Design of the Rickshaw to Improve Safety and Comfort of Passengers

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ABSTRACT

The aim of the project is to present a complete picture of the knowledge and skills needed for "Design of the rickshaw to improve safety and comfort of passengers". For safety and comfortability the height of Centre of Gravity (C.G.) and length of C.G is taken into account. For this case the height of rickshaw decreased and the length increased. For comfort the stiffness of the leaf spring which supports the seat, decreased from the current value. The major challenge in this design is to lowering the C.G. into appropriate value, which increases the stability of the rickshaw. For the comfort purpose the seat is widens and make soft to sit. Several systems and options are added for the increase in safety and comfort for both the passenger and rickshaw puller.

Keywords: *Rickshaw, Design, Safety, Comfort, Centre of Gravity (C.G.), Passenger, Rickshaw puller, Frequency*

1 INTRODUCTION

Rickshaw is one of the major types of manually driven vehicle used in rural, urban and even in the main city areas of Bangladesh for carrying passengers and commodities. If anything symbolized our capital city Dhaka; rickshaw is an omnipresent feature- probably comes first. In 1930, rickshaw came to be used in Bangladesh prolifically. With the flow of time the world has been changed

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considerably, but the shape of the rickshaw remained almost unchanged even after of 80 years of its invention. The rickshaw plied on the roads and the streets are not so comfortable especially for one gear transmission ratio and conventional cabin system.

It comes to known that most of the cities in developing countries are highly polluted. The main reasons are the air and noise pollution caused by transport vehicles, especially petrol-powered two and three wheelers.

In India, there are close to 18 million petrol powered two wheelers and about 1.5 million petrol and diesel powered three wheelers and their population is growing at a healthy rate of about 15% per annum. Besides being a major hazard

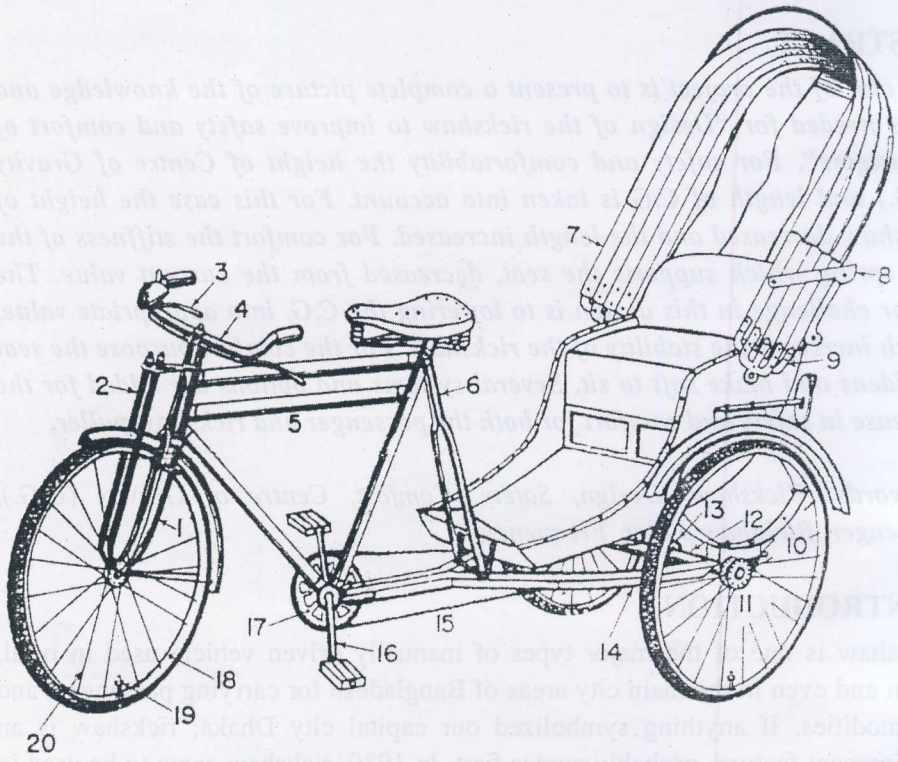

Figure 1: Existing model rickshaw in Bangladesh

Table 1: Different parts of a rickshaw as shown in Fig.1

1. Front fork	5. Front frame	9. Hood bracket	13. Free wheel	17. Chain wheel
2. Fork	6. Rear stays	10. Springs	14. Sub-frame	18. Wheel rim
3. Brake levers	7. Hood bamboo	11. Rear hub	15. Chain	19. Tube valve
4. Handle bars	8. Hood latches	12. Rear axle	16. Pedal Crank	20. Spokes

to people's health, these machines are guzzling huge amounts of petrol and diesel for which the country has to pay dearly in foreign exchange outflow. In fact it is a common sight in developing countries that during traffic jams in congested areas of cities these vehicles produce tremendous pollution. An electric cycle rickshaw can provide a non-polluting and a very silent transport system for urban and rural areas of India. Besides it is a very energy efficient and cost effective vehicle.

In USA, Manhattan University, New York has developed several design and modification on rickshaw. Now, Manhattan Rickshaw Company (MRC) is marketing the rickshaw different areas of New York City and other places of USA.

2 EXISTING CYCLE RICKSHAWS IN BANGLADESH

Rickshaws are one of the most famous sights in Bangladesh as Gallagher [1]. Dhaka- the capital of Bangladesh is called the city of rickshaw. It is impossible not to see or literally run into rickshaw in Dhaka city. Recent estimates peg the number of Dhaka rickshaws at over a quarter million- making this convenient and smog-free mode of travel one of the cities main sources of income for nearly 5 million individuals. Now rickshaw is practically a national institution. Far from appreciated, but used by citizens up and down the social ladder, Dhaka rickshaws are not just a poor man's taxi. Often personalized and decorated with colorful paintings and murals of everything from famous Bollywood actors, cricket players and global politicians to animals, birds and flowers. Some have pictures of mosques, village scenes or famous buildings. Some might even carry political statements. A few tell stories but most are just there to look colorful, described by J. Franchise [2].

Following figures show the orthographic projection with respective statistical data i.e dimensions and weight of current model cycle rickshaw that are widely using all over the country.

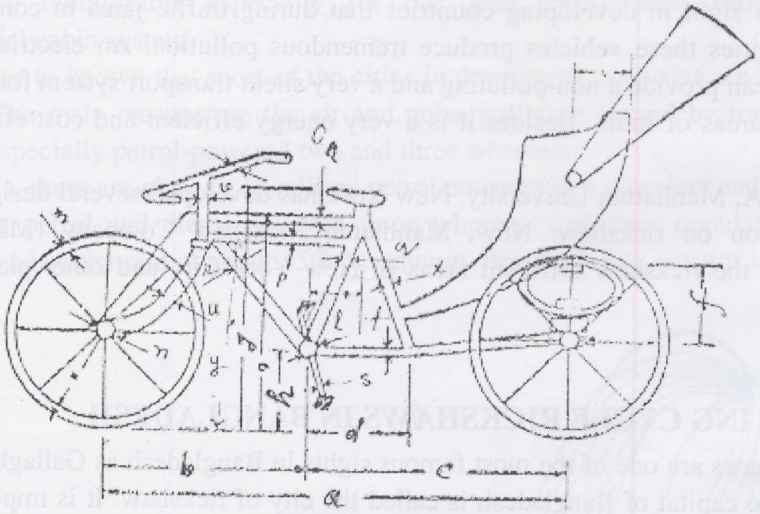

Figure 2: Front view

Table 2: Dimensions of current model cycle rickshaw as shown in Fig.2

a = 166.2 cm	h = 34 cm	o = 26 mm	v = 32 mm
b = 71 cm	i = 3.8 cm	p = 27 mm	w = 23 mm
c = 93.5 cm	j = 98.2 cm	q =29 mm	x = 15 mm
d = 39.7 cm	k = 32 cm	r = 29 mm	y = 76.5 cm
e = 18.5 cm	l = 45.1 mm	s = 13.5 mm	
f = 41.8 cm	m = 50.5 mm	t = 39 mm	
g = 85.2 cm	n = 35 mm	u = 27 mm	

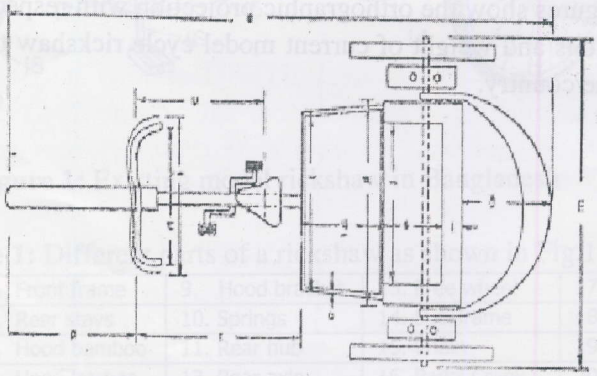

Figure 3: Top view

Table 3: Dimensions of current model cycle rickshaw as shown in Fig.3

a = 241.6 cm	e = 19.5 cm	i = 50.8 cm	m = 117.2 cm
b = 65.5 cm	f = 4.8 cm	j = 62.6 cm	
c = 73.5 cm	g = 34.2 cm	k = 70 cm	
d = 45.4 cm	h = 46.2 cm	l = 61.4 cm	

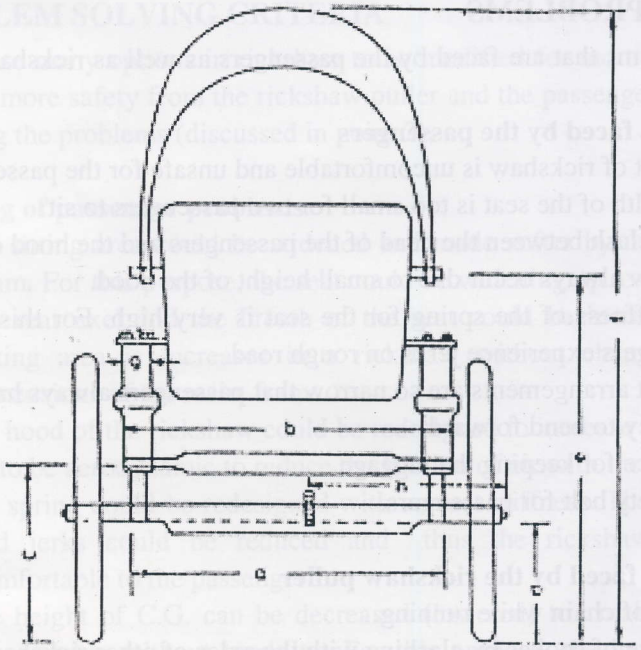

Figure 4: Right side view

Table 4: Dimensions of current model cycle rickshaw as shown in Fig.4

a = 79.3 cm	c = 46.1 cm	e = 88 cm	g = 4.6 cm
b = 82.8 cm	d = 34.4 cm	f = 173.8 cm	h = 55.5 cm

The weight includes the under different condition such as empty, front wheel and distributed load of passengers on the front wheel, rare wheel (both right and left) and distributed load of passengers on the rare wheels.

Total weight of Rickshaw

Driver + 2 passengers	= 76 kg
For rear wheel left,	
Driver + 2 passengers	= 92 kg
For rear wheel right,	
Driver + 2 passengers	= 93 kg
Total weight of Rickshaw	= 261 kg

3 LIST OF PROBLEMS

The problems that are faced by the passengers as well as rickshaw puller are as follows:

3.1 Problems faced by the passengers

a) The seat of rickshaw is uncomfortable and unsafe for the passengers.
b) The width of the seat is too small for two passengers to sit.
c) Heavy clash between the head of the passengers and the hood of the rickshaw always occur due to small height of the hood.
d) The stiffness of the spring for the seat is very high. For this reason, the passengers experience jerks on rough road.
e) The seat arrangements are so narrow that passengers always have a tendency to bend forward.
f) No space for keeping the luggage.
g) No safety belt for passengers.

3.2 Problems faced by the rickshaw puller

a) Falling of chain while running.
b) Brakeage of spokes by clashing with the axles of other rickshaw.
c) Loss of kinetic energy while rickshaw puller pulls down the paddle again from the stable condition.
d) The seat arrangement for the rickshaw puller is not comfortable.
e) There is no headlight and taillight in the rickshaw.
f) Accidents for lack of efficient brake mechanism.

4 PREVIOUS WORK DONE ON RICKSHAW

A rickshaw ban proposed by the World Bank in 2005 as [3] almost singled the end of the rickshaw in Dhaka. But the proposed ban lost out when it was sighted that vehicular traffic only accounts for about 9% of the daily traffic flow in and around Dhaka.

In Bangladesh, different projects had been carried out on rickshaw in BUET for improving the quality and comfortability of existing model rickshaw from both the passenger and rickshaw puller point of view. In IUT also a project had been done on design of regenerative braking system for rickshaw, which concern was to improve the braking system of rickshaw by applying several technical modifications from the viewpoint of loss of kinetic energy of the rickshaw puller while the puller starts to move the rickshaw from stable condition to running condition.

5 PROBLEM SOLVING CRITERIA

There are many options in rickshaw to be modified for more comfort, better riding and more safety from the rickshaw puller and the passenger point of view considering the problems (discussed in point 3),

5.1 Solving of passenger problems

a) The sitting area could be widened and made softer by using spring and foam. For this purpose, the seat could be widening up to the two ends of the rear axel and the breath of the seat could be increased. Thus the sitting area is increases in a rickshaw without changing any other dimensions of the main frame.

b) The hood of the rickshaw could be redesigned to increase the area as well as to be aerodynamic to reduce the friction of air with the hood surface.

c) The spring could be redesigned with correct stiffness. Then the vibration and jerks could be reduced and thus the rickshaw will become comfortable to the passenger.

d) The height of C.G. can be decreased (lowered) to make the rickshaw more stable without tumbling. For this purpose, the height of the seat could be reduced. In addition, for more comfort to sit the footboard can be flatten.

e) For more comfort, the space between the rickshaw puller seat and the passenger seat could be increased. Also a luggage compartment could be made under the passenger seat area, which always remains unused.

f) For the comfort while sitting lavishly, armrest could be introduced with the redesign of the seat.

g) Belt loops could be used from the roof of the hood for safety of the passenger.

h) Wide tires with reduced diameter could be used to reduce vibration and for safety with heavy load.

i) Applying additional brake system in the rear wheels can increase the brake efficiency.

5.2 Solving of rickshaw puller problems

a) The seat of the rickshaw puller could be redesigned with lowered C.G. and comfortable soft surface.

b) The electrical headlight, taillight and indicator light could be added for the safety to avoid accident. In this purpose for electricity supply a small dynamo with rechargeable lead-acid battery could be used. Instead of the tail light to reduce cost reflective type neon signs could be used.

c) The handle of the rickshaw could be redesigned to reduce cost and increase the ease of the rickshaw puller to hold.

d) Rear view mirrors could be used for safety purpose and to avoid accident.

6 POSSIBLE IMPROVEMENTS

Some improvements could be done which provides better riding, smooth running and ensures the stability of the chain, quicker response, finally ensures the safety and passenger comfort. For these circumstances the following wish list consisting of ideas and modification activities would take into account for particular purpose:

6.1 Redesign the Cabin (Lowering the cabin)

The cabin of the newly modified rickshaw has been redesigned for the higher comfort. Entire cabin has been broadening both in length and width without changing the previous dimension of rickshaw along width. Only the length has been increased about 101.6 mm. The cabin has been mounted directly on the bottom truss, which holds the entire frame of the rickshaw together. For this reason the height of the rickshaw has been decreased and C.G. goes down. The height of the C.G. is now between 16 to 19 inches or 406.4mm to 482.6mm (in current model 26 to 29 inches) from the ground level. Therefore the stability of the rickshaw has been increased.

6.2 Safety restraint for passenger

The safety of the passenger has been improved in the modified rickshaw. The sitting arrangement for the passengers has been widen than the current design. A pair of armrest made of $^1/_2$ inches GI pipe has been add in both sides for keeping the arm of the passenger. Guard made of aluminum has been provided at the

footboard eliminate the tendency to slip out from the footboard while accident condition and it also provides the resistance to the luggage to fall off.

For the wideness of the seat the sitting area has been increased to facilitate to passenger together with ease and comfort of sitting. The seat has been made of wood, rubber foam and rexin. The seat has been perfectly so leveled horizontally that the tendency to fall down at forward when the rickshaw puller applies hard brake is irrelevant. A chain cover channel to avoid accident of the passenger legs has covered the chain.

6.3 Comfort restraint for passenger

The new redesigned rickshaw has been provided with the coil springs with association of shock absorber. The spring has been designed to isolate the vibration provided by the road excitation. The shock absorbers absorb the bumps due to irregularities on the road surface and due to speed breakers. The seat has been mounted on the suspension system to provide the rider a smooth vibration free tired less ride.

The backrest of the seat has also been made with the layer of wood, foam and rexin. The backrest has been set with the seat perpendicularly. The passengers are provided enough clearance before themselves from the rickshaw puller. The luggage carrier has been provided below the passenger seat. That's why the passenger can sit with full comfort even spreading their legs.

6.4 Modified wheel and break system

In the current model of rickshaw the wheels used are about 28 inches of diameter and has less tread width. In the modified rickshaw the wheel diameter has been reduced to 24 inches and the tread width has been increased. The mountain type tire has been used which has better grip, better resistance to lateral force and side deflection. Due to decrease in diameter the height becomes reduced and the C.G. along height goes down and stability of the rickshaw increases considerably.

In the current model of rickshaw the break is applied only on the front wheel. That's why the breaking surface is less and required more brake application force and long tracking length to be stationary. In the modified rickshaw the integrated break system has been used in all the three wheels. In this system three-canti lever, double shoe break mechanism has been used. The break me chanism has been actuated by two individual break lever mounted on the steering handle. The levers are more comfortable to apply than previous. Due to this modification the break surface area has been increased so that the break efficiency has been increased highly. Thus by the modification of the wheels and break system as

Deowan et al. [4], the safety and stability of the rickshaw has been increased to a favorable extent.

6.5 Redesign the hood

The hood has been designed in arrow dynamic shape, which will reduce the difficulties to the rickshaw puller to overcome the air resistance. For redesign the hood 3 (three) aluminum flat bar has been used. Over the aluminum flat bar light rexin has been used, which will draw less air and also be nice looking. Due to use of lightweight aluminum flat bar the weight of the hood reduced from 18 kg to 7 kg. The hood has been lowered in height and widened from the previous bamboo hood. This gives the rickshaw a better reduction in weight, reduction in C.G., reduction in air drag and increase in stability. Thus the redesigned rickshaw arrived with a new nice and esthetic look.

6.6 Driver comfort and performance

Changing the seat of the driver and using straight handle have increased driver performance as Cheraski et al. [5]. The paddles of the driving sprocket have been provided the zigzag design to avoid the slip of leg while the rickshaw puller has been applying high torque or rotating the paddle crank at high rpm. The truss mechanism has been well used to reduce the dynamic resistance. That's why the rickshaw puller can easily transport the man and commodities to the desired location.

6.7 Lighting and signal system

The redesigned model of the rickshaw has the headlight to use at night. A dynamo of 12 volt has been used to produce the electricity required for the head light is attached to the front wheel. A small back light of red color has also been attached at the rear of the rickshaw for safety in the dark. This light will assure other vehicle behind the rickshaw about its existence and position.

7 CALCULATIONS

(a) Calculation for spring constant

From the calculation, it is found that, the ratio of natural frequency (ωn) and the frequency from road excitation (ω) is 2.82 (considering spring constant K= 1.167 KN/m and frequency f= 1.25 Hz). Since $\omega n/\omega$ is greater than 2.5; vibration isolation is satisfied in the modification by the coil spring.

(b) Calculation for Centre of gravity (C.G.)

The design of the chassis and the body is mainly based on tradition having a fixed gear transmission ratio of the order of 1:2.2 from the paddle shaft to the rear wheel shaft. The height of the C.G falls between 26 to 29 inches above the ground level, which is quit high. The distance of C.G from the rear axle is found between 12 and 15 inches and slightly unsafe during braking.

From the calculation, it is found that, the C.G. along the length is about 1.2779m or 50.31inches from front wheel and 0.5266m or 20.7inches from rear wheel. Since the C.G. has entered more inside than the existing model rickshaw and has a ratio of about 1/3 of length from the rear wheel, the stability is increased and the tendency of the passenger to fall off has been reduced tremendously.

8 RESULTS OF REDESIGNED RICKSHAW

Following figures shows the orthographic projection of redesigned model cycle rickshaw with respective statistical data i.e dimensions and weight (weight under different condition such as empty, front wheel and distributed load of passengers on the front wheel, both right and left rare wheel and distributed load of passengers on the rare wheels):

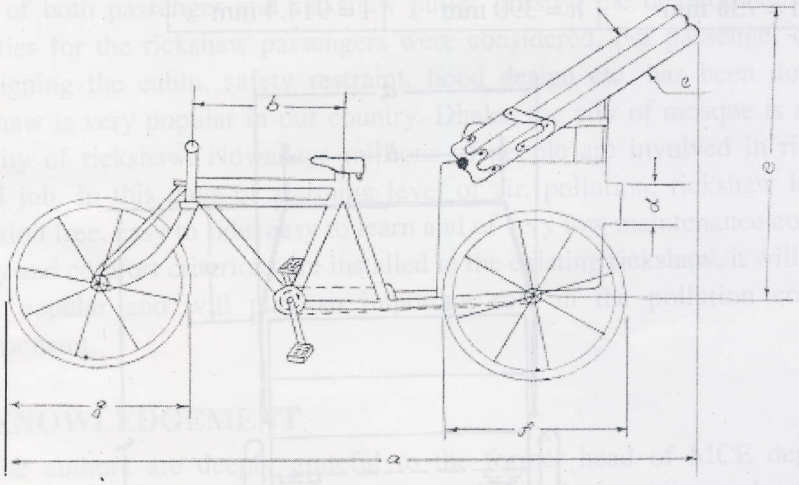

Figure 5: Front view

Table 5: Dimensions of redesign model cycle rickshaw as shown in Fig.5

a = 2463.8 mm	d = 203.2 mm	g = 609.6 mm
b = 635 mm	e = 1524 mm	
c = 304.8 mm	f = 609.6 mm	

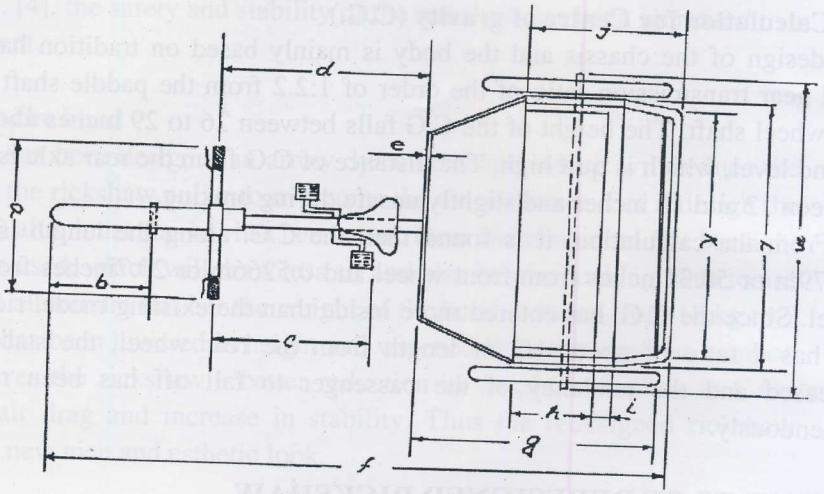

Figure 6: Top view

Table 6: Dimensions of redesign model cycle rickshaw as shown in Fig.6

a = 635 mm	e = 25.4 mm	i = 50.8 mm	m = 1172 mm
b = 305 mm	f = 2450 mm	j = 858 mm	
c = 46.2 mm	g = 787.4 mm	k = 711.2 mm	
d = 735 mm	h = 390 mm	l = 914.4 mm	

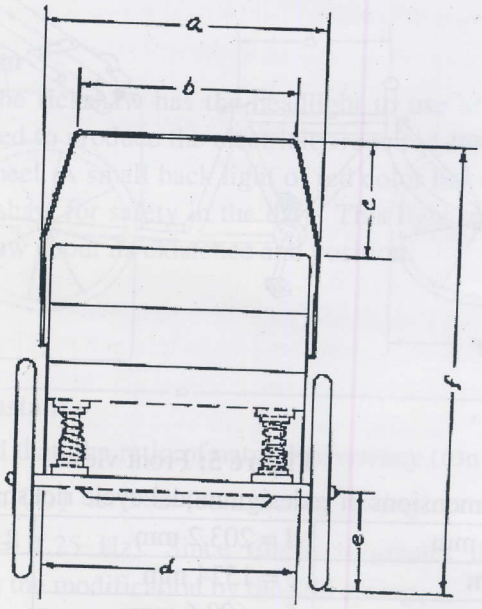

Figure 7: Right side view

Table 7: Dimensions of redesign model cycle rickshaw as shown in Fig.7

a = 914.4 mm	c = 711.2 mm	e = 304.8 mm
b = 711.2 mm	d = 914.4 mm	f = 1828.8 mm

Total weight of Rickshaw

Driver + 2 passengers = 66 kg
For rear wheel left,
Driver + 2 passengers = 79 kg
For rear wheel right,
Driver + 2 passengers = 82 kg

Total weight of Rickshaw = 227 kg

(This weight has been calculated without considering the weight of the entire body)

9 CONCLUSIONS

The purpose of this project is to design the rickshaw to improve safety and comfort of passengers, described in Hillier [6]. There are many options for development as described in the wish list from aesthetic and beneficial point of view of both passenger and rickshaw puller. Firstly, the developments of the facilities for the rickshaw passengers were considered. For passenger comfort; redesigning the cabin, safety restraint, hood design etc. has been done. The rickshaw is very popular in our country. Dhaka, the city of mosque is renamed the city of rickshaw. Nowadays millions of people are involved in rickshaw-based job. In this days of alarming level of air, pollution, rickshaw is totally pollution free, easy to ride, easy to learn and of very low maintenance cost. If the safety and comfort criterions are installed in the existing rickshaw, it will become more popular and will play an important role in the pollution control of environment.

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