International Journal of Science, Technology and Society
2015; 3(2-2): 11-21
Published online July 25, 2015 (http://www.sciencepublishinggroup.com/j/ijsts)
doi: 10.11648/j.ijsts.s.2015030202.13
ISSN: 2330-7412 (Print); ISSN: 2330-7420 (Online)

An Economically Sustainable Urban Public Transport Framework: System Dynamics Modelling Approach to Reduce Public Transport Liberalisation Impact in Harare City

Portia Mupfumira[1], Budisantoso Wirjodirdjo[2]

[1]Department of Industrial and Manufacturing Engineering, School of Engineering and Technology, Harare Institute of Technology, Harare, Zimbabwe
[2]Department of Industrial Engineering, Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

Email address:
mupfumirap@gmail.com (P. Mupfumira), budisantoso.wirjodirdjo@gmail.com (B. Wirjodirdjo)

To cite this article:
Portia Mupfumira, Budisantoso Wirjodirdjo. An Economically Sustainable Urban Public Transport Framework: System Dynamics Modelling Approach to Reduce Public Transport Liberalisation Impact in Harare City. *International Journal of Science, Technology and Society.* Special Issue: Design Innovations for Sustainable Development. Vol. 3, No. 2-2, 2015, pp. 11-21. doi: 10.11648/j.ijsts.s.2015030202.13

Abstract: Public transportation plays a key role to socio-economic development of any nation. This service enhances people's livelihood framework by facilitating mobility and accessibility to services. Moreover, there is clear global evidence that a well performing public transport is an important enabler of sustained economic prosperity. Rapid urbanization in developing countries has resulted in transport facilities and infrastructure failing to cope with demand resulting in congestion, movement delays, high travel costs, and construction of holding bays in order to decongest the city, which will contribute to an increased usage of non-renewable energy. This prompts implementation of non-comprehensive strategies such as partial deregulation of transportation systems that caused further deterioration in economic sustainability. An economically sustainable transport system advocates for mobility, resource, and operational efficiency. This research focuses on developing a bus investment conceptual framework of a public transport system that improves mobility, resource, and operational efficiency to aid in sustaining of public transportation system for an unforeseeable future. With this in mind, a Harare bus investment system has been modelled as a policy framework model to evaluate its economic sustainability. This will help develop a long-term economically sustainable public transportation and reduce the overall impact of the earlier liberalisation of the transportation sector.

Keywords: Public Transportation, System Dynamic, Partial Deregulation, Economic Sustainability, Bus Investment

1. Introduction

Public transport plays an important role in fulfilling the travel needs of people in cities of developing world. It plays a key role in the socio-economic development of any nation and enhances people's livelihood framework by facilitating mobility and accessibility to services (Nyarirangwe & Mbara, 2007). Transport networks must be able to support the economic growth, growing populations, and diverse expectations of urban activity. There is clear global evidence that a comprehensive and well performing transport system is an important enabler of sustained economic prosperity. A large volume of traffic flow does not only cause traffic congestion, it also resulted in huge losses in terms of productivity and will affect the ability of cities to compete globally. Usually there is a tendency of cities building more roads to overcome this problem. However, cost that includes financial, social, and environmental responsibility will increase with increase of urbanisation hence transportation sustainability is compromised United Nations Programme (UNEP) retrieved 10/22/2013, from http://www.unep.org/transport/. Furthermore, there is carbon dioxide emission and non-renewable energy consumption, which is a major threat to future generation. Economically sustainable transportation should advocate for resource and operational efficiency as well as efficiency in mobility and local economic development. In Zimbabwe, ninety percent of all industrial and manufacturing industries are located in the seven largest urban centres hence this is evidence that urban transport plays a key role in the national economy. Of this, ninety percent almost fifty percent

manufacturing industries are located in Harare. Any constraints in this sector would likely cause extensive repercussions in the national economy performance (T. C. Mbara, 2002). Thus partial liberalisation of the sector after population increase had caused demand to outgrow supply in urban areas.

The rapid urbanisation and impact of public transportation on sustainability has attracted considerable attention of researchers and academics. The increasing congestion, carbon dioxide emissions and consumption of non-renewable fossil fuel from transport sector calls for change in the ways of operations and policies within this sector in order to sustain the future generations. Many approaches have been used to improve transportation systems in different countries such as deregulation and liberalisation of the sector, with the recent focus on sustainability improvement. (Dirgahayani & Nakamura, 2012) analysed application of partnerships to achieve sustainable urban mobility, (Holden, Linnerud, & Banister, 2013) used the Brundtland report to redefine what sustainable passenger transport is saying that it now include anything and everything. The likes of (Egilmez & Tatari, 2012) in policy making to reduce the impact of carbon dioxide emissions of highway passenger transport and (Thuong & Noi, 2003) in identification of related causes and effects and finding effective negative loops that can be improved to reduce the urban congestion in Hanoi applied system dynamic modelling method. The former focused on usage of public transport coupled with the electric vehicles and advocation of fuel efficiency to reduce emissions. On the other hand (Kwan & Blanco, 2009) used the same methodology coupled with partnership to reduce emissions of freight transport. Other researches carried on urban transport includes previous work done in Harare by Tatenda C Mbara, (2006); Maunder & Mbara, (1995; 1996) who looked at the sudden impact, initial effects of introducing commuter omnibuses in Harare and how the public is coping with the public transport. (Pirie, 2013) gave a detailed analysis and state of the public transport in the Sub-Saharan cities. (Kodero, 2005) targeted pro-poor transport policy with the aim of building national capacity for policy dialogue and engagement in influencing transport policies and programmes in the context of poverty reduction in Zimbabwe. From the literature, there is an analysis of what the problem is and those addressing sustainability of urban transport have focused more on environmental issues yet, a business cannot sustain itself without economically sustaining its operations. Liberalisation policy has failed to create that platform which can economically sustain the transport system and keep pace with urban population growth and mobility needs within the city of Harare.

Hence, it is through this motivation from real problem that has emanated from the change of policy that prompted the researcher to aim developing a conceptual framework model of Harare city transport system that is effectively supportive and informative to decision makers in formulating policies. This will help develop a public long-term economically sustainable transportation and reduce the overall impact of the earlier liberalisation of the transportation sector.

1.1. Deregulation

Deregulation is the removal of controls imposed by governments on the operation of markets to take away barriers to entry (transport economies). According to (Menaz, 2006) deregulation is the removal of regulations, often in order to adjust competition policy. A quote from (OECD, 1997) by (Menard & Ghertman, 2009) defines deregulation as the complete or partial elimination of regulation in a sector with intent of improving economic performance, citing Kim and Prescott (2005) saying that deregulation can bring programmability of managerial behaviour and higher ambiguity in cause-effect relationship. Partial deregulation can take many forms such as deregulation of market entry or exit or deregulation of price control. It can be partial or complete, slow or fast (Menard and Ghertman, 2009). The researcher went on to say that it is a term that gained widespread currency in the period 1970-2000 seen as a process by which governments remove, reduce or simplify restrictions on business and individuals with the intent of encouraging the efficient operation of markets. It occurs when there is a significant decrease or elimination of government regulation over an industry, market or economy. A stated rationale of deregulation is that fewer and simpler regulations will lead to a raised level of competitiveness, therefore higher productivity, more efficiency and lower prices overall. Proponents of deregulation or free competition seek the complete relaxation of controls, arguing that this induces an increase in diversity of the provision of market-oriented services best suited to meet demand characteristics whilst deregulation leads to wasteful use of scarce resources (T. Mbara & Maunder, 1995).

1.2. Partial Deregulation/ Liberalisation

Partial deregulation from Menard and Ghertman (2009) means that the process of deregulation is not completed. It might not be completed because regulators chose to open up to competition only part of the regulated sector. They might for example allow market entry but still regulate the retail price. This definition might not be correct but due to its similarity to the case under study, it is the adopted for this research. Partial deregulation has negative impact on firm efficiency.

2. Case Background

2.1. Transportation History of Harare City

Public transportation in the Harare City is considered as either buses, minibuses known as commuter omnibuses or shared taxis. Cycling plays, a limited role accounting for only less than 3% of total trips in Harare and minibuses (commuter omnibuses) serve 90% of the market currently (UN-Habitat, 2013). Before partial deregulation, a bus company under certain profitability level operated pre-independence transport where in subsidies where payable if the target not met. The system was rigid with long waiting

and commuting time. Thus seen as a key sector of the economy the government pursued a policy targeted at redressing the socio-economic imbalance by acquiring 51% of the bus company, which changed to Zimbabwe United Passenger Company (ZUPCO). This participation by government was to help and influence acquisition of new fleet and boost expansion of the company, but due to population increase, the bus company ZUPCO Harare division's ability to renew and expand its fleet could not keep pace with demand. In 1990, the government embarked on an Economic Structural Adjustment Programme (ESAP) whose thrust aimed at economy liberalisation through removal of certain controls and regulations inhibiting competition. It is against this backdrop of liberalisation that urban public transport got liberated or partially deregulated in August 1993 and saw introduction of privately operated commuter omnibuses to compete with ZUPCO. Despite liberalisation of the sector quality control, continue to be enacted by the government with fare determination being solely the government's responsibility (T. Mbara & Maunder, 1996).

Partial deregulation aims to improve production and delivery of infrastructure through market force and competition (World Bank, 1994). However, this move saw an increase in low carrying capacity privately operated public transport whose instant positive impact was reduction of waiting time and queue reduction due to 'a hail and ride service' they provide. This operation threatened the viability of the bus company ZUPCO Harare division that caused its deterioration and constraining its ability to compete with commuter omnibuses and eventually collapsed to due to high operational costs. Due to urbanisation, that is at its peak Harare city now habours 16% of the nation's population, 47% of all urban population with an annual growth rate of 1.1% hence public transport is always increasing to cater for increasing demand.

2.2. Partial Deregulation Impact

Commuter omnibuses have an average carrying capacity of 15 passengers per vehicle and their legalisation aimed at supplementation of service provided by the stage bus company but due to their hail a ride service operation customers preferred the commuter omnibuses to ZUPCO, which was the main downfall of the bus company. The collapse of the bus company, population increase and commuter omnibus carrying capacity have lead to increase of commuter omnibuses until saturation point with almost ten thousand vehicles plying the routes of Harare city in order to keep abreast with demand. A holding bay out of the city centre had to be constructed as means of controlling public transport which have gotten out of hand to an extent of having 60% of the commuter omnibuses operating illegally (Chideme, 2013). (Mahachi, 2012) in unveiling of the City of Harare Strategic Plan (2012-2025) pointed out that population growth has strained the infrastructure with the increase not proportional to utilities growth rate hence there is serious supply deficiency causing a high road damage rate.

3. Theoretical Background

3.1. Sustainability

Derived from sustainable development from Brundtland report (1987) sustainable public transport can be considered as one that is able to meet today's transportation needs without compromising the ability of future generations to meet their transportation needs. Defined from the context of developing world a sustainable transport system must provide mobility and accessibility to all urban residents in a safe and environmentally friendly mode of transport (Zietsman, Rilett, & Kim, 2003). Though not regarded as the most appropriate definition, it will be used for this research. In other words sustainability is equity and harmony extended into the future, a careful journey without an endpoint, a continuous striving for harmonious co-evolution of economic, social and environmental goals (Voula & Pedersen, 1998). It integrates economics, social and environmental issues. It has economic development at its core. (Low, 2003) define it as a set of nested boxes with economic, society and environment all imbedded in each other meaning that what goes on in economy and society is subject to natural environment, which supplies the inputs and absorbs the waste. In addition, what goes on in economy is the subject to the fairness integrity and stability of society. (Beuhler & Pucher, 2011) Alluded that in practice, emphasis has been on environmental sustainability, neglecting financial has been an important omission. For example, transport systems around the world suffer from low productivity because it is perishable hence it requires subsidies and for those that are privatised in most cases experience high operational costs and are not affordable to the poor. No amount of excellent social and environmental performance will prolong the life of a business that is not economically sustainable hence for the system to be sustainable it has to, economically sustain its operations. Improving economic sustainability would realise the potential environment and social benefits of public transport.

3.2. Economic Sustainability

Used for this research, economic sustainability is the use of various strategies for employing existing resources optimally so that business continues to function over a number of years while consistently returning a profit as well as involving efficient usage of different organisational assets to allow continued functioning profitability for a longer period. The idea is to aid in identifying areas of operation in which resources are not being utilised in the most efficient manner and take steps to correct the situation. Based on previous studies, theoretical and case background it is noted that before liberalisation, transportation was characterised by long waiting times and rigidity because of the operating timetable. Even though there were long waiting time it was reliable and there was a certain level of profitability in which subsidies were payable if not met. As a means to reduce waiting time and rigidity the system was liberalised for

market entry and this era saw an introduction of small capacity vehicles whose operation was 'hail a ride', which meant a reduction in high volume vehicles. This has caused inefficiency use of resources through duplication of duties, congestion that increase operational costs, fuel consumption, CO2 emissions and illegal fare increase to cover operational costs, removal of subsidies due to numerous small vehicle. Meaning that problems being faced within the system are due liberalisation. Thus, because of the non-linear relationships in transportation, dynamism and causal effect relationship exhibited by the problem, system dynamics has been chosen as the method due to its characteristics that distinguish it from traditional management support tools. Unlike other methods, system dynamic considers a system in a dynamic way, which makes it more appropriate; in this case as the policy change, it will affect the system dynamically.

System dynamics capture highly complex, non-linear feedback relationships that exist in the real world and incorporate the variable time delays that separate actions from events. Captured by previous researchers in Harare public transport the effect of deregulation could not be evaluated at the onset of the policy due to delay. This gives credibility to system dynamic modelling, which incorporate time delay and can simulate into the future to understand the future behaviour. It includes variables that affect specific management actions. The models recreate dynamic behaviour rather than solving for steady-state solution. By mimicking the system behaviour, it allows testing of alternative assumptions, decisions, and policies within a simulated program environment that provides a dynamic analytical environment that provides a method to anticipate and plan for likely future events. Model validity depends both on a clear specification of system structure and analysis of system behaviour.

4. Methodology

Due to the causality and delay found in the problem System dynamics modelling approach methodology is a used since it has a unique characteristic of incorporating delay. Firstly, identification of key parameters was done followed by causal loop construction, which were transformed into stock and flow diagram for analysis and discussion of the system behaviour.

4.1. Overview of System Dynamics

System dynamics is a perspective and set of conceptual tools that enables understanding the structure and dynamics of complex systems, a rigorous modelling method that enables building formal computer simulations of complex systems and uses them to design policies that are more effective and organisations (Sterman, 2000). Egilmez and Tatari (2012) cited Forrester (1961) definition that it as a computer aided approach to understanding the behaviour of a system over time that have been employed to tackle dynamic problems from various fields of study. It is a strong tool used in modelling complex systems to understand the pattern of behaviour of different stages over time. The traditional approach to systems problems is to understand the behaviour of a system based on the cause and effect relationships among system elements separately. It consists of feedback loops and has the ability to mimic the real scenario and reduce the system into multiple small individual pieces, which enables whole system study (Egilmez and Tatari, 2012). Used as a holistic modelling system dynamics simulation approach has been applied in models such as urban planning (White et al).

4.2. Reference Mode

According to Stephanie (1997) reference mode is a plot of the behaviour of key variables of system over time that captures mental model and historical data on paper, gives clues to appropriate model structure and can check plausibility once the model is built, done to check for some existence of behaviour worth modelling. Public transport growth is the key variable used in reference mode as it is known fact that commuter omnibuses were introduced in 1993 and increased until an estimated value of 10 000 in 2013. A hypothesised reference mode that consists of a simplified curve capturing the key features of the behaviour pattern of the important components of the system is used when there is lack of historical data Stephanie (1997).

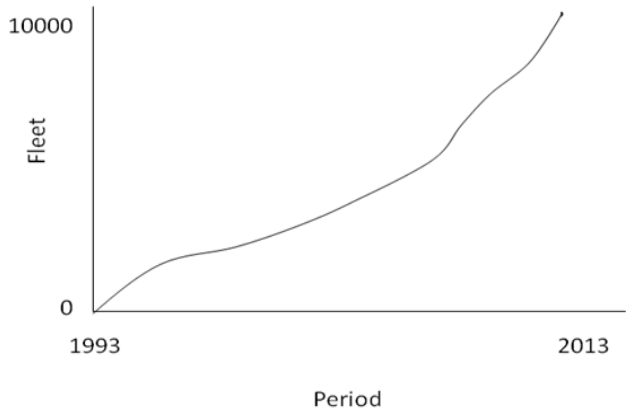


Figure 1. *Reference mode.*

4.3. Key Parameter Identification

Table 1. *Key Parameters.*

Parameter	Category	Description	Type	Unit	Affected by
Capital investment funds	Stock	The total amount of money invested	Endogenous	USD	Number of investors
Public transport demand	Convertor	Total number people to be transported	Endogenous	People	Population growth
Profit	Convertor	Amount realised after tax & operational costs	Endogenous	USD	Investor

Parameter	Category	Description	Type	Unit	Affected by
Rate of return	Flow	Rate of turnover per amount invested	Endogenous	Percent (%)	Interest rate
Revenue	Convertor	Total amount before tax	Endogenous	USD	Public transport capacity
Operational cost	Convertor	Total amount used	Endogenous	USD	Congestion
Public transport fleet	Stock	Total number of vehicles	Endogenous	Buses	Public transport capacity
Bus fare	Convertor	Price per km	Endogenous	USD/ km	Government policy
Public transport capacity	Convertor	Total number of passengers in a bus	Endogenous	Persons/ Bus	Public transport demand
Investors	Stock	Total number of investors	Endogenous	People	Rate of return
Government policy	Convertor	Bus fare control	Exogenous	-	-
Daily trips	convertor	Average number of daily possible trips	Auxiliary	-	Public transport capacity
Population	Stock	Total number of people in Harare city	Exogenous	People	-
Economy	Stock	Gross Domestic Product (GDP) of Harare city	Endogenous	USD	Investment
Congestion	Convertor	Total vehicle km travelled	Endogenous	Km	Public transport capacity
Fuel price	Convertor	Retail price per litre	Auxiliary	USD/ Litre	-
Fuel consumption	Convertor	Total amount of consumed fuel in litres	Endogenous	Litres	Total vehicle km travelled
Government policy	Convertor	Bus fare control	Exogenous	-	-

4.4. Causal Loop Diagram

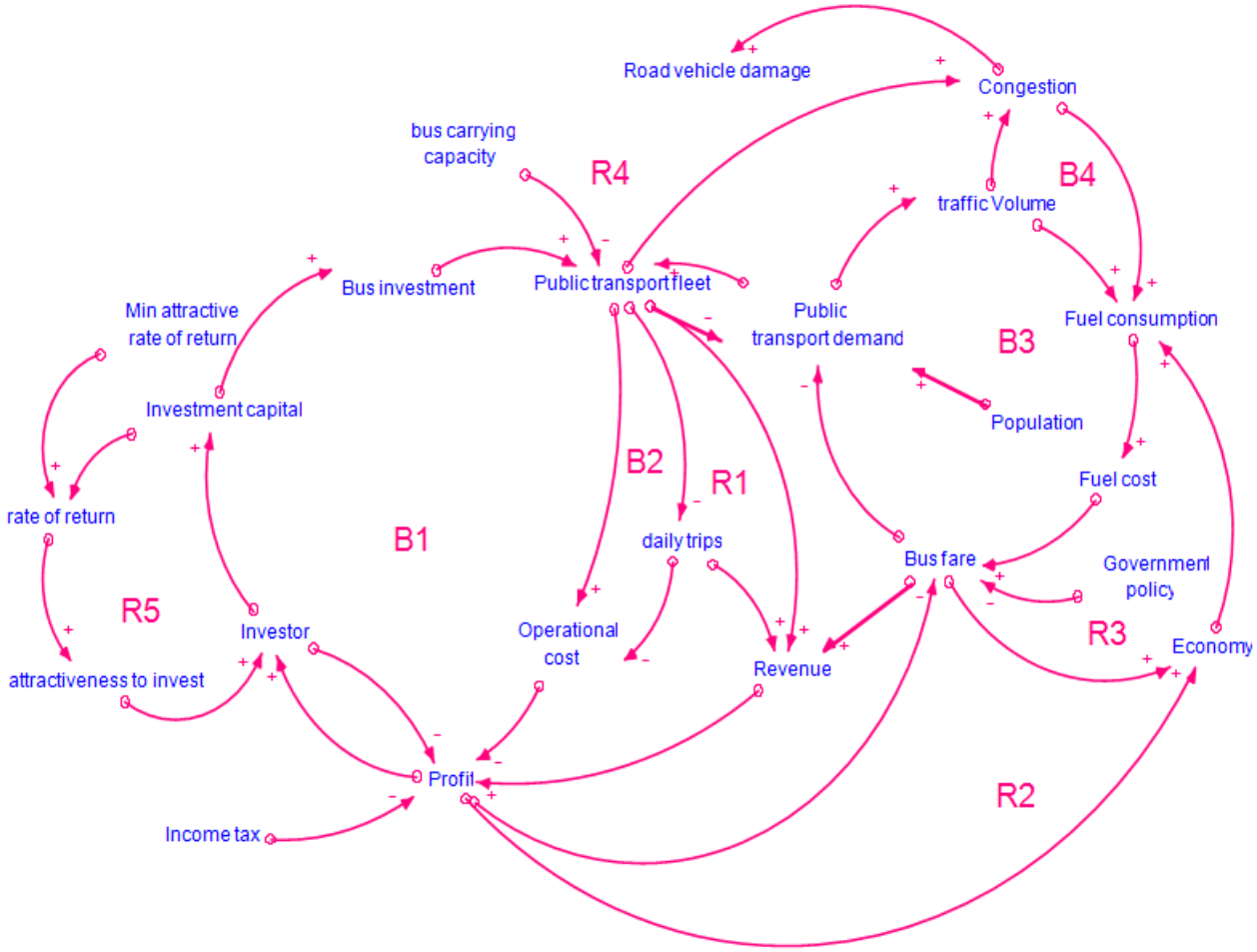


Figure 2. *Causal Loop & Relationships diagram.*

4.5. Feedback Loops

1. Negative loop B1: Availability of capital funds promotes increase in public transport fleet this will increase operational costs and in turn decrease profit that will affect attractiveness of investing.
2. Negative loop B2: Capital investment promotes increased public transport this would reduce daily trips

resulting in an increase in operational cost, which will reduce profit and affect attractiveness of investing.

3. Negative loop B3: Traffic volume increase increases the fuel consumption this increase tends to trigger an increase in bus fare to maintain equilibrium. Meaning that as bus fare increase, demand decrease and this will close the loop.
4. Negative loop B4: Traffic volume increase results in increased congestion and further increase in fuel consumption to beyond what it should have again causing an increase in bus fare. Increasing bus fare reduces public transport demand this will again close the balancing loop.
5. Positive loop R1: Availability of capital funds increases the public transport fleet that would result in increased revenue and profit meaning pulling more investors.
6. Positive loop R2: Bus fare increases revenue and profit which in turn increases the economy. An increase in economy means an extra can be used and results in increased fuel consumption that further pushes for bus fare increase to maintain breakeven.
7. Positive loop R3: an increased fuel consumption pushes for bus fare increase which in turn increase the economy as more will be used for personal consumption and again causing an increase in economy to reinforce fuel consumption.
8. Positive loop R4: Public transport fleet increase increases congestion, which in turn increase fuel consumption and advocates for bus fare increase. An increased bus fare increases revenue and profit, this will attract investors and increase the capital funds amount further reinforces the increase of public transport.
9. Positive loop R5: A better rate of return attracts more investors this causes an increase in capital funds base, which in turn increases return on investment.

5. Stock and Flow

5.1. Population and GDP Sub-Model

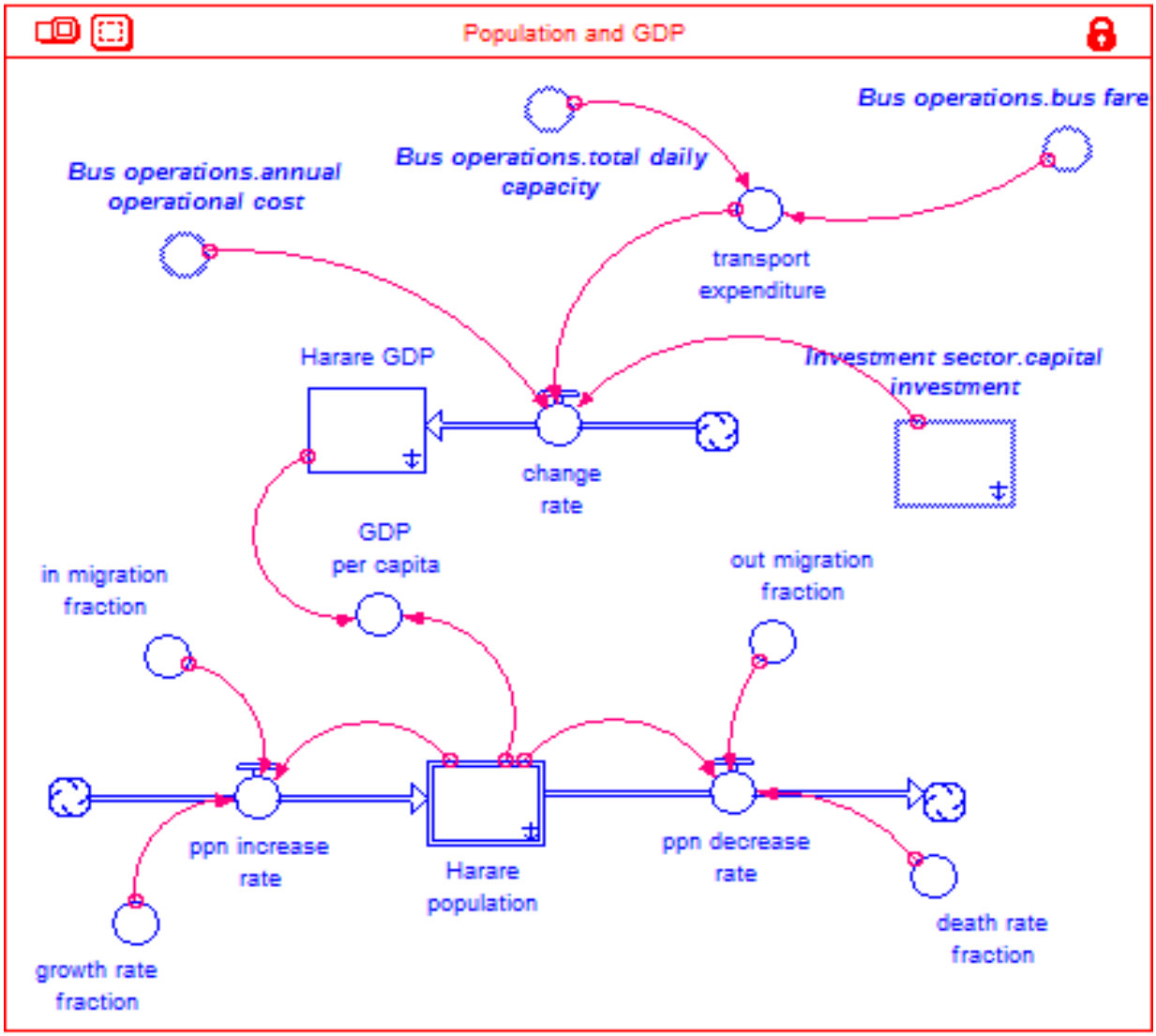


Figure 3. *Population & GDP Sub-model.*

5.2. Bus Operations Sub-Model

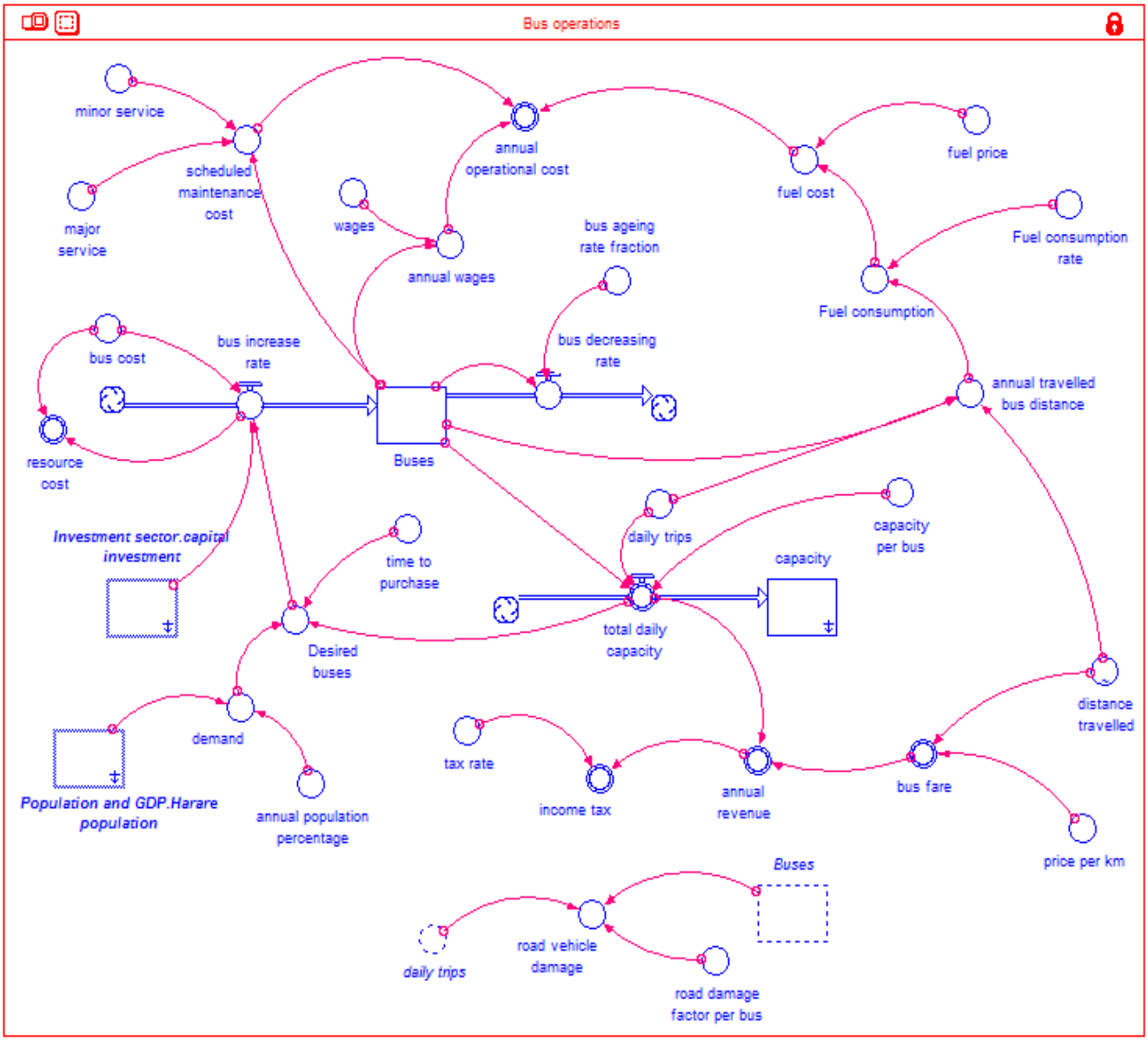


Figure 4. *Bus Operations Sub-model.*

5.3. Investment Sub-Model

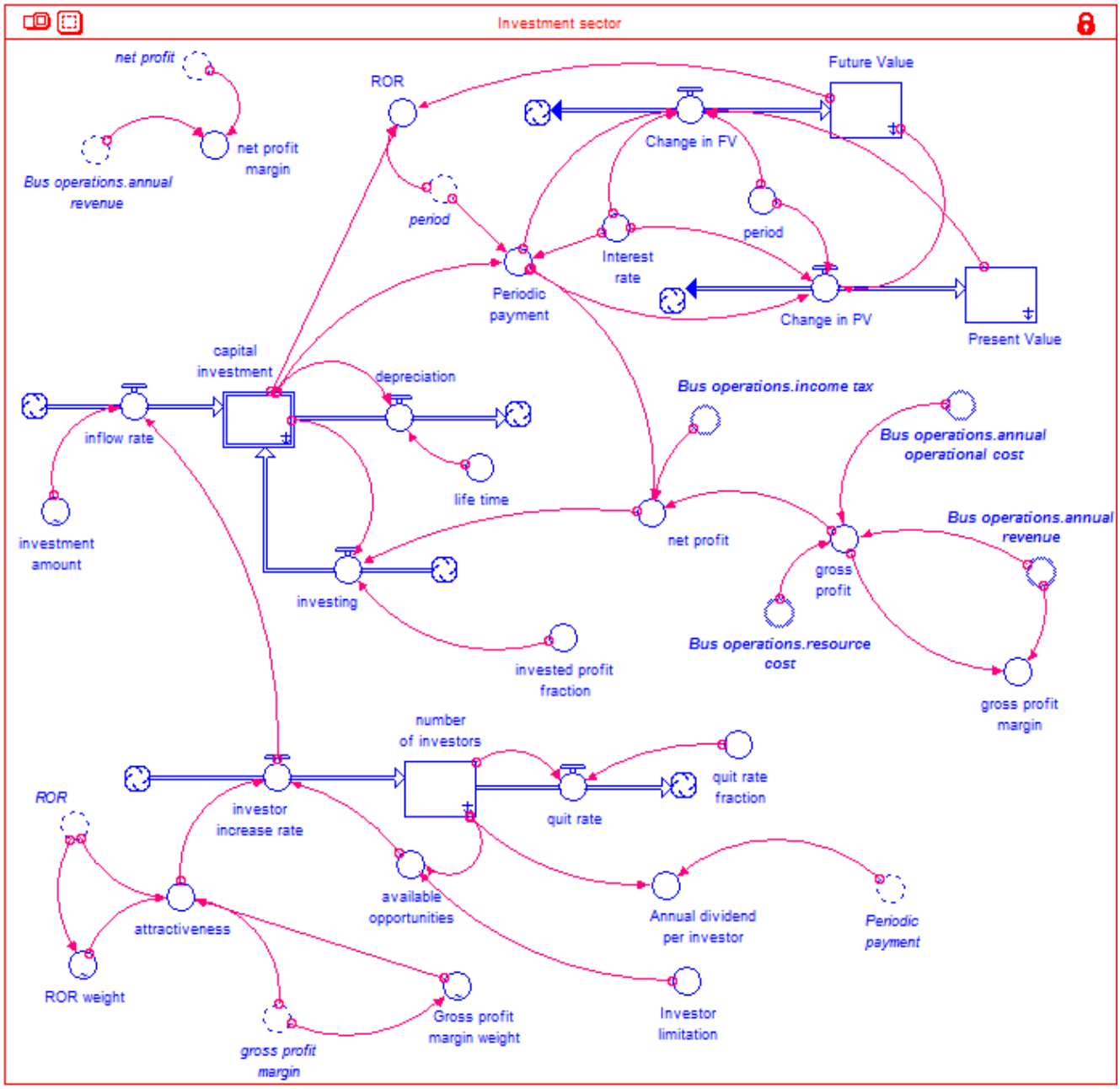


Figure 5. *Investment Sub-model.*

5.4. Validation

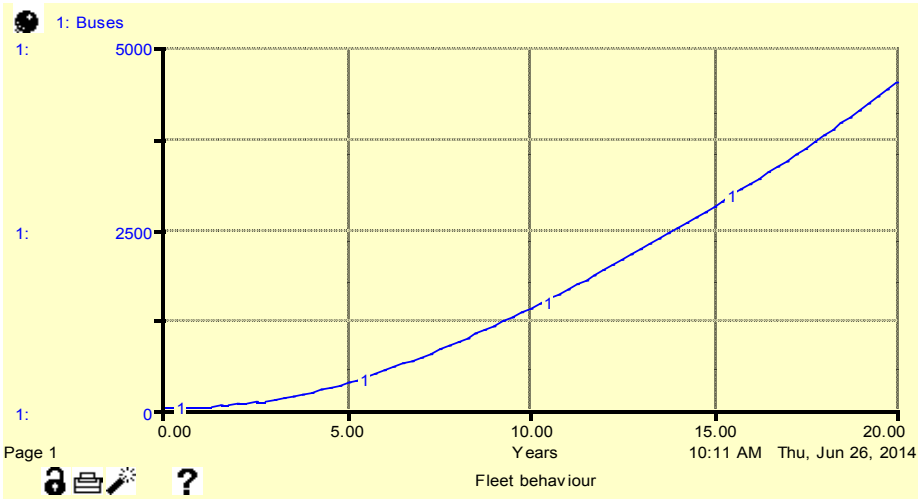


Figure 6. *Model Behaviour.*

5.5. Simulation Results

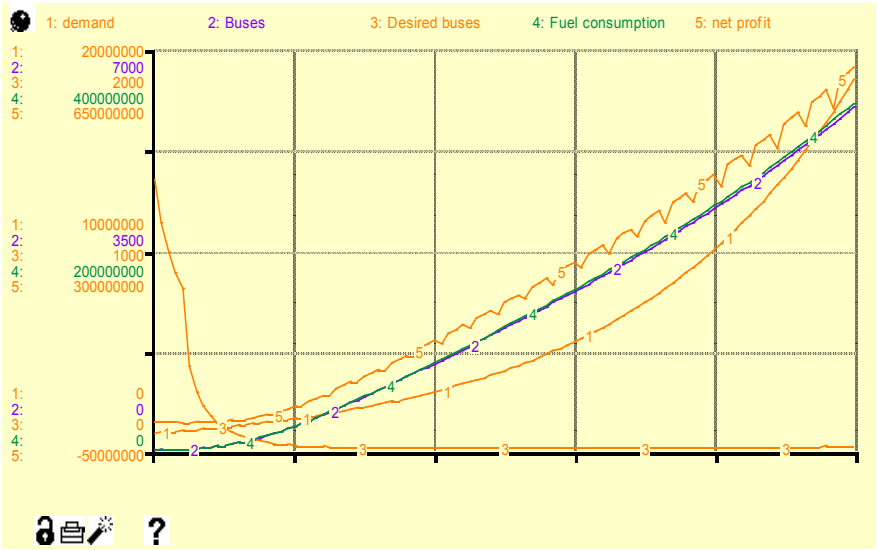
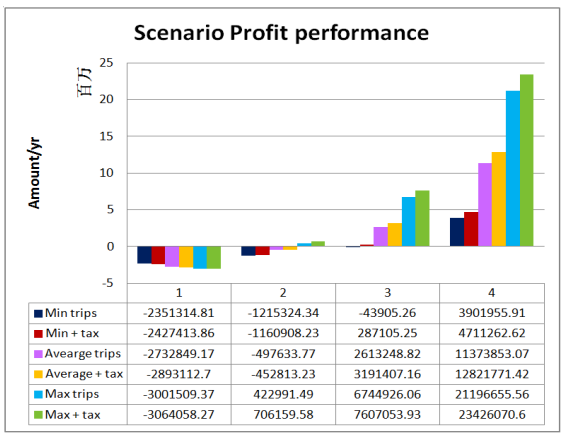


Figure 7. *Model Simulation Results.*

6. Discussion and Analysis



	1	2	3	4
Min trips	-2351314.81	-1215324.34	-43905.26	3901955.91
Min + tax	-2427413.86	-1160908.23	287105.25	4711262.62
Averege trips	-2732849.17	-497633.77	2613248.82	11373853.07
Average + tax	-2893112.7	-452813.23	3191407.16	12821771.42
Max trips	-3001509.37	422991.49	6744926.06	21196655.56
Max + tax	-3064058.27	706159.58	7607053.93	23426070.6

Figure 8. *Scenario Profits.*

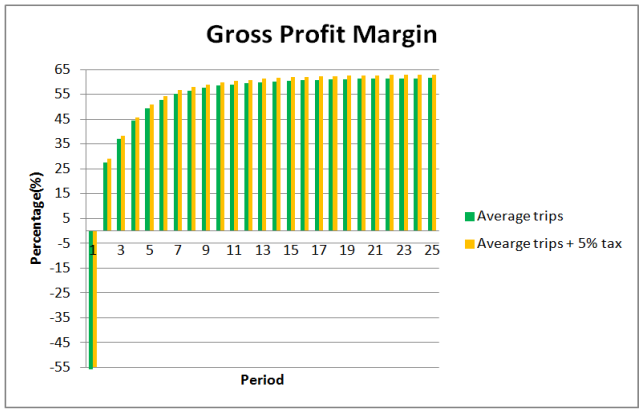


Figure 9. *System Profitability (GPM).*

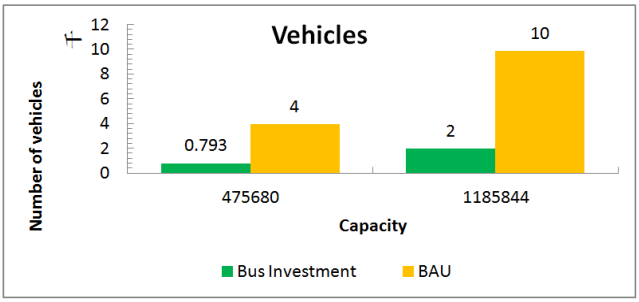


Figure 10. *Model & Current Fleet Size Comparison.*

Six scenarios were simulated and the results has shown that maximisation of daily trips coupled with earmarked tax produced the best profitable system that allows economic sustainability of the system operations. A gross profit margin obtained is on an increasing trend hence this shows that the future of the system is sound as it measures profitability and efficiency of a business.

A comparison of the current scenario Business as usual (BAU) with the bus investment model has shown that an increase in public transport capacity resulted in a huge reduction of fleet size. Since population is on an increase trend the behaviour exhibited by the system is an exponential increase of the fleet size, hence it is of paramount importance that measures taken should counter the growth to maintain the system in balance.

From this model behaviour, it is clear that there is need to re-establish a higher carrying transport system which will enable application of economies of scale and save fuel consumption, road maintenance cost as well as stabilise the public transport fare to attract members of the public to the usage of public transport. An introduction of high volume carrying capacity vehicle would reduce congestion, fuel consumption and operational cost that would see an economically sustainable system. Economically a business has to sustain its operations to be economically sustainable.

7. Conclusion and Recommendation

The research result provided an economically sustainable transport system for the Harare city through bus investment model. The six scenarios developed and simulated have shown that all scenarios having the following characteristics:

- A positive Gross Profit Margin growth trend, gross profit margin measures profitability and efficiency of the system hence, economic sustainability is achievable.
- Fleet size reduction for transportation of same number of passengers compared to current scenario.
- Fuel consumption reduction compared to that of current scenario for same services rendered.
- Daily trips reduction on the designed system
- Profitability shown by profit growth trend hence, offering fare flexibility

The System dynamics model can be run and results presented as an initial approach intended to help decision makers in determining the most appropriate actions to be taken to improve chaotic public transportation operations within all other cities of Zimbabwe. The above points show operational efficiency of the bus investment system, which does not only reduce non-renewable energy use to serve the future generation, it also has an environmental sustainability bonus package of emission reduction. The sixth scenario producing best results compared to all other scenarios hence, it shows that maximising number of trips with small fleet size is the better way to achieve economic sustainability.

Since the designed model is a pull method, as a way and means to support the designed framework the government is encouraged to apply push methods that will support the system. These include:

- ✓ Introduction of marked bus lanes, to improve system quality through travelling time.
- ✓ Congestion fee charging as a way to minimise private cars use.
- ✓ Differentiate parking fee for private and public transport.

Due to the importance of this topic and its effect on people's lives and future generation, it is has been noted as beneficial to expand this area of research. Having looked at the movable resource, this will become a basis for further improvement of the system's economic sustainability. Public transport system is an integration of both movable and fixed resources as well as a mixture of motorised and non-motorised modes. Using this research as stepping stone areas such infrastructure investment as a way for provision of an integrated motorised and non-motorised together with mass transit modes transport will be the next pot of call that can aid in achievement of sustainable development.

References

[1] Beuhler, & Pucher. (2011). Making public transport sustainable. Transport policy, 18.

[2] Chideme, M. (2013, 05/26/2013). Zimbabwe: 6 000 Kombi's Illegal On Harare Roads, The Herald Zimbabwe.

[3] Dirgahayani, P., & Nakamura, F. (2012). Fostering partnerships towards sustainable urban mobility from the national to local level: Matsuyama, Japan and Yogyakarta, Indonesia. IATSS research, 36(1), 48-55.

[4] Egilmez, G., & Tatari, O. (2012). A dynamic modeling approach to highway sustainability: Strategies to reduce overall impact. Transportation Research Part A: Policy and Practice, 46(7), 1086-1096.

[5] Holden, E., Linnerud, K., & Banister, D. (2013). Sustainable passenger transport: Back to Brundtland. Transportation Research Part A: Policy and Practice, 54, 67-77.

[6] Kodero, K. (2005). Pro-poor transport policy: Meeting the challenge in Zimbabwe

[7] Kwan, C., & Blanco, E. (2009). System Dynamics Modeling of the SmartWay Transport Partnership. Paper presented at the Second International Symposium on Engineering Systems.

[8] Low, N. (2003). Is Urban Transport Sustainable?

[9] Mahachi, T. (2012). City of Harare strategic plan 2012 - 2025

[10] Mbara, T., & Maunder, A. (1996). The initial effects of introducing commuter omnibus services in Harare, Zimbabwe: Overseas Centre, Transport Research Laboratory, Crownthorne, Berkshire, United Kingdom.

[11] Mbara, T., & Maunder, D. (1995). Sudden Impact? GLOBAL TRANSPORT.

[12] Mbara, T. C. (2002). Transport: How have African Cities managed the sector? What are the possible options. urban and city management course for Africa, Uganda.

[13] Menard, C., & Ghertman, M. (2009). Regulation, deregulation, reregulation: institutional perspectives: Edward Elgar Publishing.

[14] Nyarirangwe, M., & Mbara, T. (2007). Public Transport Service Modal choice, affordablity and perceptions in an unpalatable economic environment: the case of an Urban Corridor in Harare (Zimbabwe). SATC 2007.

[15] Pirie, G. (2013). Sustainable Urban Mobility in 'Anglophone' Sub-Saharan Africa. In U. Nations. (Ed.), Global Report on Human Settlements. Un-Habitat.

[16] Sterman, J. D. (2000). Business dynamics: Systems thinking and modelling for a complex world (International Edition ed.). McGraw-Hill Higher Education: Jeffrey J. Shelstad.

[17] Thuong, L., & Noi, H. (2003). System dynamic applied to study the urban traffic congestion of Hanoi. [Proceedings of the Eastern Asia Society for Transportation Studies]. Vol.4.

[18] UN-Habitat. (2013). Sustainable Cities Programme.

[19] UNEP. Public transport. United Nations Environment Programme Retrieved 22 October, 2013, from http://www.unep.org/transport/

[20] Voula, M., & Pedersen, J. (1998). Urban Sustainability Indicators.

[21] Zietsman, J., Rilett, L. R., & Kim, S.-J. (2003). Sustainable transport performance measures for developing communities 6. Performing Organization Code.