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A METHODOLOGY FOR A PRICING REGIME FOR THREE-WHEELER TAXI SERVICES

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Abstract

The alarming growth of the informal transport sector in Sri Lanka during the past decade has given rise to the need to develop a regulatory framework to ensure the protection of both consumers' and service providers' rights, alongside those of the society at large. This study focuses on existing socio-economic features and the operational characteristics of three-wheeler taxi services, takes note of regulatory requirements, and devises a methodology for developing a fare index for three-wheeler transport services with the objective of developing a regulatory framework. At present, there are over one million three-wheelers in operation; a number which increases daily due to the attractiveness of income generated and the minimum prevalence of barriers to enter the industry. These findings are based on a survey conducted with the participation of 342 three-wheeler drivers from Colombo District. The analysis results show that fare setting, fare meters, regulation, standardization, and inspections, service time and operating hours, registration, identification, certification from relevant authorities (Provincial/Municipal council, any governing bodies), age and minimum level of experience, police recommendation, regulations for allocation vehicles to parks and related barriers are the factors relevant to the development of a regulatory framework for informal transport operations. Further, the paper also presents a price index based on cost-plus pricing method that may be used in a future regulatory mechanism.

Key Words: *Informal transport, Para-transit, Three-Wheelers, Regulatory Framework, Price Index.*

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INTRODUCTION

Informal transport services, commonly referred as para-transits are generated to support and complement major public transportation services, and operate as individual vehicles without fixed routes and timetables. According to Cervero and Golub (2007), these 'small vehicle' modes of transport provide important benefits, particularly to the poor: such as on-demand access to medical clinics, jobs for low-skilled in-migrants, and service coverage in areas devoid of formal transit. In addition, in absence of properly planned public transportation services, there can be a significant demand for such services in urban areas as well. However, the impact of these modes on traffic congestion, environmental pollution and accidents is high, hence emphasizing the need for a proper regulatory framework to be put in place.

In the Sri Lankan context, the three-wheeler taxi has become the most popular para-transit type available with over one million vehicles in operation. According to Kumarage, Bandara, & Munasinghe (2010), three-wheelers are mostly individually operated with some owned by the operator and others rented on a monthly or daily basis. The industry is unregulated with vehicle registration and driving licenses being the only instruments of regulation. Fares are unregulated. However, most operators belong to associations which are loose collections of operators found in each locality. These associations impose a degree of self-regulation with respect to fares. They also tend to demonstrate the oligopolistic behavior.

By 2015, the total number of registered three-wheelers in Sri Lanka was 1,059,042: recording a growth of 63.9 percent new registrations from the previous year (CBSL, 2015a) and a growth of 762.6 percent from the year 2001. In 2010 the total three-wheeler population in Sri Lanka was 529,543; which doubled within the last five years (National Transport Commission, 2015). These vehicles, which first made an entry to Sri Lanka's roads in the early 1980s, account for around 16% of the active motor vehicle fleet at present. Three-Wheelers also account for around 6% of the passenger kilometers.

These statistical data showed how informal transportation contributed to the transport sector in Sri Lanka. The main reasons for the emergence and increase number of three-wheeler taxis as highlighted by Finn, Kumarage, and Gyamera (2011) is the inability of the formal transport sector to provide the mobility service which is needed to the people. Further, the following reasons are responsible for the development of informal transport sector.

The mismatch of the overall supply of the transportation with the expansion of the urban population which has led to capacity shortages and long waiting times for passengers.

• The inability of the formal transport system to sufficiently serve local trips and inter-suburban travel.

• Inadequate service provision of the formal transport system in rural areas, towns, or suburban hinterlands, leading to a significant unmet market for travel.

• The inability of the formal transport network to respond towards changing economic activities, land use and travel patterns.

With respect to vehicles involved in road accidents, three-wheelers have taken the second place among all types of vehicles and are listed as the top passenger transport vehicles to be s involved by the Ministry of Transport and Civil Aviation Sri Lanka. Based on the statistics from 2012 to 2015, over 20 percent of all road vehicle accidents and over 10 percent of all fatal road accidents involve a three-wheeler (Ministry of Transport & Civil Aviation Sri Lanka, 2017). Emission standards are in place for all motor vehicles from the year 2011 onward in Sri Lanka which is a mandatory requirement to acquire a valid license to operate any vehicle. With the increase in demand for the informal transport sector, it is required to assess the existing regulations and place a proper regulatory framework to safeguard all stakeholders. Existing regulations are only limited to the license of the drivers and vehicles without any consideration on the fare, safety of the passengers or the impact on the society and environment.

This paper is organized as follows. The next section presents the scope and objective of the research, followed by a brief review of the literature on informal transport sector and three-wheeler taxi service operation. The methodology of the paper is presented before the analysis results and discussion. The final section is the conclusion.

SCOPE AND THE OBJECTIVES OF THE STUDY

This paper mainly aims to develop a regulatory framework for the operation of three-wheeler taxi services by identifying relevant factors to be considered for further analysis. The paper also proposes a methodology to calculate fare index for three-wheeler taxis, based on vehicle operating costs. The cost of three-wheeler operations comprises of costs on inputs such as the value of fuel, tires, and spares. The methodology adopted to construct the fare index was validated through data collected from a survey. Fare index will be presented as a distance-based function which includes the fare per kilometer. A cost index must be sensitive to the variations in the operating cost of the three-wheeler taxi service due to differences in the cost components so that it can be used as a regulatory indicator to revise fares whenever it is needed. The index is, therefore, a weighted average of all individual cost inputs. Consequently, a cost index is a composite index of all components of costs under both operating types. This research sets out to derive the cost index as an iterative process.

LITERATURE REVIEW

There are several studies around the world carried on paratransit or an informal mode of public transport. In developing countries, most paratransit services were not regulated where they function in a self-regulated manner. Many cities in developing countries have their own, often highly distinctive, forms of informal transportation modes. Researchers have revealed several factors that contribute to the emergence of informal public transport service. Initially, these modes have developed to fill gaps in the conventional transport of the urban areas (Hilling, 1996).

As an efficient and convenient way for short-distance travel, taxis have been an indispensable mode of transport in most large cities. It is easily accessible and comfortable compared to other types of public transport. However, their pricing has been considered as non-transparent. Shimasaki and Mukitur (2000) showed that the fare structure of paratransit was classified into 3 groups; fixed, metered and decided through negotiation. Further, Daud and Shah (2008) found that midnight taxi charges are relatively higher than day time operation. Three-wheeler operation in Sri Lanka demonstrates characteristics of cartelized service provision featuring oligopolistic market behavior (Kumarage, Bandara and Munasinghe, 2010). This has been a challenge due to the decentralized nature of the taxi systems and taxi drivers' profit-driven behavior. In Beijing, most taxi drivers intentionally avoid working during peak hours despite huge customer demand. This is mainly because of the fact that taxi drivers' congestion costs are not reflected in the current taxi fare structure (Jiarui Gan, 2013). Thus, it is essential for decision-makers to regulate the taxi market to balance taxi supply and customer demand, and to control fares, especially during peak hours.

Research shows that fares of urban passenger transport modes vary extensively in most part of the world depending on the level of service, technology use, demand level, intermodal connectivity, and government policy towards fare setting. However, the bus is the cheapest mode of transport and taxi is the most expensive mode of passenger transport in all cities anywhere in the world. Paratransit fares are higher than the bus fares as paratransit provides a convenient means of travel with a high frequency of service. Mostly, the fares of 'individual'-type paratransit modes are decided through negotiation between passengers and drivers. In some countries like India and Nepal, they have metered auto rickshaw. But in case of 'shared' or 'collective' paratransit, fixed fares result (Shimasaki & Rahman 2000).

Regulating a transportation industry has implications for both operators and users. Commuters have a closer relationship with informal passenger transport providers like operators of paratransit modes. For this reason, the satisfaction of commuters has a positive impact on mass transit connectivity and the future use of both paratransit and mass transit. Therefore, policies regarding paratransit service improvement must be carefully drawn with the purpose of enhancing the performance of mass transit (Tangphaisankun, Nakamura, & Okamura, 2009). Even though, with improved transit systems, people may still use their private vehicle for commuting daily and those who shift from private modes may still use the convenient paratransit mode.

There is inadequate research found in the Sri Lankan context on regulating three-wheeler taxi services. Current regulations are the same as for all motor vehicles: owners are required to register their vehicle and obtain a driving license to operate a three-wheeler; both of which can be attended to at the Commission of Motor Traffic (CMT). Every year thereafter, they are required to obtain an annual revenue license from the provincial CMT. There is no special permission process required for deploying a three-wheeler for hire. It was revealed that 74% of three wheeler operators are registered at a given three-wheeler park having an informal unionized operation, while the rest park their vehicles at different locations and are not among unionized three wheelers (Kumarage, Bandara, & Munasinghe, 2010).

Kumarage (2002) stated that the lack of a fares policy has been a primary factor curbing the development of the bus industry in Sri Lanka. Paratransit and public bus service are competing to grab people in some suburban routes. Therefore, policy intervention is a much-needed factor when regulating an informal transportation sector. However, in the public bus industry, the decline of quality of services, and interference by elected governments in non-policy matters appear to arise from the non-existence of a well-formulated fares policy. It has been concluded that this deficiency has given rise to different problems under different periods of management of bus operations in Sri Lanka. Therefore, the only option for those who do not have access to a private vehicle is to look for an informal public or para transport. In that respect, three-wheeler has been a popular demand responsive travel mode. To meet transport needs for the commuters, developing demand responsive transit service with flexible routes and changeable schedules is an important attribute. The “dial a ride” system is one of the practical applications of the demand responsive transit service. Well-designed vehicle routes and schedule for “dial a ride” system can improve transportation efficiency and save total travel cost (Hu & Chang, 2013).

The conventional perception is that the taxi market is unique and requires restrictions that few other markets do. But many markets have unique problems, and a few of them stemmed from parking slot based operation, entry barriers and fare setting. Indeed, only utilities face similar entry and price regulation, and taxis are not a natural monopoly (Frankena & Pautler, 1986). To encourage the availability of taxi supply especially during off-peak period i.e. midnight time, fifty percent fare surcharge has been implemented in Malaysia. This will provide hope for people who use public transport (train or bus) where they must use a taxi to access the public transport terminal. This type of incentive would induce more drivers to work at midnight time which is currently least remunerative. Midnight surcharge is, in fact, included in the fare structures of several countries. Through a survey from midnight time airlines taxi passenger, this incentive has been abused by the taxi drivers in the Low-Cost Carrier Terminal, Sepang by adjusting their operation (i.e. beginning from 11.30p.m. until 12.30a.m.) to get an extra revenue collection. This has created inconvenience to airlines taxi passengers who frequently used a taxi at midnight time (Shah, 2008).

Many cities, including such widely studied cities such as Atlanta, San Diego, Seattle, and Indianapolis permitted free entry to taxi market. They did not fully deregulate fares and services, nor did they allow market mechanisms to overcome information problems. This limited the scope of competition between incumbents and new entrants and prevented taxis from offering new services or lower fares to win customers. In one trip, shared-ride services generally remained not as an operational feature. Yet shared-ride might be a valuable service at high-volume origins like transit terminals where an agent or stand operator helps passengers arrange shared rides. Shared-ride service is unlikely to develop in the absence of curbside coordinators or in dispersed origins especially edge cities situated far from main urban centers where virtually everyone drives (Teal, 1986).

Public transport in developing cities has a reputation of being particularly dangerous, which has been aggravated by the limited study of safety and security. Joewono & Basuki (2007) studied and evaluated the public's perception of safety and security of paratransit in Indonesia and concluded that benefits result from incorporating the public into the process of safety and security improvement, and by exploring the characteristics behind the public's decision.

The study of paratransit has a close relationship with a financial aspect of the user. One important financial aspect from the user is the ability to pay and willingness to pay. This term expresses the ability of the user to pay the transportation services, and their willingness regarding the utility of the transportation services they received. Ability to pay and willingness to pay are important elements in determining public transportation tariffs (T. B. Joewono & Kubota, 2005).

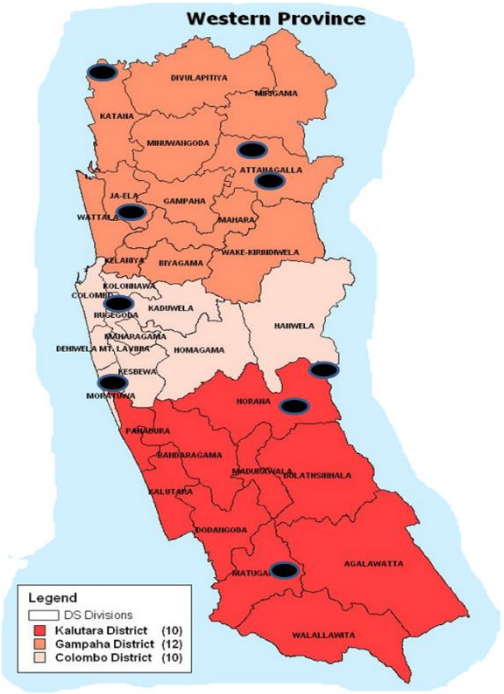
The extant literature demonstrates a thorough analysis of the characteristics of paratransit operation in any country context, while some favor deregulation. Nevertheless, the alarming proliferation of three-wheelers in public roads, increase in accident rates and other social and safety issues demand a regulatory measurement for the industry. This paper addresses a lack of a basis for developing a pricing regime for three-wheeler taxi services while identifying several areas for regulation.

METHODOLOGY

A questionnaire was developed based on the survey formulated by Kumarage, Bandara, & Munasinghe (2008). The structured questionnaire consisted of 21 questions with sub-questions to gather more profound data on owning the vehicle (license & registration costs, insurance costs), fuel cost, tire wear cost, vehicle repair, and maintenance cost. The sample consisted of randomly selected 342 three-wheeler drivers operating in Western Province (Figure 1).

Figure 1: Survey locations

The locations were Nugegoda, Moratuwa, Negambo, Ja-Ela, Nittabuwa, Awissawella, Horana, Mathugama and Veyangoda.



The questionnaire was directed at park based operators. The questionnaire covered the following aspects of three-wheeler operation.

- Demographic characteristics of three-wheeler operators (age, education, social status)
- Operational characteristics of the three-wheeler industry (ownership status, income, financing method, fare, wages, cost of operation, service time, passenger demand, industry characteristics such as entry barriers, fare decision, parking slot fee)

To develop the fare index, a cost index was developed using the fixed costs and variable costs of operation. Since there should be only a single-fare structure implemented for all types of operators, it was necessary to arrive at a single index to calculate a weighted common operating cost. The formula so developed is shown as follows:

$$VOC = (Dc + Lc + Ic + Mc + Rc + Pc) + d\,(Tc + Sc + Fc + Wc + Vc) \qquad (1)$$

Where;

VOC - Vehicle Operating Cost per journey
Dc- Vehicle depreciation cost
Lc – Leasing (Hire purchase) cost
Ic - Insurance cost
Mc - Membership cost
Pc - Parking cost

Rc – Revenue Licence Cost
d- Distance traveled per journey
Tc- Tire wear cost
Sc - Service cost
Fc - Fuel cost
Wc- Costs of Wages
Vc- Vehicle repair and maintenance cost (Spare-parts)

Vehicle operating cost itself could not provide the basis for fare determination. Therefore, a distance-based fare structure was needed to convey fare determination in a more comprehensible manner. The following formula developed by Smith and Cruz (2012) to measure travel time due to congestion was adopted to construct the distance-based fare structure.

$$F_i = [f_0 + f_i (d_i - d_0)] \quad (2)$$

Where f_0 is the initial charge and d_0 is the distance covered by f_0; f_i is the charge rate for next km traveled. Assuming d_0 is equal to one kilometer, and there is also a return journey the above formula was modified as follows;

$$F = [f_0 + f_i(d_i - 1)]*2 \quad (3)$$

For the calculation of a value for f_0 which is the initial charge (minimum fare) for a three-wheeler ride, all cost components (fixed costs + variable costs + risk premium) were considered. This follows the fundamental cost-plus formula used in economic theory. However, to calculate f_i which is the charge for next kilometer traveled, only variable costs are considered as they are the costs that would increase when the distance increases.

Since three-wheelers mainly operate based on a three-wheeler park where there will be a return trip (most trips being dead runs), the fare equation accounts for this by multiplying the one-way fare by two.

Table 1 presents the cost items considered in developing a fare index and calculation method.

Table 1: Cost items and calculation methods

Cost Item	Equation
Fuel cost per km	(Average fuel expense per day)/(Operating km) per day
Service cost per km	(Service cost per year/365)/(Operating km) per day
Tire cost per km	(Tire cost per year/365)/(Operating km) per day
Leasing Interest cost per km	(Leasing Interest cost per year/365)/(Operating km) per day
Insurance cost per km	(Insurance cost per year/365)/(Operating km) per day
Licensing cost per km	(Revenue Lisense cost per year/365)/(Operating km) per day
Membership cost per km	(Member fee per year/365)/(Operating km) per day
Parking cost per km	(Parking fee per year/365)/(Operating km) per day
Wages per km	(Parking fee per year/365)/(Operating km) per day
Spare parts cost per km	(Spare parts cost per day) /(Operating km) per day
Depreciation per km	(Annual Depreciation/365) /(Operating km) per day
Risk premium	(Vehicle operating cost*10%)

Fuel cost: Fuel cost is a key component of vehicle operating cost and is calculated on the basis of the fuel efficiency of the three-wheeler. Per kilometer fuel efficiency of the vehicle is calculated by dividing total distance travel per day by volume of fuel per day. Then the cost of fuel consumption per km was calculated by dividing the unit cost of gasoline by fuel efficiency.

Service cost: Service cost includes the cost of servicing the vehicle periodically based on the mileage or the date stipulated at first service.

Tire wear cost: Tire wear cost is a periodical cost incurred when operating a vehicle. There are different tire brands with different qualities which vary the mileage of tires. Prices of each tire brand are considered as market price. Therefore, prices of those brands and their mileages are considered when calculating the tire wear cost.

Leasing (Hire purchase) cost: Purchasing the three-wheeler is mostly carried out using “purchase-on-lease” facilities available in the market. According to Financial regulations, the total lease-purchase amount has a maximum cap of 70% (Loan to Value Ratio) of the total value of the vehicle in Sri Lanka (CBSL, 2015b). Therefore, with regard to lease (hire purchase), the payment was taken directly from the three-wheeler operators using a questionnaire item. Assuming a hire purchase period of 5 years, total interest paid was estimated (hire purchase cost per month – capital payment per month). Capital payment per month was obtained by dividing the lease-purchase amount (70% of the price of the vehicle) by 60 (which is the total number of installments).

Insurance cost: Motor vehicles are required to possess a valid insurance cover when as a legal requirement. Insurers offer two products, of which full insurance coverage provides greater protection to the vehicle and its passengers. Hence the cost of insurance payment was considered as an important regulatory provision.

Licensing cost: Obtaining an annual revenue license is a legal requirement stipulated in the Motor Traffic Act 1951 of Sri Lanka (Ministry of Justice, 2016). This is mandatory and hence is an annual fixed cost to the operator.

Membership and parking costs: Three-wheeler operators belong to informally administered societies, giving rise to annual costs. Local authorities charge a parking fee from each operator as they occupy public road space particularly near intersections.

Vehicle repair and maintenance cost: After a certain number of kilometers are traveled there should be a repair, replacement, or replenishment of parts as preventive maintenance recommended by the manufacturer. Repairing and maintenance cost was calculated using data collected from three-wheeler operators regarding service and repair costs per month divided by number of kilometers traveled per month.

Vehicle depreciation cost: Straight-line depreciation method was used to calculate depreciation of the three-wheeler (Archibald, 1967) assuming zero scrap value and a life of 10 years. Price of a three-wheeler was considered Rs. 700,000, the market price at the time of the survey. Considering the number of journeys per day, average cost contribution from depreciation was calculated to determine the fixed cost which is charged for the first unit distance traveled. Depreciation accounts for the capital cost covered by hire purchase installment payment which is the 70% of the remaining capital of the purchase price.

Wages: Other than vehicular costs driver costs were also included as wages per kilometer.

Risk premium: Like any other operation, risk is a major element for the operator. In economic terms, it is entrepreneurship for which the operator receives a return. Thus 10% of total vehicle operation cost was assumed as the risk premium (return on risk) which is a par value for a discount rate for capital contribution (30% of the vehicle price) derived based on Average Weighted Fixed Deposit Rate (AWFDR) published by The Central Bank of Sri Lanka.

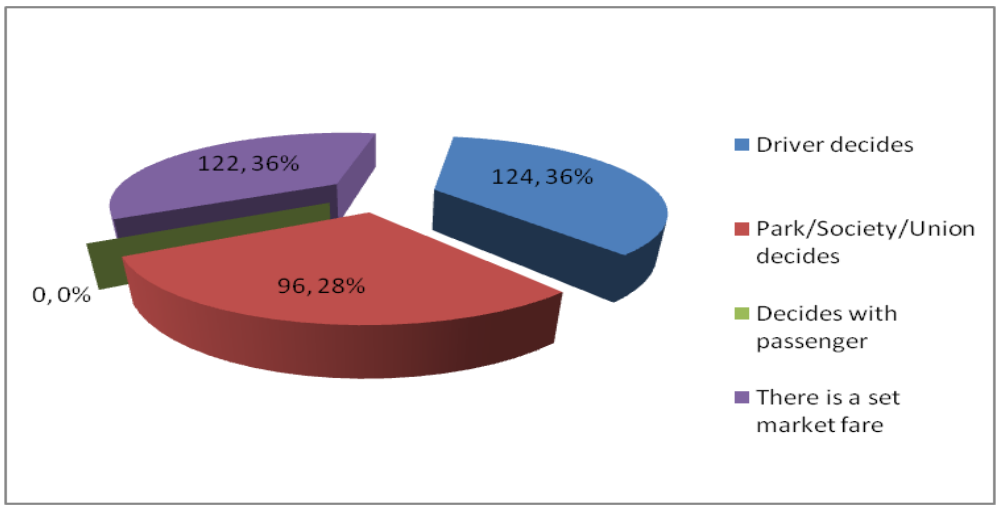
DATA ANALYSIS AND RESULTS

A majority of the drivers who participated in the survey, 84 percent to be precise, was operating from a designated three-wheeler park and only 16 percent were operating otherwise. This study considered the perception of the three-wheeler drivers on the formulation of a proper regulatory framework.

Operating type and fare determination: First, the study looked at the decision variables to determine the fare for the service. Usually, the fare is calculated using two rates, one rate for the first kilometer operated and another for the rest of the journey. Data from the questionnaire survey revealed that the fare for the first-kilometer fare ranged from 40 rupees to 50 rupees while the second per-kilometer

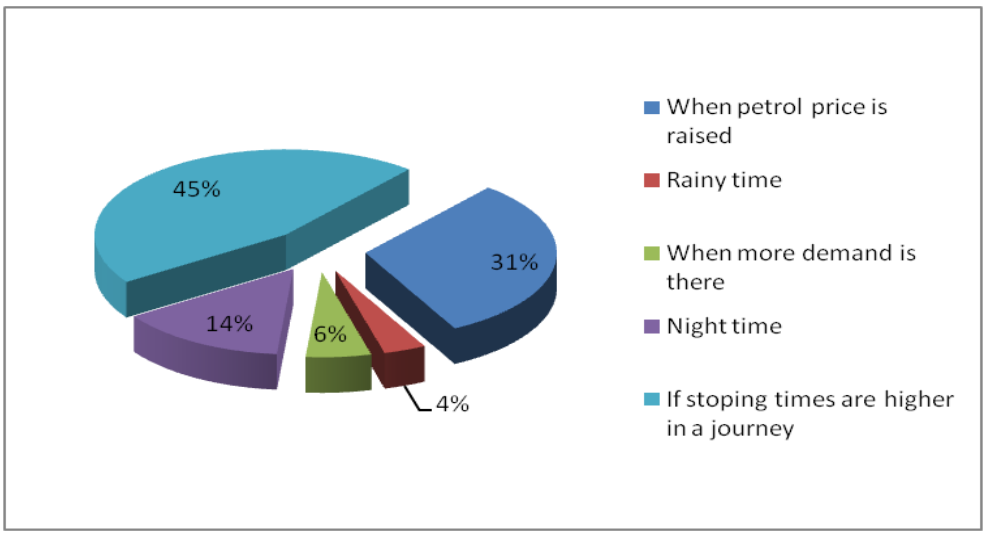
rate varied from 35 rupees to 50 rupees. Based on the survey 36 percent of the drivers make the fare decision for the passenger and a similar proportion follows the fare set by the market while 28 percent follows the fare set by the respective three-wheeler park, society or union, and the passengers do not have the privilege to influence the fare decision (Figure 2). The number of stops and the fuel prices were major concerns affecting fare decision and environmental factors such as rain and night time also played a minor role. Based on the study, 45 percent of the time the fare was increased with respect to the number of stops and 31 percent if the fuel price increased. It became evident that the fare decision would not take into account the benefits to the passenger and could be manipulated when limited mobility options were available.

Figure 2: Fare decisions



Fare decision: Taxi meters have been introduced to three-wheeler services by the market without significant administrative or regulatory authority involvement by the government, and 98 percent of the drivers believed that this made a positive impact on the passengers improving their credibility in the industry. However, the reliability and standards of these meters were often questioned in light of the possibility of manipulation as reported by passengers. Even the fare set by the market was questioned on whether it was reasonable to passengers. The survey found that there were several circumstances where fares were manipulated (Figure 3). However, the respondents (over 97 percent of the drivers) believed that standardizing the fare based distance would positively impact the three-wheeler taxi service.

Figure 3: Factors affecting the fare decision

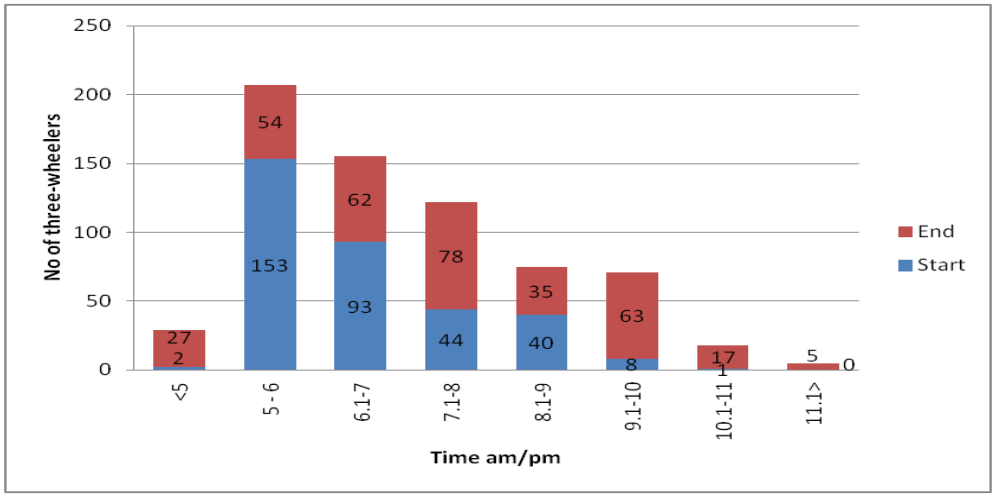


Service Time: Any passenger transport service should consider the number of operating hours and service time, which directly affects the physical condition of the drivers compromising the safety of the passengers. The study indicated that 97 percent of drivers were working every day. The highest working duration recorded was 18 hours per day with an overall average of 13 hours per day and 97 percent of the drivers working more than 8 hours per day. A similar scenario was also found in the South African taxi market (Walters, 2008). The work hours exceeded the maximum driving time span limits stipulated in international standards. For instance, EU rules limit maximum daily driving time to a maximum of 9 hours for drivers of road haulage and passenger transport vehicles (European Commission, 2018).

Over 70 percent of the drivers started operations before 7.00 am and over 75 percent of the drivers ended the operation after 6.00 pm (Figure 4). Since the survey was conducted during daytime the representation of the three-wheeler taxis operated during the night time in the sample became significantly low. Hence, this aspect needs further investigation.

The maximum number of kilometers operated per day recorded was 190 km/day, with an average of around 128 km/day including dead kilometers. The findings related to service time and operating hours indicated that the three-wheeler taxi operators were exceeding the basic standards of any mode of passenger transport, potentially affecting the physical condition of the drivers and hence compromising the safety of the passengers as well as of other road users. Further, the study revealed that 14 percent of the drivers engaged in part-time or any other form of work when they were out of operation which again is a concern of their physical condition.

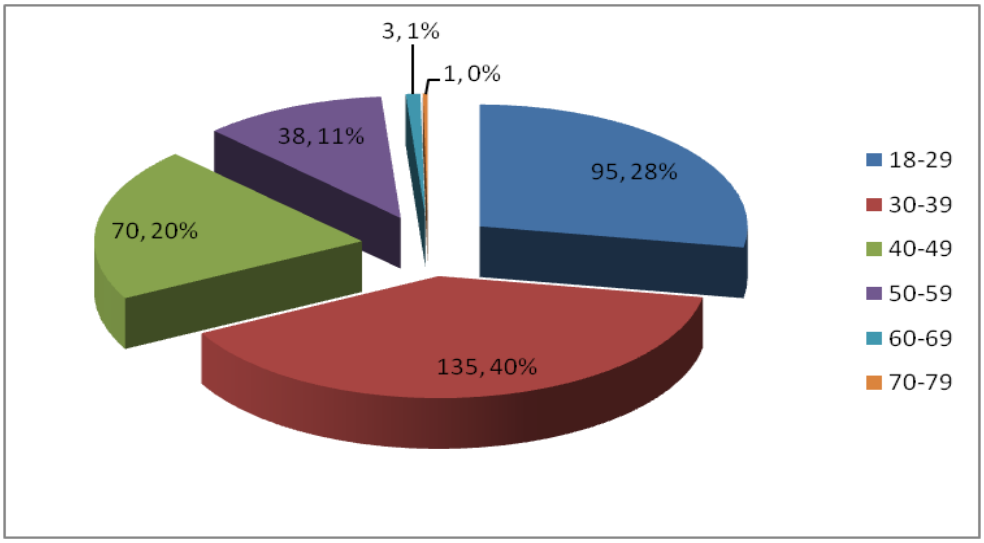
Figure 4: Service Time



According to the study over 50 percent of the drivers were not registered with any governing authority and were not aware of any mandatory legal requirements related to registration with relevant authorities. The findings revealed that over 98 percent of the drivers believed that indicating a valid certification from the relevant authorities or a photograph of the driver would increase the trustworthiness among the passengers. About 95 percent of the drivers agreed to register with the relevant provincial authorities and the restricting the number of three-wheelers allowed in each parking point. It is alarming to note that 36 percent of the three-wheeler drivers accepted the fact that 'three-wheelers break most road rules'. Thus, the need for a proper registration process put in place with the involvement of the relevant authorities such as provincial/municipal councils, police etc., in the process, becomes evident.

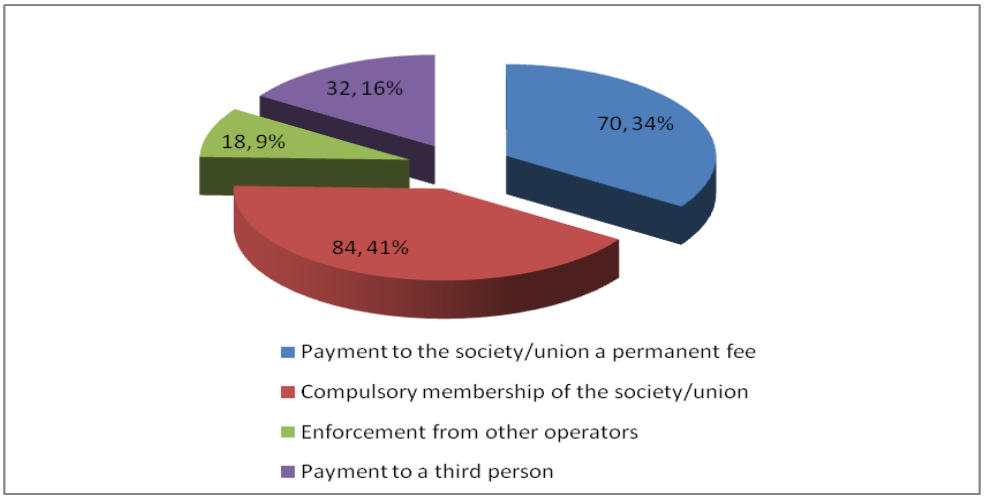
Age Distribution: Considering the demographic information of the study group it was revealed that the highest, 40 percent of the drivers were between the ages from 30 to 35 while the second place is claimed by the age group 18 to 30 (Figure 5). The youngest age recorded was 18 years while the oldest was 73 years. According to the Department of Motor Traffic - Sri Lanka, the minimum age limit requirement for obtaining the driving license for three-wheelers is set as 18 years and there is no restriction regarding the years of experience required to operate as a taxi service (Department of Motor Traffic, 2011).

Figure 5: Age distribution of three-wheeler operators



Barriers to Entry: A majority of three-wheeler drivers expressed concern regarding barriers to entering a designated three-wheeler park for the first time and evaluated each barrier (as in Figure 6). Obtaining membership and payment to the society was a requirement to operate within the parking point while a payment to a third party who informally interferes was another barrier to enter parking based operation.

Figure 6: Barriers to Entry



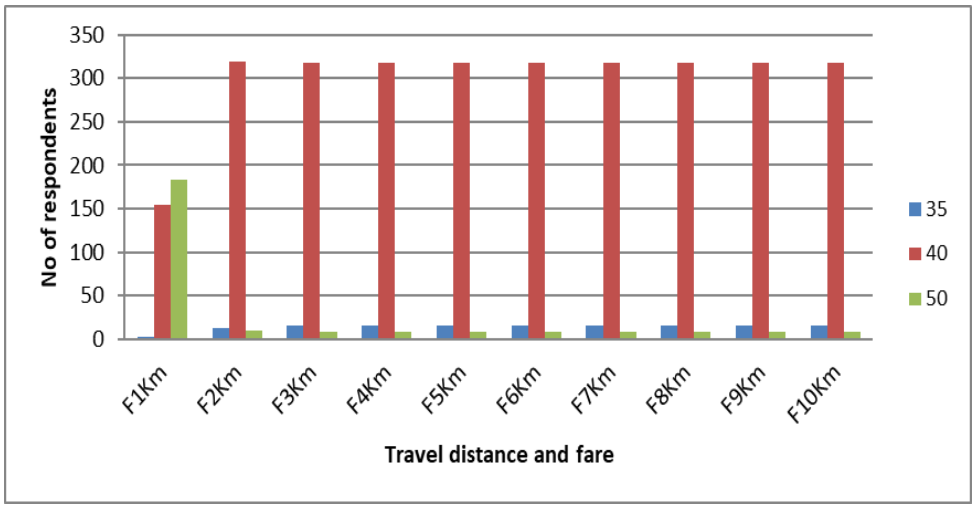
Sustainability: Sri Lankan government was concerned about emission levels and environmental impact of the three-wheelers and imposed a ban on all two-stroke

three-wheelers, and as of 2007 all three-wheelers imported to Sri Lanka have four-stroke engines. According to the survey 86 percent of the three-wheelers operated had four-stroke engines while the two-stroke vehicles still accounted for 14 percent. However, regulations for emission testing and maintaining are already in place and monitored all motor vehicles in Sri Lanka.

FACTORS RELEVANT FOR DEVELOPING A REGULATORY FRAMEWORK

Generally, a regulatory framework is put in place to improve the quality of a service ensuring that all stakeholders would benefit without any compromises. All major public transportation modes in Sri Lanka operate with respective regulatory frameworks in place. The informal transport sector, mainly three-wheeler taxi services in Sri Lanka, has been growing rapidly with high demand for the past five years raising the need for a proper regulatory framework to safeguard all stakeholders involved. Three-wheeler taxi services represent oligopolistic market characteristics and the fares determined only consider the supplier benefits. Meters have been introduced to the service which requires a proper fare calculation, standardization, and regular inspections. The existing fare levels are presented in Figure 7.

Figure 7: Current three-wheeler fare levels



The Figure 7 demonstrates that for the first kilometer, most respondents charged Rs. 50 and, for every additional kilometer, there a flat rate of Rs. 40. However, there were respondents charging either 30 or 50 rupees for an additional kilometer. This way of price setting poses the question as to what basis the initial and subsequent fares for the first and additional kilometers respectively have been set, which is apparently seen as a market-based price. Hence developing a pricing index for the service is a regulatory requirement.

Service time and operating hours of three-wheeler taxi services were found irregular with longer working periods which could affect the physical condition of the drivers, hence compromising the safety of the passengers and other road users. This implies operating times need to be controlled by regulatory means. Further, most three-wheeler drivers were found to lack knowledge on legal requirements to operate their services but acknowledged the need for proper registration, identification, certification, and involvement of relevant authorities from Provincial/Municipal councils, police, and other governing bodies. Moreover, they believed such measures would improve their credibility among passengers developing the informal transport sector in Sri Lanka. Thus, such requirements should be met by putting in place a proper regulatory framework.

Passenger transportation must consider stipulation of a minimum level of experience three-wheeler drivers should possess to ensure the safety of the passengers. In terms of violating road rules, a policy recommendation must mandatorily acquire certification for such services. The three-wheeler drivers believe the need to regulate the number of three-wheelers operating from a designated three-wheeler park and to find the remedies to overcome barriers imposed upon them.

Table 2: Estimated cost elements of three-wheeler operation

COST COMPONENT	AVERAGE IN Rs	Maximum	Minimum	STD
Fuel Cost per day	478	950	100	174
Wage per day	353	500	200	
Annual Servicing Cost	5,399	28000	400	3599
Annual Tyre Cost	25,717			
Annual Hire Purchase Payment	121,190	18500	750	3406
Annual Insurance Payment	8,418	18000	700	4146
Annual Revenue Licensing	762	1075	100	75
Annual Membership Fee	3,582	10000	50	4619
Annual Parking Fee	660	3000	100	963
Sample is 342 three-wheeler Operators				

A numerical approach was used to determine the vehicle operational cost. All pertinent cost elements were calculated as per kilometer costs. Cost data presented in Table 1 were estimated based on the data collected through the questionnaire. The estimated cost structure of three-wheeler operation per running kilometer is presented in Table 2 (above) and Table 3 (below) respectively.

Table 3: Estimated cost of operation per km

COST COMPONENT	**ESTIMATES (Rs/km)**
Fuel cost (Fc)	7.39
Service cost (Sc)	0.23
Tire wear cost (Tc)	1.09
Hire purchase interest cost (Lc)	0.08

Insurance cost (Ic)	0.36
Licensing cost (Rc)	0.03
Membership cost (Mc)	0.15
Parking cost (Pc)	0.03
Wages (Wc)	5.46
Repair & maintenance (Vc)	1.34
Depreciation (Dc)	2.96
Vehicle operating cost (VOC)	19.12
Risk premium (10%) of VOC	1.91
Fixed cost (Dc + Lc + Ic+ Mc + Rc + Pc)	3.61
Variable cost (Fc + Sc + Tc + Wc + Vc)	15.51
Initial charge *f0*	21.03
Fixed cost + Variable Cost+Risk	
After 1st km *fi*	15.51
(Tc +Sc + Fc+ Wc+ Vc)	

Based on the vehicle operating cost estimates estimated using survey data, a distance-based fare equation was derived using the equation *(3)* as given below:

$$F = [21.03\,LKR + 15.51\,LKR(d_i - 1)] * 2 \qquad (4)$$

Where; F = Minimum fare for a journey of d_i km
d_i = Total distance

Using equation *(4)*, a pricing schedule for different kilometers could be worked out. Table 4 above presents a comparison of the fare in the existing operation and the estimated fare based on the cost-plus method.

Table 4: Fare comparison

Km	Current fare	Estimated fare	Fare difference
1	50	42.07	7.93
2	90	73.09	16.91
3	130	104.10	25.90
4	170	135.12	34.88
5	210	166.13	43.87
6	250	197.15	52.85
7	290	228.17	61.83
8	330	259.18	70.82
9	370	290.20	79.80
10	410	321.21	88.79

The results in Table 4 indicate that the estimated cost-plus fare levels are lower than the existing fare structure of (metered) three-wheeler operation.

CONCLUSION

Three-wheeler taxi services are a vital contributor to the transport sector and to the economy of Sri Lanka which has been growing rapidly for the past five years. Over a million vehicles are in operation and regularly increasing, affecting the economic, social, and environmental aspects of the country. The industry has not come within the regulatory purview under of transport regulatory body. The need for a proper regulatory mechanism is widely discussed to ensure that all stakeholders of these services would benefit. Pricing and costing transport services are important for ensuring profitability even though the three-wheeler taxi sector is not regulated. If costs become too high, then demand would be less and even though transport capacity may exist, it would not benefit the passenger or the operator. On the other hand, if the price is set too low, the supplier may ultimately run out of business even though the user would benefit in the short-run.

The present study focused on the perception of the three-wheeler drivers to identify the factors to formulate a regulatory framework for the informal transport operations. A questionnaire survey was carried out with the participation of 342 operators and analysis results showed that price decisions, fare meters (regulation, standardization, and inspections) service time and operating hours, registration, identification, certification from relevant authorities (Provincial/Municipal council, any governing bodies), age and minimum level of experience, Police recommendation, regulations for allocation of vehicles to parks and related barriers, could be identified as factors relevant to developing a regulatory framework for informal transport operation.

In this research, a fare index was derived based on the value of vehicle operating cost in which fixed charge was made relevant to all costs while a variable charge based on the distance was made applicable to the operational costs. The research found that the three-wheeler operators perceived the taxi-meter as a very helpful device for both the customer and the driver. It displays the full charge for the hire, the number of hires, and the distance traveled. Therefore, a fare structure should be developed considering the value of the time as well, because taxi operators may refuse to operate with a fare structure which only considers distance traveled. Hence formula for the taxi meter should be a function of both the distance and the time taken to complete a journey that accounts for traffic congestion and waiting time.

Moreover, to develop a proper fare structure, policymakers should consider not only vehicle operational cost and operator's financial aspects but also the financial aspect of the user. This paper largely filled this gap by bringing vehicle operating costs and operators' financial aspects into the discussion of fare setting. However, this study can be further improved based on the perception of passengers as well as relevant authorities. The factors identified in this study are limited to those found through the survey conducted, and hence, further research could be undertaken to consider other relevant factors, including nighttime operations. Further future research also needs to consider user expectations and the demand. The recent emergence of the mobile app-

based taxi and ride-sharing services could also be considered to further enhance the validity and relevance of such studies in the future.

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