DEVELOPMENT OF A FARE STRUCTURE FOR THE THREE WHEELERS

Konara Mudiyanselage Nishantha

(138318A)

Degree of Master of Engineering in
Highway and Traffic Engineering

Department of Civil Engineering

University of Moratuwa
Sri Lanka

March, 2017

DEVELOPMENT OF A FARE STRUCTURE FOR THE THREE WHEELERS

Konara Mudiyanselage Nishantha

(138318A)

Thesis submitted in partial fulfilment of the requirements for the degree
Master of Engineering in Highway and Traffic Engineering

Department of Civil Engineering

University of Moratuwa
Sri Lanka

March 2017

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

The above candidate has carried out research for the Master's thesis under my supervision.

Signature of the supervisor: Date:

ABSTRACT

Three wheelers have a significant contribution towards the road transportation as a popular para-transit mode in the country. Though three wheeler taxi provides valuable services, it is not appreciated at all. Only negative aspects are highlighted. Its existence and operation fail to get the credits from the society. Three wheeler transport services is unregulated at present and is mainly criticized for its "unfair" fare structure. Many three-wheeler users view that they are often exploited by drivers who over-state distance and charge higher fares. It is also observed that the fares are generally inconsistent and may vary from operator to operator, in addition to the distance travelled and journey time. Further, three wheeler meters are calibrated arbitrarily by the operators. Absence of a proper fare structure for three wheelers causes inconvenience to both operators and passengers. Therefore development of a fare structure would lead to minimization of imbalances and inefficiency in the service under prevailing fare structures. At present, passengers are charged with a minimum fee of Rs. 50 for the first kilometer and henceforth each kilometer is charged at a rate of Rs. 40 per km. There is no systematic procedure to charge for two way trips and waiting time.

This study is an attempt to examine the price irregularities and explore the cost recovery in three-wheeler transport services and thereby develop a systematic fare structure for Three-Wheelers based on both passenger and Three-Wheeler drivers' perspectives. A fare structure should be transparent, simple and understandable by each party to be effective and fare structure is the instrument to recover cost and it acts as the communicator between the operator and the passenger of the taxi service. After considering the present operational cost and cost recovery of a three wheeler, including the profit mark-up, a new fares structure is proposed considering all stakeholder requirements and expectations.

It is shown that the three wheeler is best for shorter distances (last mile connectivity) and not efficient for longer distances. Hence, three wheelers should not be encouraged for longer distances travel as public bus transport and the van service are more efficient for longer distances.

DEDICATION

To

My Loving Wife

Who Always Encouraged Me Towards Success.

ACKNOWLEDGEMENT

I would like to acknowledge many people who supported me to complete the master's research successfully. First of all I would like to thank project supervisor Prof. Saman Bandara for giving necessary guidance and valuable instruction by encouraging me to complete the research.

Further thank go to the progress review committee member Prof. W.K.Mampearachchi for his comments to improve the research output.

Next I would like to convey my sincere gratitude to the officers of three wheel companies, spare part dealers, all operators and owners of the three wheelers, officers of insurance companies, officers of emission testing and officers of revenue license office who provide necessary information and data for the success of my research.
Further my thanks are extended to all those who helped us in numerous ways to complete this research successfully.

Konara Mudiyanselage Nishantha
138318A
Transportation Engineering Division
Department of Civil Engineering
University of Moratuwa

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Development of Three wheeler industry in Sri Lanka

The origin of Sri Lanka's three wheeler industry is traced back to the introduction of the open economy in 1978. In Sri Lanka, after a reformed public transport arrangement 1978, the private sector has taken a key role in providing transport services. Since then the private buses started their operation with a schedule time table, However unavailability of transport service in early morning or late night has become a problem for the public, especially for commuters in rural areas or in small cities. Motorcycle and bicycle have become the alternate modes to solve the mobility issue, but the capacity of these modes will not allow carrying more additional passengers. There are no other modes to support their urgent mobility needs, especially during night time and emergency situations. As a result commuters from local areas in small cities are having serious transportation problems. The Three wheelers' services comfortably started filling these needs. Three wheelers perform many of the same function as the taxi and it is considered as a next step up ladder for personal mobility to buses in small cities.

In today's world one of the most challenging problems that we face is providing optimal, efficient, cost effective and also environmentally friendly transport services. According to Aworemi, Salami, et al (2008), the demand for public transport depends on two factors. First, the desire to make a particular trip and to do so by public transport. Second, the characteristics and nature of the public transport modes that is available. Providing an optimal public transport service which maximizes social welfare is a major challenge confronted with transport stakeholders in developing countries. Impoverished conditions in public transport such as bus and rail transport in developing countries have given rise to a formation of Informal Public Transport (IPT) modes. Further, increasing urbanization, population and industrial development is increasing the demand for urban transport services. As a result, demand for comfortable yet affordable public transport has become inevitably high (Hilling, 1996). Informal Public Transport (IPT) modes are widespread social phenomena in Sri Lanka and have become an integral part of the transport sector.

The most common and visible IPT or para transit mode in Sri Lanka is the use of Three-Wheelers. Even though many representatives of Sri Lankan society consider it as a nuisance; congestion of traffic, noise and air pollution, association with illegal activities, and price irregularities, from the standpoint of passengers, the ready availability, flexibility in ‘door to door’ service, ease in communication and "affordability" have found the grounds for the existence of Three wheelers as a primary IPT mode.

The total vehicle population in Sri Lanka is 5.6 million in 2014 and this records 7.6 percent growth compared to 6.3 percent growth in 2013.The highest growth rate recorded on Motor Tricycles with 728.14 percent during this period (2001 base) and this reflects that the personal use vehicles have increased in significant level than the other type of vehicle categories specially Motor Tricycles (three wheels).As well as Total New Vehicle Registrations in Sri Lanka records 429,556 in 2014 and this reflects 31.5 percent growth compared to previous year. Of these second highest category of new vehicle registered is Three - Wheelers and it is 18 percent. (National transport statistics reports 2015 by national transport commission)

Table 1: Total vehicle population

Class of vehicle	2008	2009	2010	2011	2012	2013	2014
Motor Cars	381,448	387,210	410,282	468,168	499,714	528,094	566,874
Motor Tricycle	406,531	443,895	529,543	667,969	766,784	850,457	929,495
Motor Cycles	1,760,600	1,896,021	2,100,832	2,354,163	2,546,447	2,715,727	2,988,612
Buses	81,050	81,789	84,280	88,528	91,623	93,428	97,279
Dual purpose vehicles	196,236	197,516	209,228	242,746	280,143	304,746	325,545
Motor Lorries	276,622	284,847	296,692	311,510	323,776	329,648	334,769
Land Vehicles-Tractors	245,683	259,634	276,997	297,070	315,520	326,292	333,362
Land Vehicles-Trailers	42,823	44,156	46,457	49,578	53,020	55,286	57,298
Total	**3,390,993**	**3,595,068**	**3,954,311**	**4,479,732**	**4,877,027**	**5,203,678**	**5,633,234**

Source: (National transport statistics reports 2015 by national transport commission)

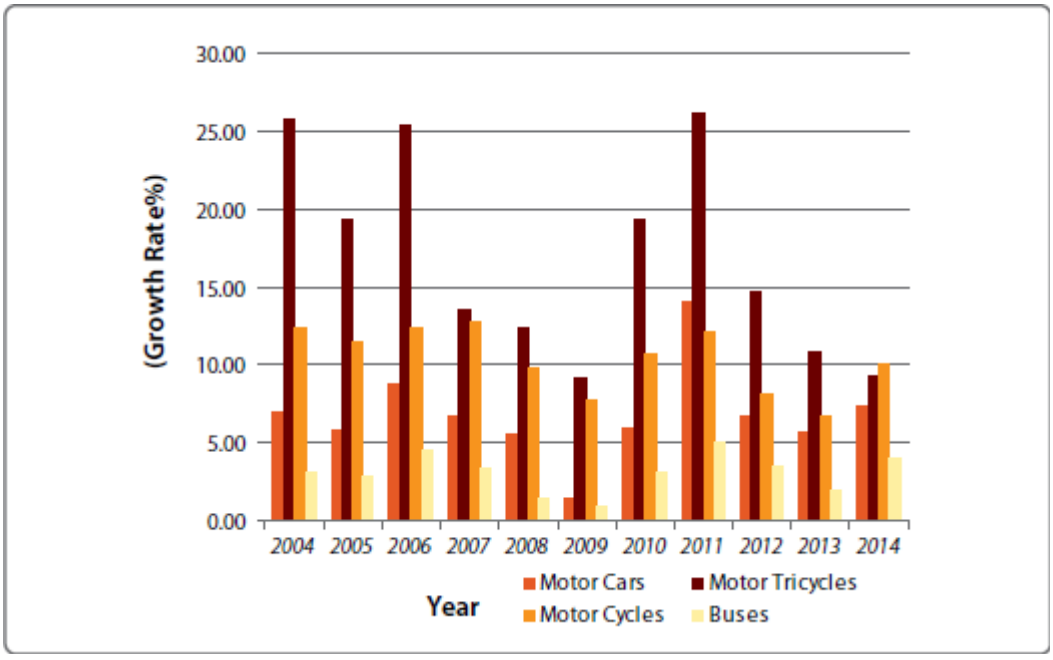

Figure 1: Vehicle Growth Rate

Source: (National transport statistics reports 2015 by national transport commission)

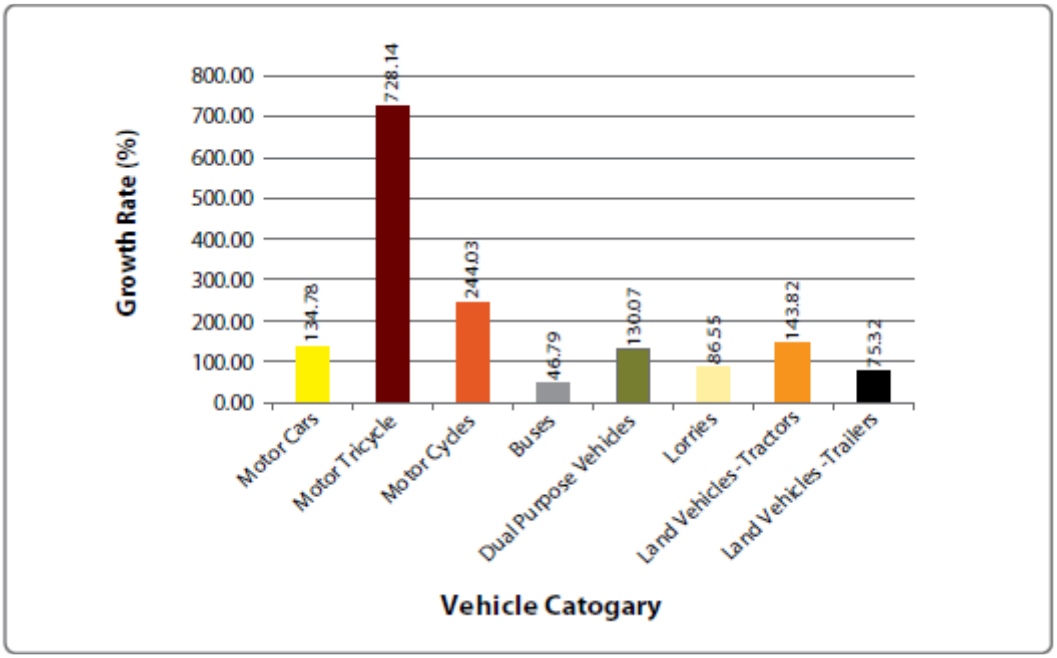

Figure 2: Vehicle Growth Rate (2001-2014) 2001 Base
Source: (National transport statistics reports 2015 by national transport commission)

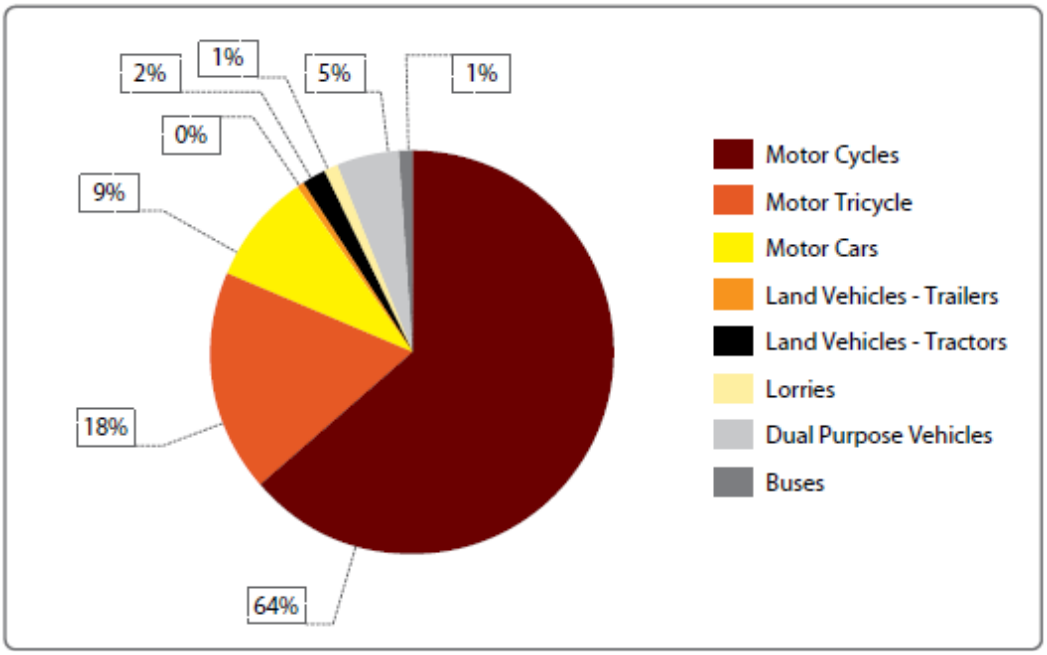

Figure 3: New Vehicle Registrations -2014
Source: (National transport statistics reports 2015 by national transport commission)

Three wheelers have a significant contribution towards the road transportation as a popular Para-transit mode in Sri Lanka. Modal contribution to the Sri Lankan market indicates that three wheelers carry 1,548 million passenger-km which is 13% total passenger-km (Kumarage, 2004). Therefore, 'Privately operated' three wheelers are now the largest 'public transport service provider in the country.

Three wheeler transport services mainly cater to the passenger transportation as well as light weight freight transportation requirements of low income group of the population. The popularity of three wheelers is rising largely due to the breakdown of public transport services' and also due to parking problems in the central business areas. The primary reason of operator's attraction is that it's being used as a means of self-employment. By now, three wheelers are one of the largest and fastest growing forms of self-employment in the country

1.2 Problem Statement and Background

Three wheeler services provide valuable mobility services; it is not appreciated at all. Only negative aspects are highlighted. Its existence and operation fail to get the credits from the society. Three wheeler transport is highly unregulated at present and is mainly criticized for its "unfair" fare structure. Many three-wheeler users feel that they are often exploited by drivers who over-state distance and charge higher fares. It is also observed that the fares are usually inconsistent and may vary from operator to operator in addition to the distance travelled and journey time. Further three wheeler meters are calibrated arbitrarily by the operators.

Absence of a proper fare structure for three wheelers causes inconvenience to both operators and passengers. Therefore, development of a fares structure would lead to minimization of imbalances and inefficiency in the service prevailing fares structures.

This study is an attempt to examine the price irregularities and explore the cost recovery in three-wheeler transport and thereby to develop a systematic fare structure for Three-Wheelers based on both passenger and Three-Wheeler drivers' perspectives. At present, passengers are charged with a minimum fee of Rs. 50 up to

the first kilometer and henceforth each kilometer is charged at a rate of Rs. 40per km for one way and two-way trips. There is no systematic procedure to charge for waiting time and there is no systematic procedure available at present for the revision of fares with fluctuation of major operation cost components. In order to revise three-wheeler fares with frequently fluctuating input price levels, such as fuel price, percentage contribution of each cost component in the total operational cost (Rs/km) were calculated. After considering the present operational cost and cost recovery of a three wheeler, including the profit mark-up, a new fares structure is proposed considering all stakeholder requirements and expectations.

A fares structure should be transparent, simple and understandable by each party to be effective. The fares structure is the instrument to recover cost and it acts as the communicator between operator and the passenger of the transport service. After considering the present operational cost and the cost recovery of a three wheeler including the profit markup, a new fares structure is proposed for the convenience of both operators and passengers.

1.3 Objectives of the Study

Prime Objective of this study is to develop cost based fare structure (Cost formula With reference to distance travelled) for Three Wheelers considering cost recovery. It can be used as guiding indicator to revise three wheeler fares.

Having understood the prevailing problems of improper fare system and the need to rectify them with a scientific system of fare revision, this research has four primaries, but related, objectives, shown below.

1. Identifying major variants of three wheeler operation.
2. Identifying the cost components of operating a three wheeler.
3. Quantifying each cost component and studying the existing fare structures.
4. Designing of an appropriate cost formula.

2. LITERATURE REVIEW

2.1 Para-Transit-Definition

These are similar to the private automobile in that they operate on demand-not following a fixed route or fixed time schedule. The service pattern is a many-to-much which passengers are picked up anywhere and are delivered to anywhere. (Alan Black, 1995)

2.2 Fares Policy for Bus Transport Services

The Secretary to the Ministry of Transport under the instructions of the Hon. Minister appointed a committee to design an appropriate cost and fare index to implement a fare policy for bus transport services. As a result the current fares policy for bus industry is implemented and the fare structure was formulated. Following information was extracted from the technical report submitted by the Committee titled 'Implementation of an appropriate fare policy for passenger transport services' in August 2001.

2.2.1 Constructing the Cost Index

A representative index of the cost was constructed for the operating of bus service in Sri Lanka. This index reflects the changes in the operating cost of bus service due to changes in the cost components, so that it can be used as guiding indicator to revise bus fares whenever it is deemed necessary.

The Twelve cost components of operating the bus service has been identified as follows:

- Fuel
- Crew
- Oil and Lubricants
- Tire and Tubes
- Air Conditioning
- Repairs
- Daily Overheads
- Monthly Overheads
- Annual Overheads
- Depreciation
- Interest on Capital
- Risk on Enterprise

The operating cost can also vary according to the different operating conditions, such as type of the bus, type of the route and speed etc. Among those different conditions the route type has been identified as the prime factor, which affects other determinants of costs indirectly. As such, constructing a representative route condition was a major task. Ten typical route types have been identified to examine how different route conditions affect the operating cost. The ten selected route types are:

A. Long Distance Low Country
B. Long Distance Low Country (AC)
C. Long Distance Up Country
D. Long Distance Up Country (AC)
E. Regional
F. Urban Line Haul
G. Urban Line Haul (AC)
H. Urban Cross Town
I. Urban Feeder
J. Rural

There are several dimensions, such as service type, operable days, distance, speed, type of bus and the age of the bus etc. of the cost of operating a bus in a selected route. Therefore, each route type was analyzed under all dimensions and then the selected ten route types were examined with twelve components of cost to obtain each cost component for revenue kilometre varies under different route conditions.
The last was to arrive at a single cost figure, which is representative of all cost components under all route types and other cost related dimensions. Combining these twelve cost components to get a single figure in a more representative way was the final task. The weighted average method was used to arrive at this final number. Accordingly, each cost scenario under each route condition was assigned a weight where the weight was the ratio of the number of buses operating under each road condition to the total number of operating buses.

Then each representative cost component was assigned as weight, where the weight was the share of each representative cost component in the total representative cost of operating the bus service under all route types. This method can be applied to price change of all cost components in a given period to arrive at a representative overall change in the operating cost of operating the bus service.

A very important characteristic of bus fare the index calculation is to treat the index value as 100 for the base period. The base period used for the calculation of the cost index was May 2001. Acocordingly, the percentage shares of all cost components were aggregated to arriave at the base period index of 100. The change of this index due to changes in any of the twelve cost components can be taken as a representative change in the cost of operating the bus service economically. Accordingly the movements of this index can be taken as the guiding indicator for revising bus fares.
Operating cost can be calculated at any point in time by ascertaining the price of at that point of time. All cost items have been linked to the cost index using unit prices or price levels such as Colombo consumer price index or the Exchange rate for the Us $.

2.2.2 Constructing Fares Index

The fares index is the amount arrived at when the project revenue after a fare increase is taken as a percentage of the revenue at the base year. This is computed by taking the projected revenue in each of the representative routes and thereafter considering single weighted revenue for all routes. This then represents the value of tickets sold in the entire bus transport system in Sri Lanka based on the fare profile.

The fares revision should then be based on maintaining the balance between total revenues and coast in the manner that.
Bus Cost Operation Index = Bus Fares Index

Both indices being set at 100 as at May 2001 can be calculated for time of revision and compared when fares stages are set.

The fares index has been constructed taking in to account the fare profile of each route in terms of the percentage of passengers travelling different distance. The cost that should be recovered from passengers has been investigated so that the benefit cost ratio for different routes is around one. This is calculated by taking the number of passenger boarding per trip and the fares collectable from the profile.

2.2.3 Fare Structure

The existing tapering fare has been modelled in to a step on fare and four different unit fare stages. The investigation of benefit cost analysis of the different types of operations found that following composition is the ideal. Here the x amount is the cost per km.

Step on Fare	3 kms (at x cents per km)
Up to 4 kms	say x cents per km
5 to 14 kms	0.9 times x cents per km
15 to 29 kms	0.75 times x cents per km
Over 30 kms	0.65 times x cents per km

2.2.4 Fare Anomalies and their Reduction

There are a number of fare anomalies that are evident in bus operating service. These may be summarized as:

(a) The per km fare for longer distance is much less than for shorter distances

(b) The per km fare should change with terrain (e.g. Up country by about 17 percent and mid country by about 11 percent)

(c) The per km fare for rural areas should also increase by about 30 percent

These anomalies can be corrected by the following adjustments.

- Air conditioned service – presently set at 2 times the normal fare, can be retained
- Up country factor – in determining fare sections, those routes that are at elevations of over 600 meters, will have a 17 percent surcharge on costs. This can be achieved by proportionately reducing the distance by 17 percent so that section lengths are 1.7 kms instead of 2 kms.
- Mid country factor – in determining fare sections, those routes that are at elevations of between 300 meters and 600 meters will have 11 percent surcharge on costs. This can be achieved by proportionately reducing the distance by 11 percent so that section lengths are 1.8kms instead of 2 kms.
- Rural services – in order to ensure cost recovery of rural operations caused by a combination of increased costs and reduced revenue due to lower population density and demand, a surcharge of 30 percent may be applied. This also can be achieved by reducing the length of section or by the provision of a subsidy for such routes, as in the practice today. However since it is the government's policy to subsidize unremunerative rural routes, the latter will not be applied.

It is proposed that these anomalies be eliminated over four staged fare increases.

2.2.5 Criterion for Future Fare Revisions

When a fare revision is to be made in future the following criterion could be adopted.

(a) The increase in the average operating cost is applied to the fares to obtain the revised fares. That is the cost index is equated to the fares index and
(b) The benefit cost ratio (BCR) of the different types of routes is brought closer to 100 percent
(c) All existing anomalies are gradually eliminated and load factors are gradually reduced

2.3 Review of Taxi fare & Taxi fare Structure for Northern Ireland

Northern Ireland's taxi tariff structure has prepared by Transport Research Institute, Edinburgh Napier University at 11 August 2011. The development of a Northern Ireland tariff was based on evidence collected from research (including a postal survey of 2,000+ taxi licence holders) and a consultation exercise.

The objectives for introducing a regulated maximum tariff in Northern Ireland were to create a tariff structure with operational integrity, specifically:

- To create a maximum tariff structure that is understandable to both taxi drivers and the users of taxis
- To create a maximum tariff structure that can be updated on an annual basis
- To create a maximum tariff structure that is evidence-based

This showed three broad cost categories for operating a taxi in Northern Ireland:

1. Fixed costs: those costs that generally do not change based on mileage. This includes vehicle purchase costs, insurance, the annual license costs, road tax etc. On the basis of the survey these were estimated to be £7,020 per annum per driver

2. Running costs: including those costs which will change depending on mileage, notably annual fuel and vehicle maintenance costs. On the basis of the survey these were estimated to be £9,194 per annum per driver for the average mileage driven (25,940 miles) with a fee paying passenger in the vehicle

3. Labour costs: drivers must also be able to make a return above the fixed and running costs, i.e. a fair return for their labour. In the absence of this, it is unlikely that drivers will be able to remain in the sector. On the basis of income data from the Office of National Statistics for this sector, these were estimated to be £24,470 per annum per driver.

On this basis, the total cost of operating a taxi in Northern Ireland is £1.57 per live mile, i.e. for the average taxi driver to cover their labour and vehicle operating costs, the tariff rate would have to be set at an equivalent of £1.57 per live mile. The survey also showed no evidence to support different tariff rates for urban and rural areas.

2.3.1 Total operating costs

Table 2 provides a summary of all the cost components included in the Northern Ireland taxi cost model. The average annual cost is approximately £40,684 with 40% relating to vehicle operating costs (both fixed and variable) and 60% relating to driver's labor costs.

Table 2: Average taxi operating costs and cost per live mile (Jan 2011)

Cost Element	**Total cost per annum**	**Cost per live mile**
Vehicle capital costs	£3,202	£0.12
Radio Circuit / Depot fees	£2,327	£0.09
Insurance	£1,133	£0.04
Road Tax	£199	£0.01
MOT Fee	£138	£0.01
Taxi Driver License	£21	£0.00
Total fixed costs	**£7,020**	**£0.27**
Fuel costs	£7,665	£0.30
Basket of parts (semi-variable)	£900	£0.03
Maintenance labour costs (semi-variable)	£629	£0.02
Total running costs	**£9,194**	**£0.35**
Driver labour costs	**£24,470**	**£0.94**
Totals	**£40,684**	**£1.57**

As can be seen from Table 2**,** the total cost of operating a taxi in Northern Ireland is £1.57 per live mile.

The key conclusions from this analysis are:

1. In order for the average taxi driver to cover their labour and vehicle operating costs, the tariff rate would have to be set at an equivalent of £1.57 per live mile

2. While accessible taxis have higher up front purchase costs, their longer effective life means that their annual operating costs are in line with non-accessible vehicles. Consequently there is no evidence to support separate tariffs rates for accessible and non-accessible vehicles

3. While drivers in rural areas have proportionately fewer fares per day compared to drivers in urban areas, the average distance travelled for these fares is longer. This, coupled with the fact that there is no evidence of operating costs varying significantly between rural and urban areas, means that there is no evidence to support different tariff rates for urban and rural areas.

3. METHODOLOGY

This chapter sets out the summary of the methodology used in the computation of the operational cost and the fares structure for three wheelers. The method can be set out as a four-stage sequential process.

Step 1: Identification of the major variants in the cost of three wheeler operations such as three wheeler type and kilometres operated. The type of three wheeler is identified as a primary variant of operating costs. (Based on fuel type used 2-stroke (petrol+2T oil), 4-stroke (petrol only) and Diesel).

220 Three wheelers were surveyed in the 10 parking areas in Divisional Secretariat area of Kalutara and it was found that share of each type of three wheelers.

Step 2: Ten different cost components have been identified, as inputs required for the purpose of operating a three wheeler service and three type of three wheelers are operating based on fuel type used namely 2-stroke (petrol+2T oil), 4-stroke (petrol only) and Diesel. Feedback from30 three wheeler operators were taken with 10 three wheeler operators in each type for questionnaire survey.

Questionnaire survey was designed to collect each kind of revenue and cost components. Price levels of inputs have been taken at current (December 2016) market prices. After identifying cost components Questionnaire survey was conducted to quantify the identified cost components. The cost of operating a three wheeler over one km distance was computed based on the information collected. Each cost component is quantified for each three wheeler type and then the actual distribution of each cost component was studied. Finally operational cost was calculated using the average value of each component and each cost component was calculated on the basis of rupees per kilometer for above mentioned three wheeler types.

Step 3: Existing fares of the three wheelers operated have been formulated based on the information obtained from the questionnaire. It is observed that present fare structure recover cost of return trip in each one way trip. Thereafter, based on the revenue and cost for an operating a three wheeler, a Benefit Cost Ratio (BCR) can be computed for different distances. It is see however, that presently, there are varying BCR values between the different distances. First kilometre has a equal benefit and cost for one way trip and henceforth each kilometre cannot recover costs for one way trip, while all range of distances in two way trips have a higher than required cost recovery.

Step 4: The new fare structure (A distance based fare structure) is developed considering each and every stakeholder requirements and expectation.

4. COMPUTATION OF OPERATING COST

This chapter deals with the computations of cost components identified in the study. Each of the steps and results of such computations are dealt with separately in the sequential process as given in previous section.

4.1 Variants of Three Wheeler Operating Cost

The cost of three wheeler operations has a number of variants. The most significant parameters identified for specified consideration in calculating the three wheeler operating cost in this study are:

4.1.1 Type of Three Wheeler`

Hydro carbons emitted by two stroke engines exceed the National Vehicular Standard of 50 micrograms. Therefore the government decided to ban Three Wheel taxis with two stroke engines with effect from 2011 and imports ceased from 2008 considering the interest of the people's health and also improve urban air quality. With that government policy four stroke engine three wheelers added to market and even though two strokes engine three wheelers were banned, two stroke engine three wheelers still available in the market.

There are three types of three wheelers identified in this study based on fuel type used and those are 2-stroke (petrol+2T oil), 4-stroke (petrol only) and Diesel. Operating cost changes with the type of the three wheelers since fuel efficiency changes with the type of engine of the three wheelers.

It was found that Average fuel efficiencies are 25 km/L, 30 km/L and 35 km/L for 2-stroke (petrol+2T oil), 4-stroke (petrol only) and Diesel respectively based on questionnaire survey .These values are less than 5 km/L according to the manufacture specification.

4.1.2 Kilometers Operated

The kilometers operated per day have a distinct bearing on operational costs as it is the base to determine the fixed costs such as financing and insurance when apportioned per km. It was found that Average 34 km (one way trip length) operated per day based on questionnaire survey.

4.1.3 Number of Days Operated

The number of days operable on a route depends on off days of the operator. Off Days varied significantly among individual operators as there was no fixed regulation. It was found that 1 day for servicing and 2 off days for each month based on questionnaire survey. Therefore number of days operable in a year is computed as follows:

Number of Days operated per year = 12* (Number of days per month - Off days per month – Servicing days per month)

= 12 *(30-2-1)

= 324 days

4.2 Cost Components

The components of three wheeler operating cost identified in this study are listed as below.

- Fuel Cost
- Repairs & Maintenance Cost
- Service Cost
- Tires Cost
- Tube Cost
- Operator Salary
- Provision for Risk (profit)
- Depreciation
- Interest on Capital
- Annual Overheads

The prices of these individual inputs have been computed using market prices and consumption rates. Following sub divisions are detailed on each cost component. Each component was calculated on the basis of rupees per kilometre.

4.2.1 Fuel Cost

The cost of fuel is calculated by dividing the unit cost of fuel efficiency. Fuel cost was calculated for each three wheeler type as follows.

i) For 2-stroke (petrol+2T oil) three wheelers

The cost of fuel comprise of two components as cost of petrol and cost of 2T oil. Mix proportion of 30ml to 1 litre of petrol was assumed when calculating the 2T oil cost.

$$\text{Fuel cost (Rs/Km)} = \frac{\text{[Cost of petrol (Rs/litre) + Cost of 2T oil]}}{\text{Fuel Efficiency (Km/litre)}}$$

The unit cost of petrol was taken as 117 Rs/L and unit cost of 2T was taken as 400 Rs/L. Both costs were obtained from the current market prices.

Fuel efficiency was obtained historical record obtained from known three wheeler operators and responses from questionnaire.

$$\text{Fuel cost (Rs/Km)} = \frac{(117 + 12)\ \text{(Rs/litre)}}{25\ \text{(Km/litre)}}$$

$$= 5.16$$

ii) For 4-stroke (petrol only) three wheelers

$$\text{Fuel cost (Rs/Km)} = \frac{\text{Cost of petrol (Rs/litre)}}{\text{Fuel Efficiency (Km/litre)}}$$

$$\text{Fuel cost (Rs/Km)} = \frac{117\ \text{(Rs/litre)}}{30\ \text{(Km/litre)}}$$

$$= 3.90$$

Fuel efficiency was obtained historical record obtained from known three wheeler operators and responses from questionnaire.

iii) For Diesel three wheelers

$$\text{Fuel cost (Rs/Km)} = \frac{\text{Cost of Diesel (Rs/litre)}}{\text{Fuel Efficiency (Km/litre)}}$$

$$\text{Fuel cost (Rs/Km)} = \frac{95 \text{ (Rs/litre)}}{35 \text{ (Km/litre)}}$$

$$= 2.71$$

The unit cost of Diesel was taken as 95 Rs/L and fuel efficiency was obtained historical record obtained from known three wheeler operators and responses from questionnaire.

4.2.2 Repair & Maintenance Cost

Repairs to three wheelers have been categorized in three types in this study. These are:

- Major Repairs to Engine and Boring
- Major Body Repair
- All other repairs inclusive of replacement and repair of suspension, brakes, clutch cable with router, clutch plate, batteries, bulb and day to day running repairs

Some of the experienced mechanics and dealers were used as the source of information in finding the repair and maintenance cost. Costs and lifetime of major repairs to engine and bodywork used in computation of repair and maintenance cost were as shown in table below.

Table 3: Cost & Lifetime of Major Repairs

Type of three wheeler	**Type of major repair**	**Cost inclusive of Labour (Rs.)**	**Frequency of Repair**
2-stroke (petrol+2T oil)	Full Engine Repair	30,000.00	Once in 4 yrs
	Body Repair	40,000.00	Once in 7 yrs
4-stroke (petrol only)	Full Engine Repair	35,000.00	Once in 4 yrs
	Body Repair	40,000.00	Once in 7 yrs
Diesel	Full Engine Repair	40,000.00	Once in 4 yrs
	Body Repair	40,000.00	Once in 7 yrs

When calculating other running repairs costs main concentration was paid on expensive spares and most frequently changing spares. According to the collected survey data from experience mechanics and spare part dealer's spare list was prepared and ranked according to the annual cost. The annual spare cost comprised with labour cost. Spares whose annual cost greater the 100 rupees were used in the calculation of repair cost. Costs and lifetime of minor repairs were as shown in table below.

Table 4: Cost & Lifetime of Minor Repairs

Type of Minor Repair	**Cost inclusive of Labour (Rs.)**			**Frequency of Repair**
	2-stroke	**4-stroke**	**Diesel**	
Replacement of Break liners (3 Break liners)	3*1,000.00	3*2,000.00	3*2,000.00	Twice per year
Replacement of Clutch cable with router (3 clutch cable)	3*370.00	3*730.00	3*1,500.00	Twice per year
Replacement of Clutch plate	700.00	700.00	400.00	Twice per year
Replacement of Resers	700.00	1,290.00	700.00	Twice per year
Replacement of Bulbs (4 bulbs)	4*230.00	4*490.00	4*300.00	Twice per year
Total cost for minor repairs	**6,430.00**	**12,140.00**	**12,800.00**	

Repair and maintenance cost was calculated using following formula.

Repair and Maintenance Cost (Rs/km) = $\{ \sum (P_M / f_M) + \sum (P_S / f_S)\} / K$

Where:

P_M - Cost of Major Repair (Rs/repair)

f_M - Frequency of Major Repair (repair/year)

P_S - Cost of the spare inclusive of labour cost (Rs)

f_S - Frequency of change (yr)

K - Kilometres operated per year (km/year)

i) For 2-stroke (petrol+2T oil) three wheelers

$$\text{Repair and Maintenance Cost (Rs/km)} = \frac{(30{,}000/4) + (40{,}000/7) + (6{,}430/0.5)}{68*324}$$

$$= 1.18$$

ii) For 4-stroke (petrol only) three wheelers

$$\text{Repair and Maintenance Cost (Rs/km)} = \frac{(35{,}000/4) + (40{,}000/7) + (12{,}140/0.5)}{68*324}$$

$$= 1.75$$

iii) For Diesel three wheelers

$$\text{Repair and Maintenance Cost (Rs/km)} = \frac{(40{,}000/4) + (40{,}000/7) + (12{,}800/0.5)}{68*324}$$

$$= 1.87$$

4.2.3 Service Cost

Frequency of the service is obtained from questionnaire, service stations and manufacture's specifications. Cost per service is obtained from service stations and considered to be inclusive of cost for oil and lubricant current prices. The cost of regular service of a vehicle has been calculated as follows:

$$\text{Cost of Service (Rs/km)} = \frac{\text{Cost of Service (Rs/Service)}}{\text{Frequency of Service (km/service)}}$$

i) For 2-stroke (petrol+2T oil) three wheelers = 2,000.00/3500
= 0.57

ii) For 4-stroke (petrol only) three wheelers = 3,000.00/3500
= 0.86

iii) For Diesel three wheelers = 3,000.00/3500
= 0.86

4.2.4 Tire Cost

The cost of tires has been considered by taking several industrial norms. The life of each type of tire is obtained from three wheel operators through questionnaire and verified by manufacture's specifications.

Table 5: Tire Prices & Life Time for 2-stroke and 4-stroke three wheelers

Brand Name	**Average Market Price (Rs)**	**Average Life Time (km) (to nearest 50km)**
CEAT	2,500.00	21,000
MRF	3,400.00	28,000
DSI	2,300.00	20,000
Average Market Price (Rs) and average life time (km)	**2,733.33**	**23,000**

Table 6: Tire Prices & Life Time for Diesel three wheelers

Brand Name	**Average Market Price (Rs)**	**Average Life Time (km) (to nearest 50km)**
CEAT	4,500.00	21,000
MRF	6,500.00	28,000
DSI	4,400.00	20,000
Average Market Price (Rs) and average life time (km)	**5,133.33**	**23,000**

Tire cost was calculated for each type of three wheelers using following formula.

Tire cost (Rs/km) = [3* Market Price (Rs.)] / Tire Life (km)

i) For 2-stroke and 4-stroke three wheelers = 3*2733.33/23000
= 0.36

ii) For Diesel three wheelers = 3*5133.33/23000
= 0.67

4.2.5 Tube Cost

Tire and tube costs were calculated separately due to the difference in usage pattern. However, the tube usage varies significantly due to factors like road condition. Furthermore this component showed higher level uncertainty among operators. Two scenarios of replacement of a tube and patch cost were included in tube cost. Frequency of replacing a tube and costs incurred for patches during specified period was obtained from the questionnaire. The cost of new tube was obtained from the current market price and it was amounted to be 700 Rs/tube for 2-stroke and 4-stroke three wheelers and 900Rs/tube for Diesel three wheelers.

$$\text{Tube Cost (Rs/km)} = [P_1 * N) + P_2] / K$$

Where;

P_1 - Cost of tube (Rs/tube)

N - No. replacements per year (tube/year)

P_2 - Cost of patches per year (Rs/year)

K - Kilometres operated per year (km/year)

i) For 2-stroke and 4-stroke three wheelers = (3*700+1200)/(68*324)
= 0.14

ii) For Diesel three wheelers = (3*900+1200)/(68*324)
= 0.17

4.2.6 Operator Salary

In current situation this component shows a higher variation among operators and not controlled by any regulation. In majority occasions operator keeps rest of the revenue after deducting fixed daily payment to the owner. To avoid this uncertainty, operator salary was fixed considering on the basis of a minimum daily wage for workers in any industry or service given by the Gazette Extraordinary national minimum wages of workers Act, No. 3 of 2016 published on 23rd March 2016. Therefore a fixed salary of Rs. 700 is assigned to the three wheeler operator

Operator Salary (Rs/Km) = Operator salary (Rs/day) / km operated per day(km/day)

Operator Salary (Rs/Km) = 700/68
= 10.29

4.2.7 Provision for Risk (profit)

In general profit is payable on capital and entrepreneurship. Since the cost of capital has been provided for in the above, the profit due from entrepreneurship will be provided as a fixed amount of 300 rupees per day. This is existing profit level provided for the owner. Hence, the profit per km would be given as

Provision for Risk (Rs/km) = 300 (Rs/day) / Kilometres Operated per day (km/day)

Provision for Risk (Rs/km) = 300 (Rs/day) / 68 (km/day)
= 4.41

4.2.8 Depreciation

Depreciation of a three wheeler was first considered to be proportional to its use that decided to apportion in terms of kilometres operated.

The average market prices of used three wheelers of different ages were obtained and It was found that the resale value of used three wheeler is 25% of initial average market value and it is assumed a lifetime of 10 years. Finally, annual depreciation in nature of fixed cost was transferred to per kilometre cost.

Depreciation (Rs/km) = [(I-R)/N] / K

Where;

I - Initial Investment (Rs)

R - Resale Value (Rs)

N - Age of three wheeler (year)

K - Kilometres Operated Per Year (km/year)

i) Depreciation for 2-stroke three wheelers (Rs/km) $= \frac{((315000-78750)/10)}{68*27*12}$

$= 1.07$

ii) Depreciation for 4-stroke three wheelers (Rs/km) $= \frac{((610,000-152,500)/10)}{68*27*12}$

$= 2.07$

iii) Depreciation for Diesel three wheelers (Rs/km) $= \frac{((565000-141250)/10)}{68*27*12}$

$= 1.92$

4.2.9 Interest on Capital

Interest on the capital cost of three wheelers is based on the source of financing. A three wheeler financed by borrowings would require a higher rate of interest usually in keeping with the Prime Lending Rate. If the purchase of the three wheeler is made from savings, then the opportunity cost may be considered equal to a zero risk investment usually comparable to Treasury bill rate. However, when computing the contribution per kilometer it is required to apportion total interest payable in total kilometers operated during lifetime. Therefore, in this calculation it is assumed a lifetime of 10 years. Therefore annual cost of financing would be calculated in two different methods according to the source of financing.

Method I: Source of financing is barrowings

$$\text{Annual cost of financing (Rs/km)} = \frac{\text{Total Interest (Rs)}}{\text{Kilometres Operated Per Year(km/year)*10(yr)}}$$

Method II: Source of financing is savings

$$\text{Annual cost of financing (Rs/km)} = \frac{\text{Initial Investment (Rs)* Av.Treasury Bill Rate}}{\text{Kilometres Operated Per Year (km/year) *10(yr)}}$$

In the case of the Prime Lending Rate as well as the Treasury Bill Rate an average for the period over which the revision is made will be used to avoid sudden changes in rates.

It was found that 99% of three wheelers have bought from leasing with four year payback period based on questionnaire survey. Therefore it was used method I for calculating of interest on capital of entrepreneurships and used 9.0% as Prime Lending Rate(Total Borrowing Rate, Av: January 2016 to December 2016 from *Central Bank of Sri Lanka*) for calculate total interest.

i) Interest on capital for 2-stroke three wheelers (Rs/km) $= \frac{(315000*(9*4/100))}{68*27*12*10}$

$= 0.51$

ii) Interest on capital for 4-stroke three wheelers (Rs/km) $= \frac{(610000*(9*4/100))}{68*27*12*10}$

$= 0.99$

iii) Interest on capital for Diesel three wheelers (Rs/km) $= \frac{(565000*(9*4/100))}{68*27*12*10}$

$= 0.92$

4.2.10 Annual Overheads

These refer to payments that are of an annual nature and hence treated as fixed costs. These are further identified as follows

- Revenue License Fee

Revenue License fees are those payable to the Commissioner of Motor Traffic. This is presently amounted as Rs.505 per year.

- Insurance Costs

Insurance cost varies according to the insurance agent and type of insurance. Namely two types of insurance have identified as comprehensive insurance cover and 3rd party insurance cover. Type of insurance and name of the agent was obtained from the questionnaire and the relevant annual premium was obtained from the leading insurance companies. Three wheelers which have leasing should obtained comprehensive insurance cover and hence it was used for calculation of annual overheads.

Table 7: Insurance Premiums on Three Wheelers

Insurance Agent	**Premium (Rs/year)**	
	Comprehensive Insurance Cover	**3rd Party Insurance Cover**
Ceylinco Insurance Ltd.	9,500.00	1,200.00
Janashakshi Insurance	9,000.00	1,100.00
Sri Lanka Insurance Cooperation	8,500.00	900.00

- Membership fee / Payment to local Authority

It was found that some operators pay a fee to local authority or a membership fee to operate in a three wheeler stand and average payment for local authority is Rs.650 for each three wheeler.

Therefore annual overheads per kilometre run was calculated as follows

Annual Overheads (Rs/km) = (R +E+ I + M) / K

Where:

R - Revenue License Fee (Rs/year)

E -Vehicle emission Fee (Rs/year)

I - Insurance cost (Rs/year)

M - Membership fee (Rs/year)

K - Kilometres Operated Per Year (km/year)

$$\text{Annual Overheads (Rs/km)} = \frac{(505+750+9000+650)}{68*27*12}$$

$$= 0.49$$

4.3 Operational Cost

After identifying and quantifying above cost components, next step was to compute operational cost for predetermined conditions for each type of three wheelers. Each cost component was quantified for each type of three wheelers and then the distribution of each component was studied.

The rates of utilization for each of these inputs (e.g. fuel consumption, frequency of regular servicing) have been calculated on the basis of questionnaire prepared for three wheeler operators and manufacturer specification. 30 Three wheeler operators feedback were taken for questionnaire survey. (10 Three wheeler operators in each type)

Price levels of inputs have been taken at current (March 2016) market prices.

220 Three wheelers were surveyed in the 10 parking areas in Divisional Secretariat area of Kalutara and it was found that share of each type of three wheelers as follows.

Table 8: Share of Three wheelers

Three wheeler type	**Share (%)**
2 stroke(petrol+2T)	16
4 stroke(petrol only)	80
Diesel	4

Finally operational cost was calculated using the weighted average value of each cost component. The following table sets out a summary of weighted average operational cost for three wheelers.

Table 9: Weighted average operational cost of Three Wheeler

Cost item	**2 stroke**	**4 stroke**	**Diesel**	**Weighted average operational cost(Rs/km)**	**Share of cost component (%)**
Fuel Cost	5.16	3.90	2.71	4.05	16
Repairs & Maintenance Cost	1.18	1.75	1.87	1.66	7
Service Cost	0.57	0.86	0.86	0.81	3
Tires Cost	0.36	0.36	0.67	0.37	1
Tube Cost	0.14	0.14	0.17	0.14	1
Operator Salary	10.29	10.29	10.29	10.29	41
Provision for Risk	4.41	4.41	4.41	4.41	18
Depreciation	1.07	2.07	1.92	1.90	7
Interest on Capital	0.51	0.99	0.92	0.91	4
Annual Overheads	0.49	0.49	0.49	0.49	2
Total Cost				**25.03**	**100**

After calculating the total operational cost sensitivity analysis was conducted to understand which cost components has significant contribution on total operational cost compared to other components. The result of sensitivity analysis is presented below and it can be concluded that the fuel cost, operator's salary and the provision for risk were components which had significant bearing on total operational cost and can be calculated percentage change in total cost with revision of each cost components.

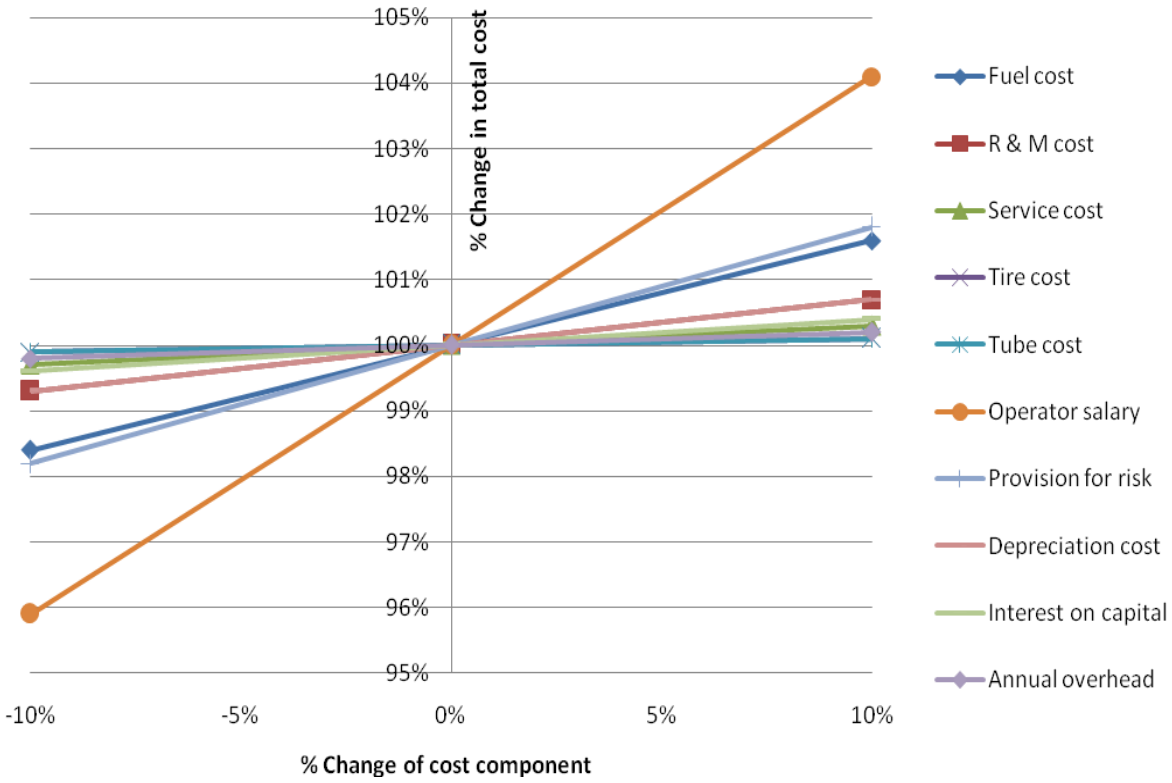

Figure 4: Sensitivity Analysis of Cost Components

5. FORMULATION OF FARES STRUCTURE

Fares structure is the instrument to recover cost and it act as the communicator between operator and the passenger of transport service. A fares structure should be transparent, simple and understand by each party to understandable by each party to be effective structure. This chapter deals with existing fares structure and the proposed structure for the three wheelers operation.

5.1 Existing Fares Structure

There is no regulated fares structure for the three wheeler operation currently. However after analyzing the information obtained from the questionnaire correlation between distance and the fare was found for one-way and two way trip. According to that a minimum charge of Rs.50.00 was set for a ceiling of 1km distance. And further distance in excess of 1km was charged at a rate of Rs. 40 per kilometre for one way and two way trip. Therefore, the structure can be summarized as follows. There is no systematic way to charge for waiting times.

F1 = 40 (X-1) + 50

Where;

F1 - One-way and Two way fare in Rupees

X - Travel distance in kilometres ($X \geq 1$km)

Table 10: Existing Fares Structure

Distance (km)	**One way trip**		**Two way trip**	
	Fare (Rs.)	**B/C Ratio**	**Fare (Rs.)**	**B/C Ratio**
1	50	100%	90	180%
2	90	90%	170	170%
3	130	87%	250	166%
4	170	85%	330	165%
5	210	84%	410	164%
6	250	83%	490	163%
7	290	83%	570	163%
8	330	82%	650	162%
9	370	82%	730	162%
10	410	82%	810	162%

However it was found that the cost of operating a three wheeler was Rs. 25.03 per kilometre. Therefore, it was evident that the prevailing system has charged a fare to recover the cost of return trip in one-way trip within first kilometre. In addition to that presently two way charges are nearly 2 times that of one-way charges since it would consider as another one way trip. Passengers are charged additionally for the waiting time in a two-way trips. In present situation, waiting charges are decided by the operator arbitrary and not regulated.

When the operational cost and the existing fares structure were compared against Benefit Cost Ratio and it was observed that presently, there are varying BCR values between the different distances. First kilometre has a equal benefit and cost for one way trip and henceforth each kilometre cannot recover costs for one way trip, while all range of distances in two way trips have a higher than required cost recovery.

It can be concluded that longer distance (more than 1 km) one way trips are operated at an expense while short distance (within 1 km) trips are tied with cost recovery with profit. However, present situation is in favour of operator as three wheeler is a mode used mainly for short distance services. This fact can be evident from the following figure which depicts the trip length distribution of an average three wheeler operator in a day.

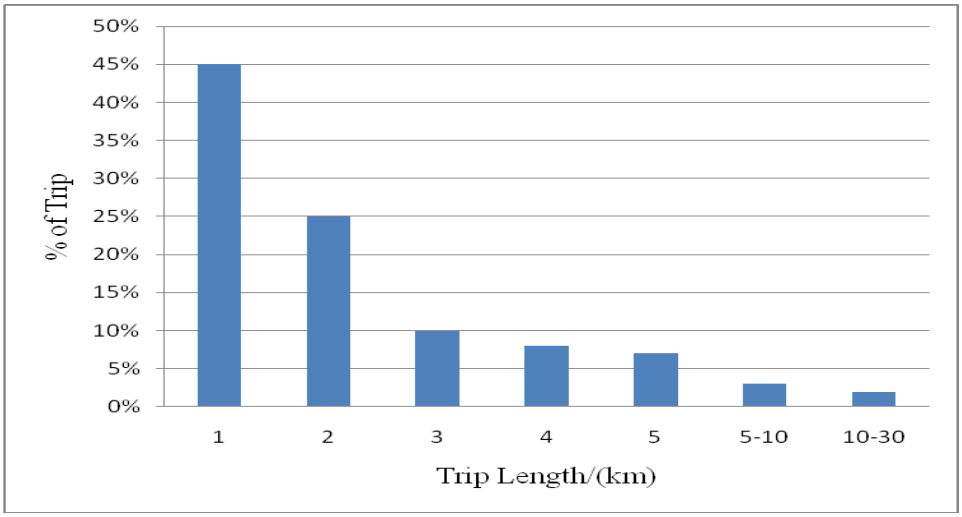

Figure 5: Trip Length Distribution

Share of two way trips is 4% in total trips and Charge for two way trips is as same as one way trips in existing taxi service system.

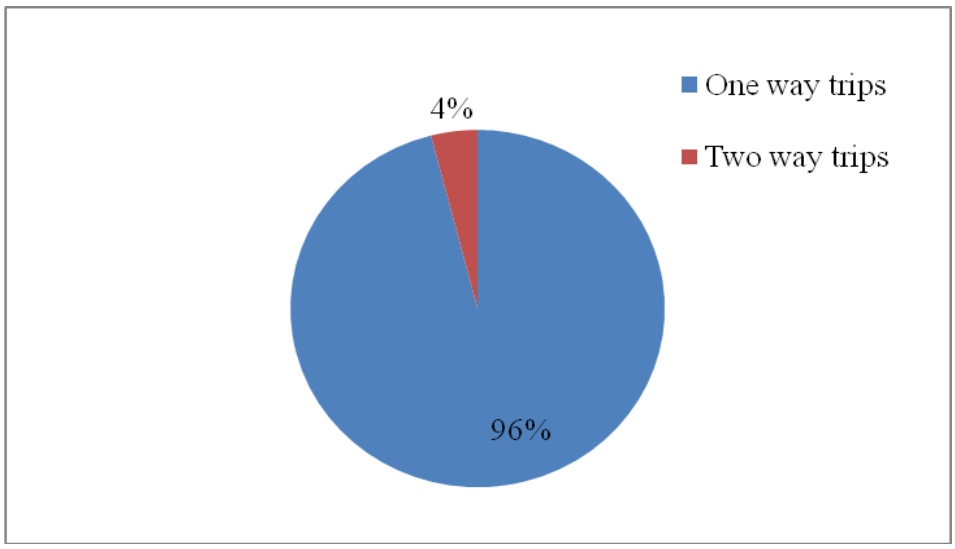

Figure 6: Trip Type Distribution

5.2 Proposed Fares Structure

Pricing and costing transport services is important for ensuring the profitability even though the three wheeler taxi sector is deregulated. If costs are too high, then demand will be less and even though transport capacity may exist, it will not benefit the user or the operator. On the other hand if costing is too low, the supplier may ultimately run out of the business even though the user will benefit.In this research new fare structure is proposed considering operational cost of a three wheeler with profitability (Rs.25 per km operation) and each and every stakeholder requirements and expectations. Three wheeler service related stakehlder requirements and expectations are as follows.

Table 11: stakeholder requirements and expectations

Stakeholders	**Requirements**	**expectations**
User	Conveninet travel Availability Reliability flexible personal mobility	Less cost Comfort Less travel time Solution for unavailable of parking area
Operator	Self employment	Profits
Government	Provide firsr and last mile connectivity for transit trips serve as a supplementary on-demand service for people with a disability and those for whom walking, cycling or conventional public transit are not feasible	Less traffic on roads Reduce number of three wheelers to control congestion and emmission.
Public Transport Industry	To be complementory	No competition

Proposed fare structure consists of a fixed fare of Rs. 50.00 up to a one-way distance of 1km and henceforth a graduated fare of Rs. 50.00 per kilometer. However, the fixed fee and rate are selected allowing the recovery of the cost of

return trip. This can be presented in the following formula. This formula ensures a Benefit Cost Ratio is not less than 100% for all range of distances .

F = 50(X-1) + 50

F - Fare in Rupees

X - Travel distance in kilometers (X>1km)

Share of two way trips is 4% in the trip distribution and fare structure for two way trips is as same as one way trips in the existing taxi services. Always two-way trips are associated with additional passenger waiting time. The rate for the additional waiting time was computed considering the hourly cost of fixed components such as operator salary, provision for risk, annual overheads, depreciation and interest on capital and it is Rs.2.00 per minute. Operators are always reluctant to two way trips, because they can earn higher amount by operating than waiting. Therefore, a new fare structure is developed only for one-way trips and two way trips are also considered as one way trips since two way trips are not practical.

This fact can be justified from the existing trip distribution which depicts the fare structure for two way trip is as same as another one way trip.

Table 12: Fixed cost component per hour

Fixed cost component	**Av.cost per hour (Rs./h)**
Operator salary	87.50
Provision for risk	18.74
Annual overheads	8.07
Depreciation	3.86
Interest on capital	2.08
Total fixed cost per hour	**120.25**

Table 13: Proposed Fares Structure

Distance in one direction(km)	**One way trip**		**Two way trip**	
	Fare (Rs.)	**B/C Ratio**	**Fare (Rs.)**	**B/C Ratio**
1	50	100%	100	200%
2	100	100%	200	200%
3	150	100%	300	200%
4	200	100%	400	200%
5	250	100%	500	200%
6	300	100%	600	200%
7	350	100%	700	200%
8	400	100%	800	200%
9	450	100%	900	200%
10	500	100%	1000	200%

5.3 Breakeven Analysis

Breakeven analysis was conducted for the daily operation of three wheeler in order to calculated minimum kilometer operated per day to recover costs. In this situation all the fixed costs including operator salary, daily provision for risk, annual overheads, depreciation and interest on capital were calculated in daily basis and the contribution per unit distance was computed in terms of proposed fare structure and the computed operational cost. According to the analysis, breakeven one-way kilometers were found to be 34km/day. When computing this value an extreme case of one-way trips only condition was assumed.

6. CONCLUSIONS & RECOMMENDATIONS

Three wheelers have already become a key part of Sri Lanka's public transport network. They have become important in city sector for short hauls and in urban and rural areas they transport a significant number of people to places where other forms of public transportation, such as buses or trains do not run. More importantly, they provide employment opportunities for thousands of drivers, and livelihood opportunities to even more people. It has also evolved as an attractive occupation for youth with a certain level of education and solution to the unemployment problem.

passengers are more likely to use three-wheeler service for short distance travel, in most cases for about 1k.m. travel. It is the mode readily available for emergency situations as well.

When considering the vision of public and private transport services, public transport would want to provide services that are economically sound for the public. In contrary the private transport services would want to maximize profit. This conflict of interest display in three wheeler market as well. For the three wheeler drivers it is a mode of living while for the public transport sector it an essential service that a government should provide. In reality, coordination of these two structures is needed since at the end of the day it is commuters who rely on either of these service providers for a reasonable price.

In this research efforts are made to identify salient cost components of operating cost of the three wheeler service, based on a sample survey undertaken covering 30 three-wheeler operators and 10 experienced mechanics and spare parts dealers. It is found from the analysis that Current operating cost (2016) of three wheeler is Rs. 25.03/km.

When the operational cost and the existing fares structure were compared against Benefit Cost Ratio and it was observed that presently, there are varying BCR values between the different distances. First kilometre has a equal benefit and cost for one way trip and henceforth each kilometre cannot recover costs for one way trip, while all range of distances in two way trips have a higher than required cost recovery.

It can be concluded that longer distance (more than 1 km) in one way trips are operated at an expense while short distance (within 1 km) trips are tied with cost

recovery with profit. However, present situation is in favour of operator as three wheeler is a mode used mainly for short distance services.

It can be concluded that Three wheelers need to be promoted as the transport mode providing the "last mile connectivity" in the urban transport system.Last mile connectivity is movement of people and goods from a transportation hub to a final destination in the home.

That service can be provided with the rate of kilometer is 50 rupees and it will be optimum value for both operator and user.Longer trip should be discoraged since longer distance (more than 1 km) are operated at an expense to operator. If three wheelers can be promoted for last mile connectivity Traffic congestion is not escalated due to low number of three-wheelers in the urban areas. Further, two way trips can be considered as one way trips since two way trips are very less in trip distribution. Fare structure should be displayed in the three wheeler so that it is clearly visible and In fact, the operator enjoys excessive income which should be distributed between owner and operator when one way distance operated exceeding 34km per day.

Then Three wheel service will be more benifical to all related stakeholders.

Furteher current van/taxi rate is equal to the proposed three wheeler rate (Rs. 50/km).But cost per head for three wheeler users is four times of the same for users of twelve seating vans as the capacity of the three wheeler is three.

Vans are unavailable for shorter distances eventhough cost per head is lower than three wheelers.But three wheelers are readily available for shorter distances.

Therefore three wheeler is best for shorter distances (last mile connectivity) and not efficient for longer distances. Hence, three wheelers should not be encouraged for longer distances travel as and the van service and public bus transport are more efficient for longer distances.

REFERENCE

Committee on Fares Policy, Ministry of Transport. 2001. Final Report, Formulation of A Fares Policy For Bus Transport Service

National taxi fare review report 2012 of Ireland by National Transport Authority

Kumarage, A.S, 2004. *Regulatory Impediments in the Land Transport Sector of Sri Lanka.* Institute of Policy Studies of Sri Lanka (IPS) in collaboration with the Centre on Regulation and Competition (CRC), Institute for Development Policy and Management (IDPM), University of Manchester, U.K, Workshop on Regulatory Impact Assessment. Ceylon Continental Hotel, Colombo, Sri Lanka 23-24 June 2004

Kumari, M.B.I.T, Rupasinghe, R.A.U.S, Siriwardana, D.H.S.D.A & Dr. Somasundareswaran, A.K 2005, *Evaluation Of Three Wheeler's Operational Characteristics in Small Cities In Sri Lanka*[Under Graduate Project Report], February 2005. Faculty of Engineering: University of Ruhuna.

Road passenger transport authority statute 1996. 947-11-1996, Southern Provincial Council of the democratic socialist republic of Sri Lanka

Road passenger transport three wheeler service statute 2003, No.06 of 2002, No.1276/15 Provincial Councils Notifications, Western Provincial Council of the democratic socialist republic of Sri Lanka

Aid Sri Lanka, 2009. Tuk-Tuks : *Taking Foreigners for a Ride*
Available at: http://www.p2prescue.org/travel/tuk-tuks-taking-foreigners-for-a-ride/

Black,A.,1995. *Urban Mass Transportation Planning*,McGraw-HILL International Editions
Central Bank of Sri Lanka, 2016. *Interest Rates*
Available at: www.cbsl.gov.lk/pics n docs/08 statistics/docs/xls monetary sector/table 4.03.xls

The Gazette Extraordinary 2016, the Democratic Socialist Republic Government of Sri Lanka, National minimum wages of workers Act,No.3 of 2016 published on 23rd March 2016

APPENDIX A : DISTRIBUTION OF BASIC PARAMETERS OF THREE WHEELERS

Fuel efficiencies of Three wheelers

No.of Three wheeler	**Fuel efficiency km/l**		
	2-stroke	**4-stroke**	**Diesel**
1	25	28	34
2	24	30	35
3	25	30	35
4	25	30	35
5	26	32	35
6	25	30	36
7	25	30	35
8	25	30	35
9	25	30	35
10	25	30	35
Average	**25**	**30**	**35**

Share of Three wheelers

Station	**No of Three wheelers**			**Total**
	2-stroke	**4-stroke**	**Diesel**	
Station 1	3	31	1	35
Station 2	9	29	2	40
Station 3	3	7	0	10
Station 4	4	11	0	15
Station 5	3	17	0	20
Station 6	1	18	1	20
Station 7	4	15	1	20
Station 8	2	17	1	20
Station 9	3	16	1	20
Station 10	3	15	2	20
% of share	**16**	**80**	**4**	**220**

Variables of Three wheeler operation

Three wheeler No.	Days operated per year	km operated per day
1	324	70
2	336	80
3	336	60
4	324	60
5	312	60
6	312	65
7	324	60
8	324	60
9	324	60
10	324	80
11	312	75
12	312	60
13	336	80
14	336	75
15	312	60
16	312	60
17	324	80
18	336	80
19	336	80
20	324	60
21	312	60
22	312	65
23	324	70
24	324	80
25	324	60
26	324	70
27	324	70
28	324	70
29	336	60
30	336	70
Average	**324**	**68**

o

APPENDIX B : QUESTIONNAIRE PREPARED FOR THREE WHEELER OPERATORS

RESEARCH ON THREE WHEELER OPERATING SERVICE

This questionnaire is presented for Master research conducted by myself of University of Moratuwa and we do not expect any personnel details. Further we request accurate answers as much as possible.

Date :…….

Name Of the Stand :……..

Town :……

1. Basic Information

1.1 Type of fuel used in the vehicle : Petrol ☐ Diesel ☐

1.2 Model of the Vehicle : 2 Stroke ☐ 4 Stroke ☐

1.3 Year of Registration :……..

1.4 Are you owner of the vehicle…….

1.5 If not how much paid for you ……

1.6 If not how much you paid for owner to vehicle per day…….

2. Cost items

2.1 State the Information regarding mode of acquisition

Type of Acquisition	Amount You Spent	Year of purchase
Brand New		
Second Hand		

2.2 If you are the owner of the vehicle please specify the method of acquisition below.

I. Savings ☐

II. Borrowings ☐

III. Installments ☐

Iv. On leasing ☐

Other……

2.3 State the information regarding the above method of payment

Down Payment (Rs.)	Monthly Instalment (Rs.)	No. Of Instalments

2.4 Amount you have spent yesterday

Petrol :Rs……

2T :Rs……

Diesel :Rs……..

Other Rs……(Please specify)

2.5 (a) what is the average distance travelled before servicing? …….. km

(b) Amount you spent for the service? Rs…….

2.6 What is the type of insurance of the vehicle and cost for insurance? (Put a " √" and cost in the appropriate box)

Insurance Company	Type of Insurance	Amount
Sri Lanka Insurance		
Janashakthi Insurance		

2.7 How much you spent for recently for major repair and state the type of repair ……

2.8 a) Spare parts used for the Vehicle

Genuine ☐ Duplicate Parts ☐

b) What is the Frequency of changing such frequently changed spare parts and cost for such items?

Spare parts	Frequency of change	Cost at once

2.9 (a) what is the brand of tire that you use?

I. CEAT ☐

II. MRF ☐

III. DSI ☐

IV. Other ☐

State if 'Other' ……..

(b) How many kms do you travel before you change the tires?.....

2.10 (a) How many times did you changed the tubes within last year ……

(b) Amount of money you spent for above change of tubes. Rs……

(c)Amount you spent for patches in tubes within last 3 months Rs.....

2.11 Apart from the fuel cost the net amount of money that you spent for the maintenance of the vehicle Rs……..

2.12 (a) Have you registered in any three wheeler stand or association?

Yes ☐ No ☐

(b) If yes the annual fee that you pay:
Rs…….

3. Revenue

3.1 The net revenue that you earned yesterday : Rs……

3.2 Distance and No of trips travel yesterday Rs……..

3.2 (a) what is the minimum fee that you charge? :Rs……..

(b) For what distance do you charge the above mentioned fee?
……..km

3.3 Have you install taxi meter?

Yes ☐ No ☐

3.4 State the fee for the followings

Trip Distance(km)	**Charge(Rs)**
First kilometre (Up)	
First kilometre (Up & Down)	
Additional kilometre (Up)-Rs /km	
Additional kilometre (Up& Down)-Rs/km	
For waiting time (Rs for 15min)	

4. Other

4.1 The amount of kms that could travel with one litter of petrol/Diesel
……..

4.2 Amount of kms travelled during yesterday
……..

4.3 Daily average working time, from …….hours to ……..hours

4.4 Which of the following days are off days for you?

Saturday	☐	Poya days	☐
Sunday	☐	Public holidays	☐

4.5 How many days did you have to spend for service and maintenance within last 3 months?