity mirror to their passenger side to resolve the blind spot issue (Republic of Rwanda Ministry of Infrastructure, 2009:64).

*Under DS scenario:*

If it is decided to switch road side use, the following guidelines must be implemented to smooth over the transition of driving in the right side of the road to driving on the left side of the road:

i. Set up of a special administrating committee to administer the switch;
ii. Any decision made on road side switching should happen before the implementation of ongoing signage project;
iii. All relevant regulation must be prepared long before implementation;
iv. Conformation of driving modalities and transition time is required;
v. For safety reasons, public operators should be allowed two years to change from LHD to RHD and should be subsidised. Due to the advantageous nature of RHD, market forces will price out LHD vehicles;
vi. Additional import duties can be imposed to prevent the flood of cheap RHD vehicles that will increase congestion and earn government extra revenue;
vii. Preparation of driving laws, standards and treaties is important;
viii. There should be sufficient time to change signage in urban areas when change is applied;
ix. For at least a month prior to change, an extensive awareness campaign must be launched, targeting written, visual and social media as effective as possible. Handing out informational pamphlets to religious, scholar and political organisations will increase effectivity;
x. All private vehicles should be banned at least 6 hours before and 2 hours after implementation of the ban;
xi. The use of special traffic forces and soldiers for changing traffic signs and signals is available;
xii. Junctions should be closed temporarily to change signals and signage;
xiii. With implementation of the change, a low speed limit of 10km/h should be imposed to relegate traffic. This process should not be allowed to continue for more than a month after change (Republic of Rwanda Ministry of Infrastructure, 2009:64-65).

### 6.2 Guidelines on Analysing Road Side Change

From the case investigated by the Republic of Rwanda Ministry of Infrastructure some transferable guidelines can be established for evaluating a possible road side change. These include the following:

- It is important to establish two scenarios in the use of a CBA: one for keeping the current road side or the DN (do nothing) scenario and one for changing road side use or a DS (do something) scenario.
- When establishing economic cost and benefits, shadow prices must be used to establish the true resource value of benefits and costs.

- There are a specific list of costs and benefits with switching driving side and data must be collected accordingly (these costs and benefits will be discussed in the following section)
- Conducting a sensitivity analysis with different scenarios of increasing and decreasing benefits and costs is important. This will indicate the impact of costs and benefits in the different scenarios.

### 6.2.1 Costs and benefits for switching driving side

Gathered from the information portrayed in Section 6.1 there are certain costs and benefits that should be included when assessing the possibility of switching driving side. Some costs and benefits are difficult to quantify in a monetary value and future research must focus on improving or adding additional costs and benefits to ensure greater effectivity in future analysis. These costs and benefits give an indication to the type of data that should be collected.

**(a) Vehicle import costs**

Vehicle import cost includes vehicle price and import duties (based on price). Vehicle import cost is dependent on vehicle type and importation source. The MININFRA report stated that vehicle importation costs can be up to 49% cheaper when importing cheap RHD vehicles from India. If for instance a country would choose to switch from RHD to LHD, importation cost might increase. It is important for the country that is considering road side change to collect data on vehicle import cost for both LHD and RHD vehicles to establish a relationship between these costs (Republic of Rwanda Ministry of Infrastructure, 2009:44).

**(b) Vehicle operation and maintenance costs**

Vehicle operation and maintenance costs are dependent on a few factors. These include capital costs, labour, tyres, fuel and maintenance. Capital cost is the only direct fixed cost of vehicle operation cost and cannot be avoided by ceasing operations. Labour, tyres, fuel and maintenance are all variable direct costs and are influenced by external factors like traffic and road conditions, the way in which the vehicle is operated by its operator and how frequent the vehicle is operated. Vehicle operating cost is different for each vehicle type and operating condition. Vehicle operating cost will be discussed in greater detail in the next section (Republic of Rwanda Ministry of Infrastructure, 2009:44).

**(c) Vehicle conversion costs**

The cost of converting a vehicle from LHD to RHD or the other way around may prove to be costly. The study done in 2009 by the Rwanda Ministry of Infrastructure shows that the

conversion cost of a car is about 401 USD. This is very high considering that Rwanda's GDP per capita in 2009 was 494 USD. This means that it would not be economically beneficial for the people majority of residents to convert their vehicles. The recommendation would be that when conversion data is collected, GDP per capita should be should be evaluated(Republic of Rwanda Ministry of Infrastructure, 2009:45-46).

**(d) Benefits at border crossings**

This benefit is applicable to all countries that have cross-border transport activities, especially the land-locked countries that are very dependent on surface transport and those whose neighbouring country has a different driving side. Crossing borders between countries that differ with regards to driving side proves to be very time consuming as vehicles need to be taken of the road for inspection and clearance and then placed back on the other side of the road. If driving side in both countries are the same, vehicles would be able to stay on the road for inspection and clearance, creating a one-stop clearance system that significantly reduces time wasted at border crossings. Data collection on time savings will be ideally conducted in a country with more than one border country where one or more border crossing has the same driving side and one or more with different driving side (Republic of Rwanda Ministry of Infrastructure, 2009:46-48).

**(e) Accident costs**

Accident cost is an everyday occurrence in all countries. Accident costs usually comprise of monetary cost to the government in the event where infrastructure is damaged, and the loss of GDP when an individual is not able to work anymore (due to death or serious injury). Accident costs are likely to increase with the change of road side use as residents become disorientated with new rules. Overall between LHD and RHD countries, accident statistics show no significant difference in fatal road accidents in RHD and LHD countries. With implementing a change in driving side, accident cost will initially be much higher but will eventually subside to represent the norm. Data collection should focus on current accident statistics and on historic accident data of countries that changed their driving side (Republic of Rwanda Ministry of Infrastructure, 2009:45).

**(f) Signage cost**

With driving side change the change of road marks, road signs and traffic signals are essential. This can be a costly expense to government, especially where these road and traffic signs are complex. One way to minimise signage cost would be to implement a driving

side change close to when normal upgrade of signage is necessary (Republic of Rwanda Ministry of Infrastructure, 2009:50).

**(g) Cost to government**

Two main sources of government revenue that can be affected by changing the side of the road used are fuel levies and vehicle import tax. With the import of cheaper vehicles, government will most likely loose revenue from import tax, but the increase in vehicle ownership may lead to an increase in fuel tax received as more vehicles lead to higher fuel consumption (Republic of Rwanda Ministry of Infrastructure, 2009:54-55).

When considering the individual vehicle owners, sections (a)-(c) above will influence the individual vehicle owner the most when switching driving side. Table 21 indicates that the cost for the individual vehicle owner to convert his/her vehicle it would cost USD 201, which is very high considering the Average GDP per capita for the last ten years only equalling around USD550. If the initial investment for converting a vehicle is possible (either through savings or government subsidies) decreased maintenance and import costs will offset the initial investment cost over the evaluation period. The next section will identify the main cost determinants for the vehicle and individual vehicle owners.

### 6.3 Microeconomic analysis of driving side change

This section focusses on the data collected by the Council for Scientific and Industrial Research (CSIR) for the Rwanda Transport Development Agency (RTDA) in 2014. Taking what was learned from the previous section, the data that was collected can be analysed in terms of costs and benefits. The main focus is to identify the VOC (Vehicle Operating Cost) of LHD and RHD vehicles in Rwanda. This will give an indication on a microeconomic level if there are benefits and costs with regards to vehicle operating cost. Individuals mostly focus on perceived costs (out of pocket expenses) and vehicle operating cost is the one of the most important cost perceived by individuals when traveling with private transport.

#### 6.3.1 Vehicle operating cost of LHD and RHD vehicles in Rwanda

Vehicle operating cost (VOC) varies with the use of a vehicle and includes maintenance, fuel, mileage-dependent depreciation and tires. Vehicle operating cost can be influenced through projects that influence traffic speed and delays, roadway geometry, vehicle miles travelled and roadway surfaces. Vehicle ownership costs are fixed costs that are not directly influenced by the use of a vehicle. These costs include time-dependent depreciation, financing, parking fees and vehicle mileage. Vehicle ownership costs can be influenced through projects altering the quality of alternative modes of travel, per capita vehicle ownership and land use accessibility (Transportationeconomics.org, 2015).

There are various factors that can influence VOC. These are listed below:

- *Vehicle speed*: operating costs will decrease as speed increases, until a certain point where operating costs increases with speed.
- *Road surface*: road surfaces influences rolling resistance, which influences operating costs. Rough surfaces decreases speed, increases fuel and tyre costs and ultimately leads to an increase in operating costs.
- *Vehicle type*: vehicle size, class and other physical characteristics may influence operating costs. For instance, cars are usually more fuel efficient and less costly to maintain than trucks.
- *Gradient*: driving uphill puts more strain on vehicle engines and fuel consumption than driving downhill. Driving downhill may lead to reduce vehicle operating costs but can increase brake wear.
- *Curvature*: countering centrifugal force needs increased engine power and leads to extra tyre wear. These two factors will lead to an increase in vehicle operating costs (Transportationeconomics.org, 2015).

If the switching driving side change yield significant economic benefits for a country as indicated by the MININFRA report, the monetary benefits could be reinvested into transport and infrastructure projects that could decrease the effect of some of the factors influencing VOC. Cost savings on fuel, oil and maintenance costs due to increased efficiency of road surfaces and road networks can be obtained. Vehicle operating costs is divided into fixed operating costs and variable operating costs. All vehicles operating cost will be determined in USD (United States Dollar). Fixed operating costs include the following:

- *Depreciation*: Time based depreciation, calculated annually.
- *Cost of capital*: Opportunity cost of buying a vehicle rather than investing the capital.
- *Insurance cost*: Annual insurance cost of vehicle
- *Staff cost*: Only applicable to transport operators
- *Overheads*: General overheads for transport operators.
- *Licensing fees*: Annual vehicle license and registration.

Variable operating costs are usually expressed in US cent per kilometre or US cent per mile units and include the following:

- *Fuel*: The cost of fuel per unit (litre or gallon) for every kilometre or mile travelled.
- *Oil*: Oil and lubricant costs as percentage of fuel.
- *Maintenance*: Annual maintenance costs and the costs of unforeseen maintenance.

- *Tyres*: the cost of tyres spread over the life expectancy of the tyre.

Considering these cost factors, some are more applicable to transport operators than the average vehicle owner. Cost of capital (investment cost) and maintenance are the two cost components that are most likely to be influenced by a road side change. Now that fixed and variable costs components are identified, they can be compared to the data collected by the RTDA in 2014.

The questionnaire the RTDA used can be found in Appendix C. The questionnaire collects sufficient data on vehicle costs and operation but with the data collected it is not possible to effectively calculate the vehicle operating costs in c/km according to the parameters above. Depreciation, which is a very important part of VOC, is not collected and calculating VOC without it would give inaccurate results. The data however does give a lot of important costs factors and comparing the LHD and RHD cost factors will still give great insight into the cost of owning and operating a LHD vs RHD vehicle in Rwanda. Some important cost figures can be seen in Table 28.

**Table 28: Average vehicle purchase cost of various motor vehicles in Rwanda**

| Average Total Vehicle Purchase Cost (USD)* | | |
|---|---|---|
| | LHD | RHD |
| Bus | $56,112.42 | $20,453.02 |
| Truck | $28,608.96 | $17,558.96 |
| Pick up | $18,474.31 | $6,024.31 |
| Jeep | $20,331.32 | $8,083.75 |
| Microbus | $8,365.36 | $5,234.90 |
| Minibus | $11,227.23 | $4,843.43 |
| Trailer & Semi-trailer | $141,364.99 | $143,650.70 |
| Car | $6,054.52 | $3,912.91 |
| Average | $36,317.39 | $26,220.25 |
| *Cost converted to USD. 1USD = 745RWF | | |

**Table 29: Average costs of LHD and RHD vehicles in Rwanda**

| | Average Cost in USD* | | |
|---|---|---|---|
| | LHD | RHD | % Difference |
| Average Cost Price*** | $36,317.39 | $26,220.25 | 38.51% |
| Average Import Tax | $ 5,470.05 | $ 2,664.10 | 105.32% |
| Average Insurance** | $ 92.27 | $ 39.10 | 135.98% |
| Average Licence | $ 501.90 | $ 230.36 | 117.88% |
| Average Last routine Maintenance | $ 42.50 | $ 34.00 | 25.00% |
| * All costs have been converted to USD. 1USD=745RWF | | | |
| ** Insurance is on average monthly basis. | | | |
| *** Based on Table 26 | | | |

When referring to Table 28 and 29, it is important to note that the average costs are for all vehicles on average for all vehicle types in the different categories. Tyre costs are not included in Table 29 as the cost of tyres is not steering side specific, but rather specific to a certain vehicle type. The difference in licensing cost is also dependant on vehicle classification rather than steering side. Licensing cost of larger vehicles will be more expensive. The same can be said for the insurance cost of larger vehicles. Staff costs and overheads are also not included as it is only applicable to the operation of a transporting company.

The average cost of LHD vehicles includes all vehicle types. From Table 29 it is apparent that LHD vehicles are on average more expensive to buy and maintain. Cost prices of LHD vehicle are almost double that of RHD vehicles. Import tax on LHD vehicles are more than double that of RHD vehicles. It is slightly cheaper to maintain RHD vehicles according to the RTDA data. Insurance of LHD vehicles are almost 3 times as expensive as that of RHD vehicles. It seems that the data collected by the CSIR for the RTDA shows that it would be beneficial for Rwanda to switch driving side when looking purely at vehicle operation costs. As seen earlier in this chapter, there are other costs that also need to be taken into account when doing a full benefit and cost analysis on switching driving side. The costs and benefits associated with LHD and RHD makes up a big portion of analysing the possibility of switching driving side and the analysis of this is important.

Both studies share important facts for evaluating driving side change. Establishing cost for the individual should be considered first. The economic evaluation on driving side change conducted by MININFRA shows that there would be a net economic benefit for Rwanda if

they chose to switch driving sides. The main problem for driving side change is the direct out of pocket cost for the people. With the average GDP per capita for Rwanda over the last ten years equalling to around USD 550, the conversion cost of USD 401 would be difficult to afford. The study conducted by the CSIR for the RTDA focusses on the vehicle operating cost of vehicles in Rwanda. It is apparent that RHD vehicles are cheaper to buy, import and maintain than LHD vehicles. For future research it is suggested that focus first be placed on the economic costs and benefits for individuals before evaluating total net economic benefit for the country when a driving side change is evaluated. A combination of rules and guidelines used in both studies would be beneficial for evaluating a driving side change.

## Chapter 7: Conclusion and Recommendations

This study was set out to identify if there are any costs or benefits that can be associated with countries driving on the left side of the road (RHD) and the countries driving on the right side of the road (LHD). The study also sought out to identify if a change in driving side would lead to economic benefits or costs and what these benefits and costs would be. To achieve this goal five questions needed to be answered:

1. What is the history surrounding driving side? How did countries first decide to adopt either the LHD or the RHD traffic rule?
2. How does the world look now in terms of driving side? Which countries are LHD and which countries are RHD?
3. Are there countries that have changed their driving side? If there are countries that changed driving side, why and when did they change their driving side?
4. Are there any macroeconomic indicators that distinguish the LHD and RHD countries from one another and are there a significant change in these indicators for the countries that changed their driving side?
5. Are there any costs and benefits associated with driving side change? What are these microeconomic factors that would provide costs and benefits?

The findings of my research are chapter specific and will be presented in this chapter in the same manner. The first conclusion drawn from the research is that history conveys very different hypothesis of how countries chose their side of the road. One certain conclusion about the history is that North America pursued the keep-right traffic rule and British colonies pursued the keep-left traffic rule. Most of the world at this stage uses the keep-right traffic rule. Air and maritime transport uses the keep-right traffic rule for oncoming traffic and rail has no specific traffic rule, much like road transport.

Secondly, there are 18 countries that changed their driving side since 1858. Three main reasons for driving side change was identified and categorised as being (1) economic and trade relationship reasons, (2) spatial and regional integration reasons and (3) political reasons. From the literature it seems that more recent driving side changes are due to spatial and regional integration reasons. Earlier changes seem to have been more motivated by political reasons, which include occupation and war.

Thirdly, the macroeconomic indicator that was used to identify differences between LHD and RHD countries on a global scale showed no significant difference between the two. The results of a t-Test (two-sample assuming unequal variances) for both GDP and GDP per

capita revealed no statistically significant differences, indicating that the driving side of a country does not have any influence on its GDP or GDP per capita. Neither GDP nor GDP per capita is in any way statistically different between LHD and RHD countries. There seems to be no concrete evidence that GDP per capita and GDP growth is significantly influenced by the change in road side use. Vehicle ownership in LHD countries is higher per 1000 of the population than for RHD countries. The relationship between GDP per capita and vehicle ownership per 1000 of the population for both LHD and RHD countries shows the same logarithmic trend. Initially there is a strong relationship between the two variables but as GDP per capita reaches a certain level, vehicle ownership increases at a diminishing rate. The same trend is seen in countries that changed their driving side. This leads me to believe that individuals prefer quality over quantity when it comes to purchasing vehicles, irrespective of their driving orientation. If there was a significant influence on GDP and GDP per capita, one could conclude that it would influence vehicle ownership rates in relation to these indicators

African countries also show no difference in GDP between countries that are LHD and RHD. Determining the characteristics of the transport environment in Africa is important as it influences vehicle operating costs, transport costs and transport prices. The African transport environment is labour intensive with low wages. These low wages might indicate low transport costs, and prices but the truth is that transport prices are very expensive, especially in Central Africa, and is accompanied with poor service delivery. If switching driving side can lead to lower vehicle operating costs, will have a positive effect in reducing transport prices and costs in Africa. Africa experience barriers to entry that are more prevalent than in other continents, such as rent seeking activities that drive up transport costs and prices. Africa has some of the worst roads in the world, which also drives up variable operating cost factors such as maintenance and fuel. The cost structure of vehicle operating cost in Africa is characterised by high variable cost and low fixed costs.

Although Africa is launching projects to improve transport in Africa, they seem to not take driving side challenges into account. From the research it is apparent that the Road Side Stations (RSS) in the RSS project is configured for RHD countries. In total, six countries are involved in this project from which only two are RHD. The majority of stations will be placed in these two RHD countries but it is still unclear how these stations will be adapted for LHD countries. If left in RHD configuration, the stations will cause accidents and traffic jams at these RSS points. Gathering information from OEM's can provide substantial insight with relation to technical and production related costs and benefits of LHD and RHD vehicles. Future research should focus on building relationships with OEM's and focus on understanding these production cost and benefit factors of LHD and RHD vehicles.

Lastly, looking at the case of Rwanda some interesting findings was made. Research done by MININFRA shows that most of the vehicles imported by 2008 was older than 10 years. The perception of the people of Rwanda indicated that they believe RHD vehicles cause fewer accidents than LHD vehicles and are easier to operate. More than half of the people of Rwanda are for switching road side use to RHD. From this report some guidelines for analysing road side change was identified. These are as follows:

- It is important to establish two scenarios, one for keeping the current road side or the DN (do nothing) scenario and one for changing road side use or DS (do something) scenario.
- When establishing economic cost and benefits, shadow prices must be used to establish the true resource value of benefits and costs.
- There are a specific list of costs and benefits with switching driving side and data must be collected accordingly
- Conducting a sensitivity analysis with different scenarios of increasing and decreasing benefits and costs is important. This will indicate the degree of impact these costs and benefits will have in the different scenarios.

The Rwanda Ministry of Infrastructure report also indicated the costs and benefits that should be considered in switching driving side change. They are as follows:

- Vehicle import costs
- Vehicle operation and maintenance costs
- Vehicle conversion costs
- Benefits at border crossings
- Accident costs
- Signage cost
- Cost to government

One main factor of these costs is vehicle operating cost and maintenance. The most relevant cost elements which form part of vehicle operating cost that was analysed included the cost price of the vehicle, the import tax on the vehicle, insurance for the vehicle, licensing the vehicle and the last routine maintenance cost. Tyres are not steering side specific but rather vehicle specific, so this was not calculated as the price of one LHD tyre is the same as one RHD tyre. From the analysis of the vehicle operating cost elements, RHD vehicle are much cheaper to buy and maintain than those of LHD vehicle is Rwanda. When switching driving side is considered, there are more than just vehicle operating cost to consider, but if vehicle operating cost is the main determining factor, Rwanda should change driving side. The cost

savings for transporters and private vehicle owners would be significant. As vehicle operating cost is one of the main drivers of transport prices and costs in African countries, a reduction in vehicle operating cost will most likely lead to a reduction in transport prices and costs.

Future research in this topic should consider the total vehicle operating cost of each vehicle type and class. Establishing an accurate value for vehicle operating cost must include all cost variables. With this said, when setting up a questionnaire all facets of vehicle operating cost must be collected to establish a vehicle operating cost value for each questionnaire. More effort should be put into establishing the effects of external costs of switching driving side. As vehicle operating cost is of great importance, it is important to note that the road and traffic conditions influence this greatly. More research should be focussed at the improvement of road conditions. This also will have a great influence on the vehicle operating cost of individuals and transport operator. There is definitely a great need for more research surrounding this topic at a local and international level.

The biggest limitation experienced in this research was the lack of available data and information surrounding this topic. Working with raw data was challenging but made it more interesting to gather results. There are a few countries that changed their driving side throughout history but it is poorly documented and analysis has not been done on the economic impact it had on the country that changed. It is a challenge working with a topic that is very new in the academic community and there is still a lot that needs to be done surrounding this topic. The research opportunity surrounding driving side is endless.

History has indicated why people chose their driving side and why they chose to change or keep their driving side. As the world become more trade driven, the need for integrating transport for trade becomes more important. The current investment in transport projects to help facilitate trade and regional integration reiterates the fact that research surrounding transport and driving side is becoming increasingly important. Changing driving side is not an easy task to accomplish in any country and should only be considered if economically viable. Trade driven change is more likely to become prevalent in Africa in the future. African countries have the greatest opportunity for embracing change and reaching a harmonized transport network throughout the continent and should indefinitely consider planning towards an integrated future. This topic presents the opportunity for new discovery in every part of the world and may just change the way in which the world look at their driving side.

**Reference List**

African Development Bank. 2014. *East African transport corridors to adopt the Japanese Michi-no-Eki (Road Side Stations) concept - African Development Bank* [Online]. Available: http://www.afdb.org/en/news-and-events/article/east-african-transport-corridors-to-adopt-the-japanese-michi-no-eki-road-side-stations-concept-14214/ [2015, July 14].

African Development Bank. 2016. *AfDB approves USD 245 million to finance Uganda-Rwanda transport project and boosts regional trade in East Africa* [Online]. Available: http://www.afdb.org/en/news-and-events/article/afdb-approves-usd-245-million-to-finance-uganda-rwanda-transport-project-and-boosts-regional-trade-in-east-africa-15873/ [2016, July 16].

Barta, P. 2009. *Shifting the Right of Way to the Left Leaves Some Samoans Feeling Wronged* [Online]. Available: http://www.wsj.com/articles/SB125086852452149513 [2014, August 2].

BusinessDictionary.com. 2016. *What is shadow price? definition and meaning* [Online]. Available: http://www.businessdictionary.com/definition/shadow-price.html [2016, July 22].

Dagen. H. 2014. *The day Sweden switched sides of the road, 1967* [Online]. Available: http://rarehistoricalphotos.com/dagen-h-day-sweden-switched-sides-road-1967/ [2014, June 15].

Hiskey, D. 2010. *Why Some Countries Drive on the Right and Some Countries Drive on the Left* [Online]. Available: http://www.todayifoundout.com/index.php/2010/06/why-some-countries-drive-on-the-right-and-some-countries-drive-on-the-left/ [2014, July 6].

Internetworldstats.com. 2015. *Ten Countries with the Highest Population in the World* [Online]. Available: http://www.internetworldstats.com/stats8.htm [2015, June 23].

Investopedia. 2007a. *Cost-Benefit Analysis* [Online]. Available: http://www.investopedia.com/terms/c/cost-benefitanalysis.asp [2016, July 14].

Investopedia. 2007b. *Economic Indicator* [Online]. Available: http://www.investopedia.com/terms/e/economic_indicator.asp [2016, July 14].

Investopedia. 2009. *Gross Domestic Product - GDP* [Online]. Available: http://www.investopedia.com/terms/g/gdp.asp [2011, July 14].

Investopedia. 2003. *Macroeconomics* [Online]. Available: http://www.investopedia.com/terms/m/macroeconomics.asp [2016, July 14].

Investopedia. 2003. *Per Capita Gross Domestic Product* [Online]. Available: http://www.investopedia.com/terms/p/per-capita-gdp.asp [2016, July 14].

Johnson, P. 2005. *Rent-seeking behavior: A Glossary of Political Economy Terms - Dr. Paul M. Johnson* [Online]. Available: http://auburn.edu/~johnspm/gloss/rent-seeking_behavior [2016, September 10].

Kincaid, P. 1986. *The rule of the road*. New York: Greenwood Press.

Leeming, J. and Mackay, G. 1969. *Road accidents: prevent or punish?*. London: Cassell.

Louw, N. 2015. RESEARCH REQUEST/HULP OM MEESTERS NAVORSING, email to B.L. van der Westhuizen [Online], 3 June. Available e-mail: nicol_louw@yahoo.co.uk.

Northern Corridor Road Side Stations. 2015. *ESTABLISHMENT OF ROADSIDE STATIONS/WELLNESS CENTRES (RSSs) ALONG THE NORTHERN CORRIDOR* [Online]. Available: http://www.roadsidestations.org/about-rss/ [2015, July 14].

Nwanze, C. 2014. *#HistoryClass: Who sold Nigeria to the British for £865k in 1899?* [Online]. Africa is a Country. Available: http://africasacountry.com/2014/04/historyclass-who-sold-nigeria-to-the-british-for-865k-in-1899/ [2016, May 14].

Pinterest.com. 2016. [Online]. Available: https://www.pinterest.com/pin/313281717802210802/ [2016, January 16].

Portney, P. 2016. *Benefit-Cost Analysis: The Concise Encyclopedia of Economics | Library of Economics and Liberty* [Online]. Available: http://www.econlib.org/library/Enc/BenefitCostAnalysis.html [2016 ,July 16].

Republic of Rwanda Ministry of Infrastructure. 2009. *Study on the possibility of switching driving side in Rwanda*. Kigali: Republic of Rwanda Ministry of Infrastructure, pp.1-84.

Selth, A. 2009. *Burma's 'superstitious' leaders* [Online]. Available: http://www.lowyinterpreter.org/post/2009/10/22/Burmas-superstitious-leaders.aspx?COLLCC=161541353& [2014, June 24].

Sidler, V. 2014. *Infographic: Trans-African highways for 'pit to port' planning* [Online]. Available: http://www.miningreview.com/infographic-trans-african-highways-for-pit-to-port-planning/ [2015, November 12].

Sine nomine. 2015. *ClassicCarShop - worldwide sales of classic left- and right-hand-drive British sports cars* [Online]. Available: http://www.classiccarshop.fr/lhd_rhd_map.htm [2015, May 12].

Sine nomine. 2010. *Which Side Of The Road To Drive On? Left Or Right, Country By Country Around The World* [Online]. Available: http://www.i18nguy.com/driver-side.html [2014, July 20].

Stack Exchange.com. 2014. *Apart from safety, has there been any research conducted, hopefully current, with respect to user-experience and right- vs left-hand traffic?* [Online]. Available: http://ux.stackexchange.com/questions/51990/apart-from-safety-has-there-been-any-research-conducted-hopefully-current-wit [2015, May 12].

Star, M. 2009. *What side does the world drive on? | BoysBS Blog* [Online]. Available: http://boysbs.com/2009/10/14/what-side-does-the-world-drive-on/ [2015, February 20].

The World Bank. 2014a. *Indicators | Data* [Online]. Available: http://data.worldbank.org/indicator [2014, June 15].

The World Bank. 2014b. *Motor vehicles (per 1,000 people) | Data | Table* [Online]. Available: http://data.worldbank.org/indicator/IS.VEH.NVEH.P3 [2014, June 15].

The World Bank. 2009. *Transport Prices and Costs in Africa: A Review of the Main International Corridors*. Washington DC: The International Bank for Reconstruction and Development/World Bank, pp.1-106.

Transportationeconomics.org. 2015. *Vehicle Costs - Transportation Benefit-Cost Analysis* [Online]. Available: http://bca.transportationeconomics.org/benefits/vehicle-operating-cost [2015, November 24].

United Nations Economic Commission for Africa, 1961. *Possibilities of standarizing road motor vehicle legislation in West Africa*. Addis Ababa: United Nations Economic Commission for Africa, pp.1-72.

Volvoclub.org.uk. 2007. *Driving On the Right In Sweden* [Online]. Available: http://www.volvoclub.org.uk/history/driving_on_right.shtml [2014, June 10].

Wilde, R. 2016. *The Velvet Divorce: The Dissolution of Czechoslovakia* [Online]. Available: http://europeanhistory.about.com/od/historybycountry/a/Velvetdivorce.htm [2016, May 14].

World Health Organization. 2015. *GHO | By category | Road traffic deaths - Data by country* [Online]. Available: http://apps.who.int/gho/data/node.main.A997 [2015, November 12].

**Appendix A: Presidential order N° 40/01 of 16/10/2005.**

PRESIDENTIAL ORDER N° 40/01 OF 16/10/2005 MODIFIFYING AND COMPLEMENTING PRESIDENTIAL DECREE N° 85/01 OF 02 SEPTEMBER 2002 REGULATING GENERAL TRAFFIC POLICE AND ROAD TRAFFIC:

**Article: 1**

Article 88 of the Presidential Decree n°85/01 of 2 September 2002 regulating General Traffic Police and Road Traffic has been modified and complemented as follows:

Every motor vehicle must be provided with a strong steering apparatus allowing the driver to change easily, quickly and safely the direction of his vehicle.

All motor vehicles registered in Rwanda must have a steering apparatus on the left hand side. However, motor vehicles in transit and or those belonging to foreigners visiting Rwanda for different purposes with steering apparatus on the right hand side, are allowed to use them for a period not exceeding three months. But when the period of three months expires, an authorisation from the Minister who has transport in his /her attributions is required.

**Article: 2**

People already owning motor vehicles with steering apparatus contrary to what is stipulated in article 1 paragraph 2 of this order; have a period not exceeding 4 years, to have respected this order, starting from day of its signature.

**Article: 3**

All articles prior or contrary to this order are hereby abrogated.

**Article: 4**

This Order comes into force on the date of its publication in the Official Gazette of the Republic of Rwanda. Kigali, on 16/10/2005.

**Appendix B: Descriptive statistics surrounding Driving side, GDP, GDP per capita and Vehicle Ownership**

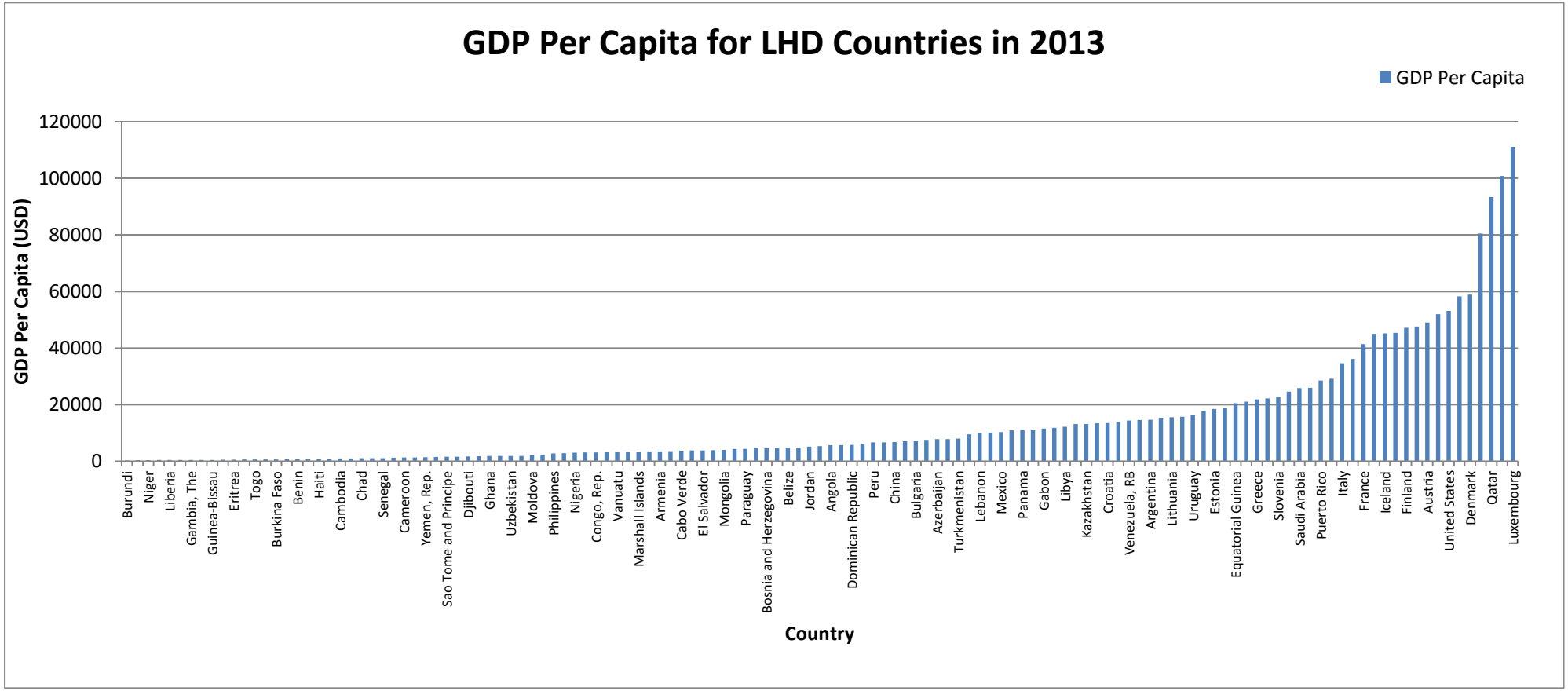


**Figure 18: Gross Domestic Product Per Capita for LHD Countries in 2013**

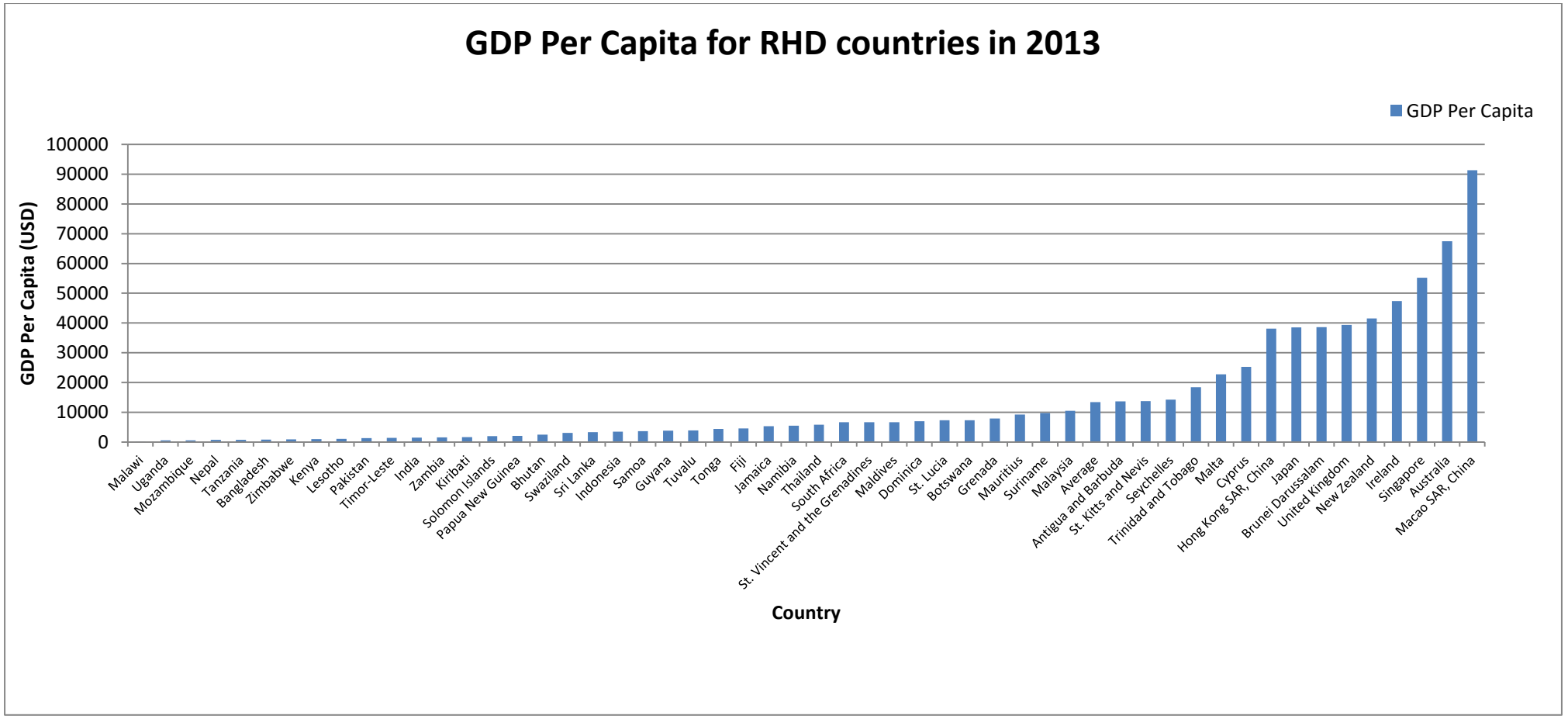


**Figure 19: Gross Domestic Product Per Capita for RHD countries in 2013**

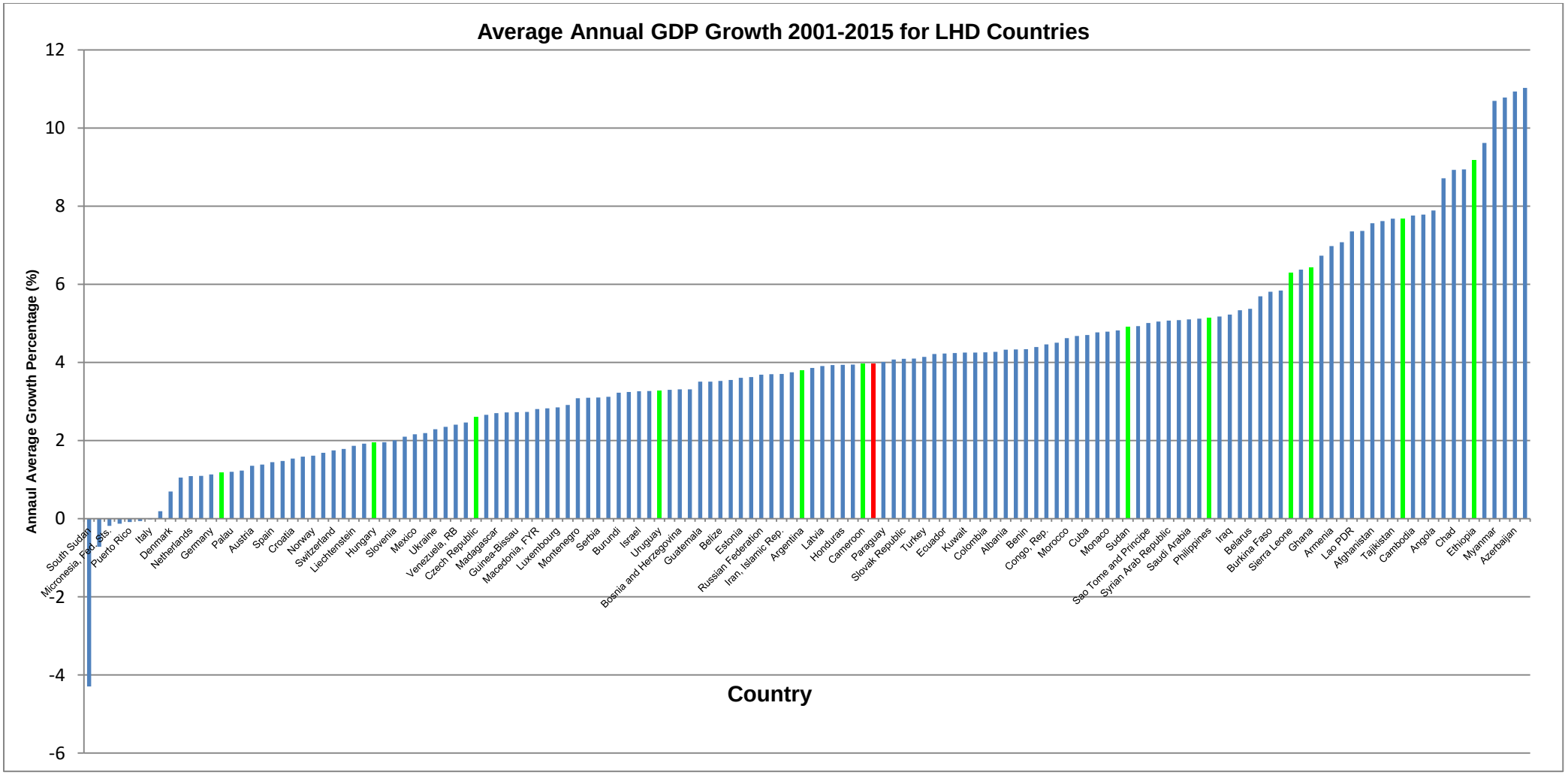


**Figure 20: Average GDP growth 2000 – 2015 for LHD countries**

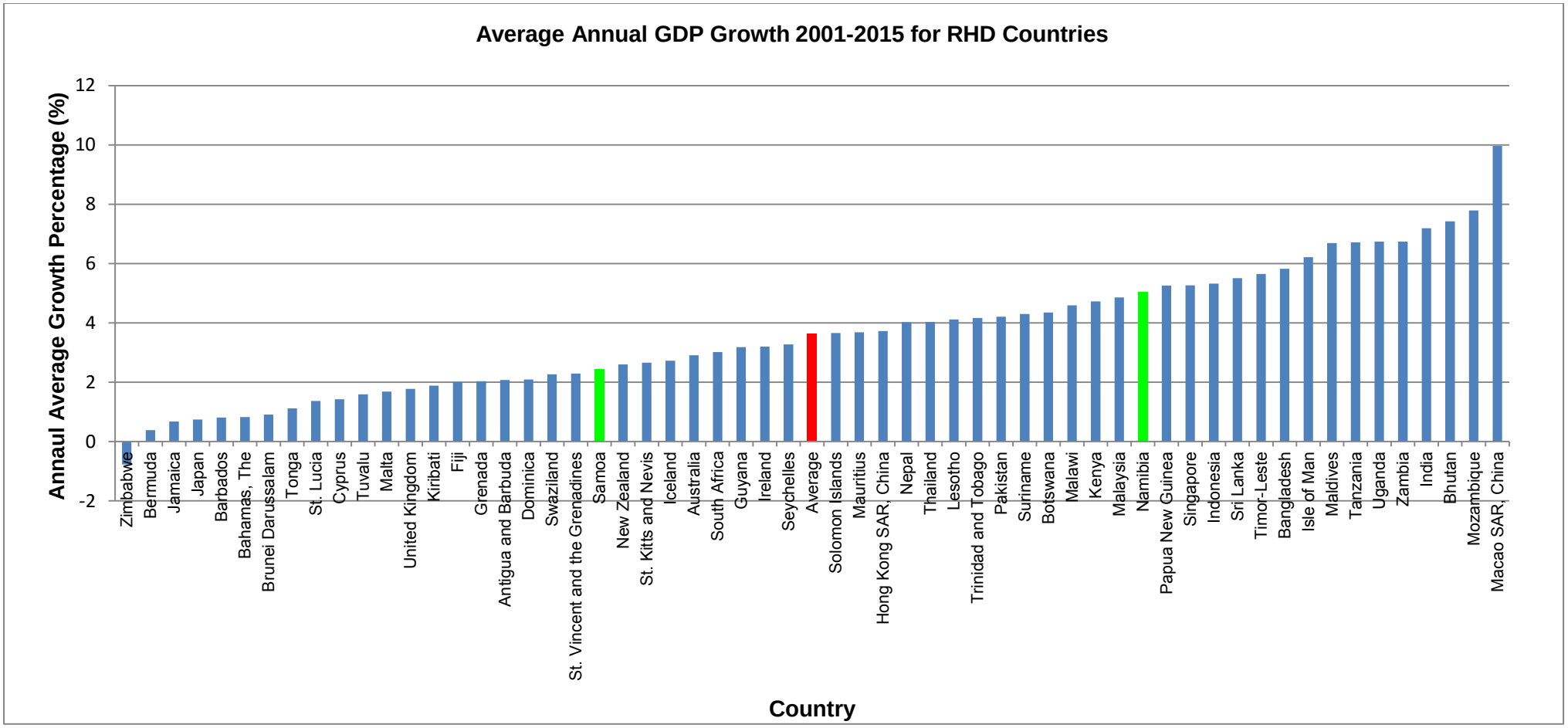


**Figure 21: Average GDP growth 2000 – 2015 for RHD countries**

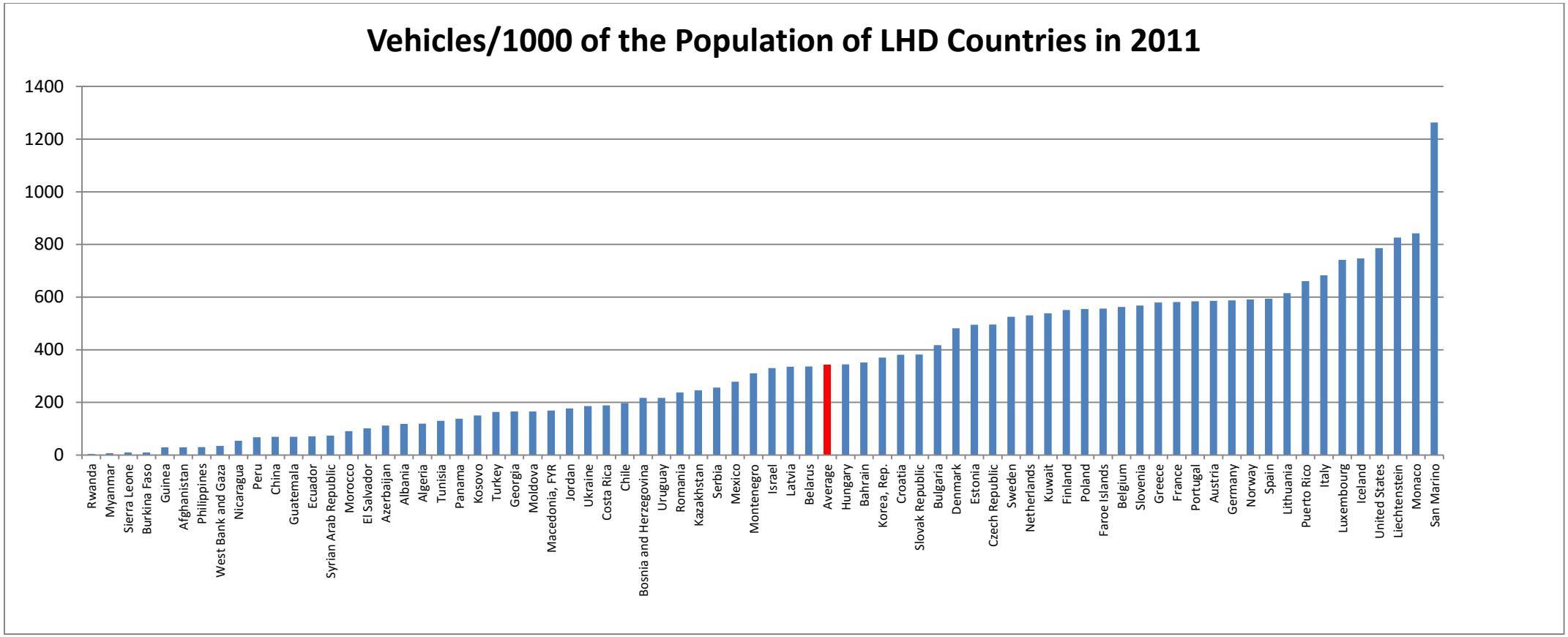


**Figure 22: Vehicles per 1000 people in LHD countries in 2011**

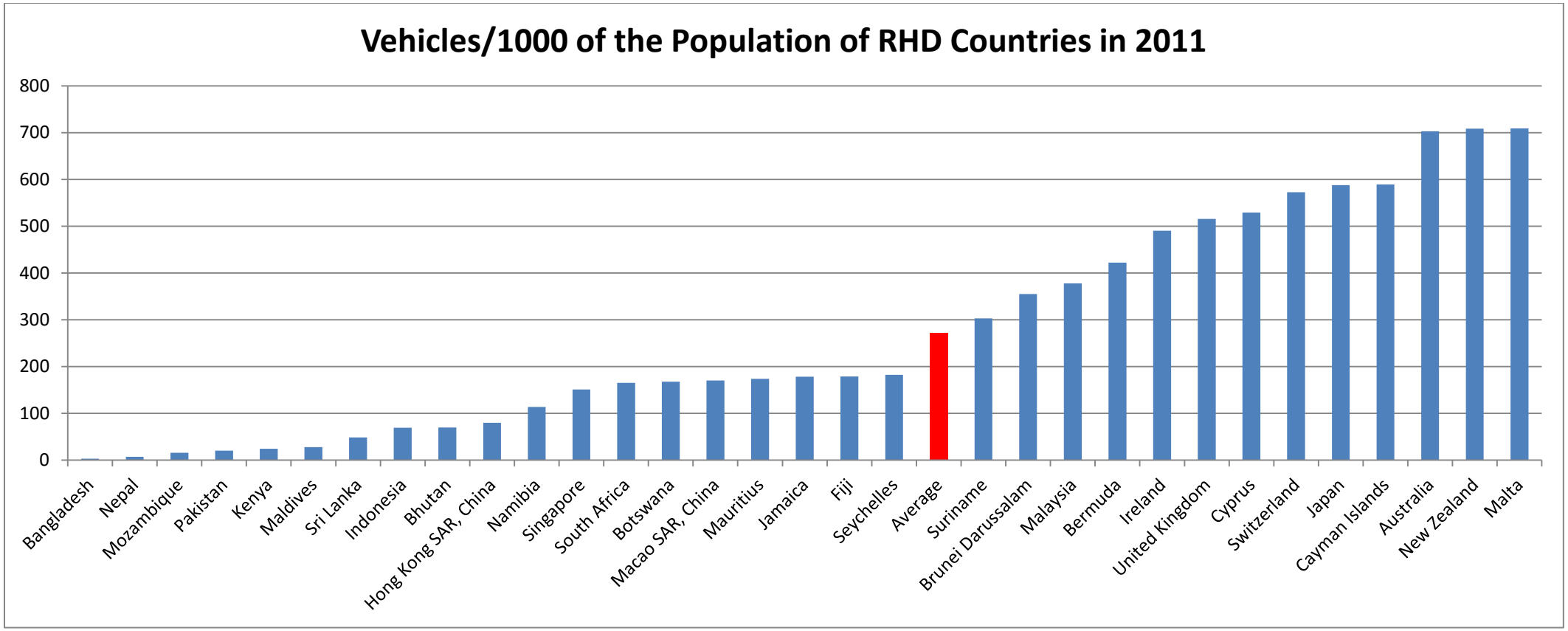


**Figure 23: Vehicles per 1000 people in RHD countries in 2011**

## Appendix C: RTDA questionnaire

**VEHICLE OPERATING COST SURVEY**

Introduction

Good morning /Good afternoon, my name is.....we are conducting a vehicle operating cost survey in Rwanda. The survey is conducted by Rwanda Transport Development Agency (RTDA). This survey will provide reliable statistics which will help planning and development of transport sector as related to this survey.

**PlaceID_____Date_____ Time_____**
**SurveyorID_____ Form No._____**

| **1: Vehicle registration** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1.1. Ownership status of respondent | 1: Own vehicle | 2: Borrowed vehicle | 3: Work/Business vehicle | 4: Other | | | | |
| 1.2. Vehicle registration number | 1: | | | | | | | |
| 1.3. Vehicle type | 1: Bus | 2: Truck | 3: Pick Up | 4: Jeep | 5: Microbus | 6: Minibus | 7: Trailer & Semi-trailer | 8: Car |
| 1.4. Number of seats (Micro bus & Minibus &Autobus) | 1: | | | | | | 2: N/A | 3: Don't know |
| 1.5. Weight (Camoinnette, Camion &Remorque) | 1: ( ) poids à vide (unladen weight/TARE) | | | | | | 4: N/A | 5: Don't know |
| | 2: ( ) masse totale du véhicule / poids total autorisé en charge (PTC/ PTAC / GVM / GVWR) | | | | | | | |
| | 3: ( ) masse brute combinée (GCM/ MAM / GCWR) | | | | | | | |
| 1.6. Remorque, Camion &Camionnette Classification | 1: | | | | | | | |
| 1.7. Steering side | 1: Left | 2: Right | 3:Conversion | | | | | |
| 1.8. Vehicle make (Manufacturer) | 1: | 2: Don't know | | | | | | |
| 1.9. Vehicle model | 1: | 2: Don't know | | | | | | |
| 1.10. Year model | 1: | 2: Don't know | | | | | | |
| 1.11.Year of first registration in Rwanda (RRA) | 1: | 2: Don't know | | | | | | |
| 1.12. Status when bought | 1: New (0 km) | 2: New Second Hand | 3. Normal Second Hand | 3: Built-Up | 4: Don't know | | | |
| 1.13. Total vehicle purchase cost | 1: RWF ( ) | 4: Don't know | | | | | | |
| | 2: USD ( ) | | | | | | | |

| | | | | |
|---|---|---|---|---|
| | 3: EURO ( ) | | | |
| 1.14. Vehicle purchase cost (at time of purchase) (capital cost only, excluding tax, insurance etc.) | 1: RWF ( ) | | | Don't know |
| | 2: USD ( ) | | | |
| | 3: EURO ( ) | | | |
| 1.15. Transportation cost from one port to Kigali | | | | |
| 1.16. Importation vehicle tax | 1: ( ) once-off payment | | | 2: Don't know |
| 1.17. Registration fees | 1: ( ) once-off payment | | | Don't Know |
| 1.18. Additional payment for public transport business permit or tax | 1: ( ) yearly payment | | | 2: Do not pay tax / 3: Don't know |
| | 2: ( ) Once every two years | | | |
| | 3: ( ) Less than a year | | | |
| 1.19. Year of vehicle purchase | 1: | | | 2: Don't know |
| 1.20. Engine size | 1: | | | 2: Don't know |
| 1.21. Size of fuel tank (litres) | 1: | | | 2: Don't know |
| **2: Vehicle use** | | | | |
| 2.1. Vehicle primary use | 1: Private (own vehicle) | 2: Business | 3: Government | 4: Other |
| 2.2. Vehicle secondary use | 1: Private (own vehicle) | 2: Business | 3: Government | 4: Other |
| 2.3. Is this vehicle used as a taxi or for public transport? | 1: Yes | | 2: No | |
| 2.4. Current odometer reading (km) | 1: | | | 2: Don't know |
| 2.5. Odometer reading when purchased (km) | 1: | | | 2: Don't know |
| 2.6. When are you planning to replace vehicle (year) | 1: <1 year | 2: 1-3 years | 3: 3-5 years | 4: 5-10 years / 5: 10 years or more / 6: Never / 7: Don't know |
| 2.7. Km travelled | 1: ( ) km per day | | | 4: Don't know |
| | 2: ( ) km per week | | | |
| | 3: ( ) km per month | | | |
| 2.8. Fuel Consumption | 1: ( ) km per full tank | | | 4: Don't know |
| | 2: ( ) km per litre of fuel | | | |
| | 3: ( ) km per 10 litres of fuel | | | |

| 3: Vehicle maintenance | | | | | | |
|---|---|---|---|---|---|---|
| 3.1. Insurance payment | 1: ( ) monthly<br>2: ( ) 3 months<br>3: ( ) 3 months and 9 months<br>4: ( ) yearly | | | 5: Not insured | 6: Don't now | |
| 3.2. Insurance type | 1: Third Party Liability | | 2: Third Part Liability and insurance of the driver | 3: Comprehensive insurance | 4: Not insured | |
| 3.3. How is maintenance performed on the vehicle? | 1: Commercial | 2: Own | 3: Informal | 4: Not serviced | 5: Don't know | |
| 3.4. Regular maintenance frequency | 1:For ( ) | Times in | 2: ( ) week<br>3: ( ) months<br>4: ( ) year<br>5: ( ) km | 6:Only when broken | 7: Never | 8:Don't know |
| 3.5. Amount paid last routine maintenance | 1: | | | | 2: Not applicable | 3: Don't know |
| 3.6. Unscheduled maintenance and repairs | 1:For ( ) | Times in | 2: ( ) week<br>3: ( ) months<br>4: ( ) year<br>5: ( ) km | | 6: Never | 7: Don't know |
| 3.7. Amount paid for unscheduled repairs | 1: | | | | 2: Not applicable | 3: Don't know |
| 3.8. Regular tyre replacement frequency | 1:Number of tyres ( ) | 2: For ( ) | Times in | 3: ( ) week<br>4: ( ) months<br>5: ( ) year<br>6: ( ) km | 7: Never | 8: Don't know |
| 3.9. Amount paid last tyre replacement | 1: Number of tyres ( ) | | 2: Amount paid ( ) | | 3: Not applicable | 4: Don't know |
| 3.10. Technical control costs | Every | 1: ( ) 3 months<br>2: ( ) 6 months<br>3: ( ) 1 year | | | 4: Not applicable | 5: Don't know |
| **4: Accident data** | | | | | | |
| 4.1. Involvement in traffic accident | 1:Yes | | 2: No | | | |
| 4.2. Number of accidents | 1: | | | | | |

| | | | | |
|---|---|---|---|---|
| 4.2. Degree of injury | 1: Fatal | 2: Severe (hospitalisation) | 3: Slight | 4: No injury |
| 4.3. Duration in hospital or other medical facility | 1: ( )Days | 2: ( ) Months | | 3: Not hospitalised |
| 4.4. Time away from work | 1: ( ) Days | 2: ( ) Months | | 3: Not away from work |
| 4.5. Income lost due to time away from work (amount) | 1: | 2: Not applicable | | 3: Don't know |
| 4.6. Health costs | 1: | 2: No costs | | 3: Don't know |
| 4.. Damage costs | 1: | 2: No costs | | 3. Don't know |
| 4.8. Transport costs | 1: | 2: No costs | | 3. Don't know |
| 4.9. Other implications (e.g. time or income lost by other members of household while caring for victims, etc) | 1: | | | 2: Amount: |

**Ending the interview**

On behalf of RTDA, I would like to thank you for your time and for the information you provided. I assure you that all the information you provided will be kept confidentially.

Thank you.