

Possibility of Consensus Building for Traffic Congestion Management in Central Dhaka by Fuzzy AHP

Hokkaido University
Hokkaido University

Student member
Regular member

○ Tasnuva Humyra
Kunihiro Kishi

1. INTRODUCTION

Dhaka is the capital of Bangladesh and the principal city of Dhaka Division. Dhaka is a megacity and one of the major cities of south Asia. Also the most densely populated cities in the world. The transportation system of Dhaka is predominantly road based where non-motorized transportation mainly rickshaw has a substantial share; the city is described as the rickshaw capital of the world. So far traffic congestion has now become a very serious problem particularly in Dhaka and the traffic congestion occurs mainly due to the mixture of motorized and non-motorized transport (Rickshaw) on the same road space.

Under the pressure from the World Bank Dhaka City Corporation (DCC) banned rickshaw from some important roads. The reasons given for the ban were that rickshaws cause traffic congestion because they take up too much road space and move more slowly than motor vehicles.

Dhaka Urban Transport Project (DUTP) impact assessment study has assessed that in the transport corridors from which rickshaws have been withdrawn, total commuter transporting capacity of those corridors have increased by about 30% and at the same time traffic jam will reduce.¹⁾ Under DUTP, the government has been taking measures to improve urban transport infrastructure and services, and to address long-term transport planning, coordination and institution development in Dhaka. As a part of taking measures to improve urban transport infrastructure and services, resurfaced non-motorized from some of the complementary traffic roads and crossings.²⁾ The World Bank's role under the DUTP has been to provide financing and technical assistance to help the government with the development, refinement and implementation of appropriate strategies for managing road traffic and services in Dhaka.

The urban transport issues of mobility, congestion, safety, travel time, environmental and economical aspects are becoming increasingly important and critical in Bangladesh.

So far government's consideration is to ban rickshaw from main road but most of the residences consideration is not to ban rickshaw. Because after rickshaw bans poor and middle class residences suffer so much because of finding no adequate replacement transport and often experiencing greater travel costs in term of time and money. So there is a conflict between government and residence opinion. It is very important for government to build consensus for traffic congestion management in central Dhaka.

Consensus building known as collaborative problem solving or collaboration is a conflict-resolution process used mainly to settle complex, multiparty disputes.

Several researchers studied on urban transport issues and improvement option for Dhaka and so on. Hoque *et al.*³⁾ discussed about the possible solution strategies for enhancing mobility, safety and the environment by means of better traffic management measures. Alam⁴⁾ in his study said that vehicle emissions are increasingly being recognized as the dominant cause of air pollution and health problems in Dhaka. The pressing demands for motorized form of personal mobility are pressures on road network and resulting in congestion.

In this study a few immediate and possible alternative planning options are considered, which banning of rickshaw from the main road and promote efficient public transportation and only rickshaw for the central part of Dhaka city. This

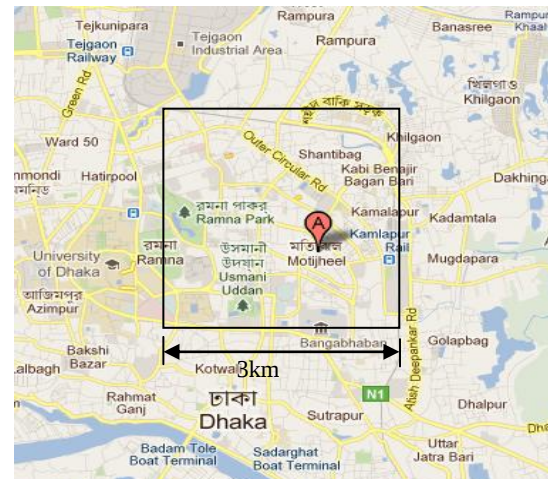


Fig.1 Study area at the central part of Dhaka city

study considered four evaluation factors to evaluate the alternatives. The evaluation factors are safety, travel time, economical impact and environmental impact. Residences and national governments opinion were taken to find out the selected solution, from the view point of their opinion for reducing traffic congestion in central Dhaka.

2. PURPOSE OF THE STUDY

Based on the background, the following objectives have been identified:

- (i) Regarding rickshaw, consensus building to Dhaka, Bangladesh is focused on in order to reduce traffic congestion in central Dhaka.
- (ii) To identify the respondent's opinions about traffic congestion management and find out the selected solution from the view point of different types of people's opinion for reducing traffic congestion in central Dhaka.
- (iii) To identify the possibility of consensus building for traffic congestion management in central Dhaka by Fuzzy AHP.

3. STUDY AREA

Dhaka is the most densely populated cities in the world. This study applied on Motijheel area, one of the most important places in central Dhaka. Besides, this place is commercial area. At Motijheel traffic congestion is the main problem for everyday. In this study considered 9km² land area in Motijheel, which is shown in the Fig.1.

4. METHODOLOGY

4.1 Applying Fuzzy AHP

This study applied Fuzzy AHP for to build consensus building on traffic congestion management in central Dhaka. Figure 2 shows the hierarchy chart. In this study the evaluation factors are considered from the following substances,

Safety: Traffic congestion sometime causes road accidents and people become injured. Therefore, traffic congestion hampered safety.

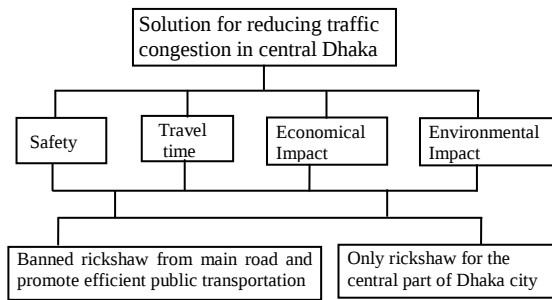


Fig.2 Hierarchy chart



a) Banned rickshaw from main road and promote efficient public transportation
 b) Only rickshaw for the central part of Dhaka city

Fig.3 Alternatives

Travel time: Everybody likes short travel time. However due to traffic congestion, travel time become longer.

Economical impact: When the government introduces new transportation plan, social economical effect becomes important. For example people's income, travel cost (Example: fare), time value etc.

Environmental impact: Due to traffic congestion, the air pollution rate in Dhaka city increase day by day. The pollution causes health hazard.

Among the four evaluation factors two alternatives are considered. Those alternatives are "banned rickshaw from main road and promote efficient public transportation" and "only rickshaw for the central part of Dhaka city". **Figure 3(a)** shows the alternative "banned rickshaw from main road and promote efficient public transportation", in this situation only motor vehicles move on the road and rickshaws are banned. **Figure 3(b)** shows the alternative "only rickshaw for the central part of Dhaka", for this situation only rickshaw can move and motor vehicles can't enter at the central Dhaka.

4.2 Outline of the questionnaire survey

In this study questionnaire survey was done by five members, from 2nd to 7th, June, 2011 at the central part and some other parts of Dhaka city. 178 questionnaires were collected from residents and 3 questionnaires were collected from national government.

4.3 Analyzing Fuzzy AHP

4.3.1 Degree of importance of evaluation factors

This study analyzed the pair comparison of evaluation factors from residences and national governments found different results. From **Fig.4** it is found that on residences consideration economical impact and safety are more important. After economical impact and safety they considered travel time and environmental impact. Furthermore, the most important factor for national government is economical impact. Environmental impact is second important factor for government, because traffic congestion causes highly air pollution in Dhaka. After economical and environmental impact government consider about safety and travel time.

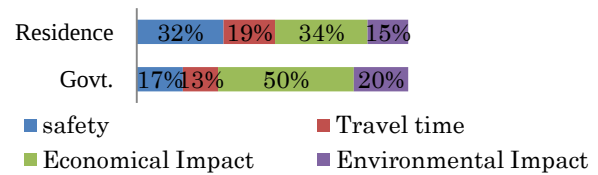


Fig.4 Degree of Importance

Table 1 Mode of travel and modal share

Mode of Travel	Present Modal share	Banned Rickshaw	Only Rickshaw
Car	0.04	0.04	0
Bus	0.11	0.13	0
Auto-Rickshaw	0.06	0.12	0
Rickshaw	0.14	0	0.25
Pedestrian	0.65	0.71	0.75

Table 2 Accidents number by different types of alternatives

	Types of vehicle	Modal Share	Accidents Rate	Trip Number	Accidents Number
Banned Rickshaw	Car	0.04	2.8×10^{-5}	1×10^6	5570
	Bus	0.13	1.16×10^{-3}		
	Tempo	0.12	0.42		
	Pedestrian	0.71	0		
Only Rickshaw	Rickshaw	0.25	3.8×10^{-4}	1×10^6	56
	Pedestrian	0.75	0		

Table 3 Required travel time for different alternatives

	Distance	Velocity	Modal share	Trip	Travel time(hr)
Banned rickshaw	1.5km	24	0.29	1×10^6	18125
Only rickshaw	1.5km	6	0.25	1×10^6	62500

Table 4 Economical impact for different alternatives

	Economical Impacts	Amount (Tk)	Total (Tk)
Banned rickshaw	Travel cost	2636000	4389900
	Rickshaw driver's income loss	2520000	
	Profit of motor vehicle authority	1000000	
	Time value	263900	
Only rickshaw	Travel cost	4500000	4610000
	Profit of rickshaw driver's	1980000	
	Loss for motor vehicle authority	1180000	
	Time value	910000	

Table 5 Environmental impact for different alternatives

Alternatives	Vehicles	CO ₂ emission rate	Total amount of CO ₂
Banned rickshaw	Car	9,332kg	17,812 kg
	Bus	2080 kg	
	Tempo	6400 kg	
Only rickshaw	Rickshaw	0 kg	0 kg

4.3.2 Evaluation of alternatives

Almost 1 million trips induce in 9km² land area in central Dhaka every day. To move within central Dhaka residences use different types of vehicle. **Table 1** shows the modal share of transportation at Dhaka for different alternatives. For analyzing the alternative "banned rickshaw from main road and promote efficient public transportation", considered 40% of the residence travel by rickshaw before will travel by tempo, 20% by bus and 40% will move by walking. For the alternative "only rickshaw for the central part of Dhaka"

considered 40% of the residence travel by bus or other public transport before will travel by rickshaw and 60% will move by walking.

This study by considered the factor safety, considered accidents rate. Rickshaws accidents rate is much lower than motor vehicle which is shown in **Table 2**. Travel time analysis considered velocity of the vehicles. **Table 3** shows the required travel time for different alternatives. Rickshaws velocity is lower than motor vehicle. Economical impact analysis considered travel cost, income loss or gain of rickshaw driver and bus service authority, and time value. **Table 4** shows the economical impact for different alternatives. Environmental impact considered CO₂ emission rate from vehicle. **Table 5** shows the environmental impact for different alternatives. By using that information this study find out the results of evaluation factor's score of alternatives which are shown in **Table 6**.

4.3.3 Evaluation by FUZZY AHP

This study analyzed by Fuzzy AHP uses accountable degree of the evaluation factors. Accountable degree is the degree that evaluation factor can represent upper level purpose. **Table 7** shows accountable degree of the evaluation factor for the residence. U, L, and N evaluation of the alternatives of residences are analyzed by using the evaluation factor's score for alternatives and accountable degree of residences from **Table 6** and **Table 7** respectively.

U-Evaluation : (Upper evaluation/emphasize advantage)
Calculation by using highest evaluation factor

$$U(A) = \sum_{i=1}^n \Delta_i \times \max(A_i)$$

$$U(B) = \sum_{i=1}^n \Delta_i \times \max(B_i)$$

$$\Delta_i = E_i - E_{i+1} (E_{n+1} = 0)$$

$$A_i = A_1, A_2, A_3, \dots, A_n$$

$$B_i = (1 - A_1), (1 - A_2), (1 - A_3), \dots, (1 - A_n)$$

$$A, B = \text{Alternatives}$$

$$i = 1, 2, 3, \dots, n$$

$$E = \text{Accountable degree}$$

L-Evaluation : (Lower evaluation/emphasize disadvantage)
Calculation by using lowest evaluation factor.

$$L(A) = \sum_{i=1}^n \Delta_i \times \min(A_i)$$

$$L(B) = \sum_{i=1}^n \Delta_i \times \min(B_i)$$

N-Evaluation: (Normal evaluation/average) Intermediate between U and L-evaluation.

$$N(A) = \sum_{i=1}^n \Delta_i \times \text{mean}(A_i)$$

$$N(B) = \sum_{i=1}^n \Delta_i \times \text{mean}(B_i)$$

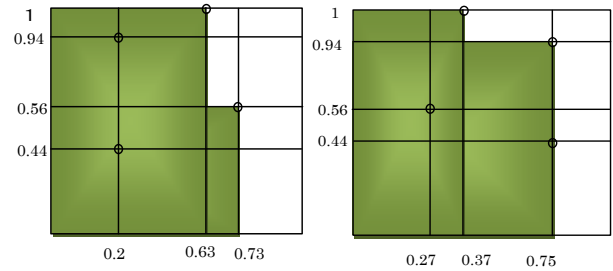
Figure 5 shows the U-evaluation of residences for "banned rickshaw from motor vehicle and promote efficient public transport" and "only rickshaw for the central part of Dhaka". In the same way this study analyzed U, L and N-evaluation of the two alternatives for national governments. Results of the U, L and N-evaluation of the alternatives for residences and national governments are shown in **Table 8**. By analyzing the questionnaire survey from residences and national governments found that residences consider only

Table 6 Evaluation factor's score of alternatives

	Safety	Travel time	Economical Impact	Environmental Impact
Banned rickshaw	0.25	0.73	0.63	0.25
Only rickshaw	0.75	0.27	0.37	0.75

Table 7 Accountable degree by residence

	Importance degree	Accountable degree
Safety	0.32	0.94
Travel time	0.19	0.56
Economical Impact	0.34	1.00
Environmental Impact	0.15	0.44

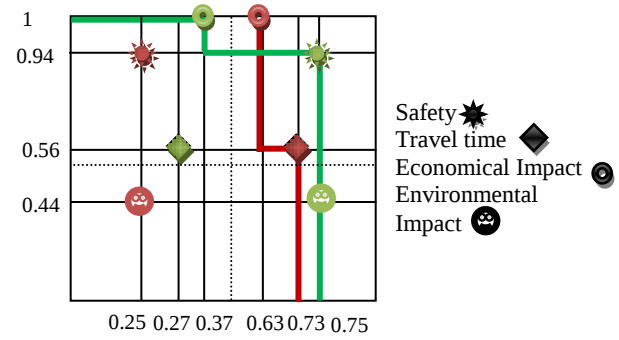


a) Banned rickshaw from main road and promote efficient public transportation
b) Only rickshaw for the central part of Dhaka city

Fig.5 U-evaluation by residence

Table 8 Analysis result

		U-evaluation	L-evaluation	N-evaluation
Banned Rickshaw	Residence	0.67	0.27	0.48
	Government	0.66	0.49	0.57
Only Rickshaw	Residence	0.73	0.31	0.52
	Government	0.52	0.34	0.43



Green for only rickshaw; Red for banned rickshaw

Fig.6 U-evaluation by residence

rickshaw and governments consider banned rickshaw from main road and promote efficient public transportation will be the best solution for traffic congestion management in central Dhaka.

5. CONCEPT OF THIS STUDY FOR CONSENSUS BUILDING:

This study considers some concept to build consensus for traffic congestion management in central Dhaka. For residence it's very difficult to change their importance degree. So the only way for government to build consensus, is to improve their preferred alternative.

The concept's are-

- Importance degree of residence is fixed, so it should not be changed.

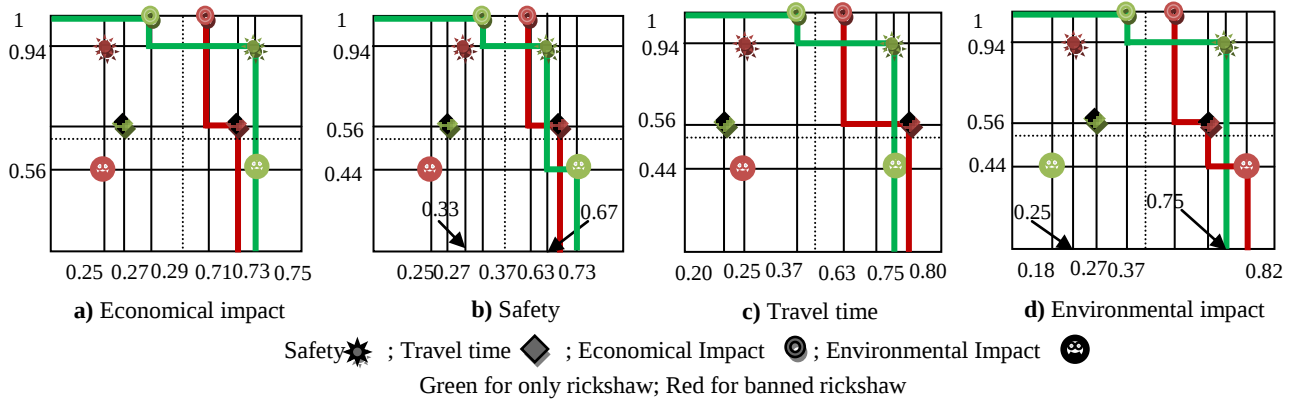


Fig.7 U-evaluation by residence after improvement for each factor's of banned rickshaw

- (ii) So to build consensus building, government has to improve their preferred alternative (banned rickshaw).

6. IMPROVING ALTERNATIVE FOR CONSENSUS BUILDING:

In this study to build consensus consider about U-evaluation, because U-evaluation emphasize advantage. Figure 6 shows the alternative's U-evaluation by residence, found that banned rickshaws economical impact and travel time's evaluation is more than only rickshaws evaluation. On the other hand in case of only rickshaw safety and environmental impact is more than banned rickshaws evaluation.

To build consensus for traffic congestion management in central Dhaka this studies main principal is to improve banned rickshaws evaluation factor. So, if government can improve banned rickshaws evaluation factor then on residence consideration banned rickshaws importance will be not be less than only rickshaws importance.

In this study try to find out the situation in which condition banned rickshaw and only rickshaws evaluation will be same for residence. At first consider to improve economical impact of banned rickshaw and found that when economical impact's evaluation score have to improve up to 0.71 for banned rickshaw then banned rickshaw and only rickshaws evaluation score become same and the score will be 0.72. Figure 7(a) shows the U-evaluation when banned rickshaw and only rickshaws evaluation will be same for residence. After that consider to improve safety of banned rickshaw and found that when safety have to improve up to 0.67 for banned rickshaw then banned rickshaw and only rickshaws evaluation score become same and the score will be 0.69. Figure 7(b) shows the U-evaluation when banned rickshaw and only rickshaws evaluation will be same for residence. After that consider to improve travel time of banned rickshaw and found that when travel time have to improve up to 0.80 for banned rickshaw then banned rickshaw and only rickshaws evaluation score become same and the score will be 0.73. Figure 7(c) shows the U-evaluation when banned rickshaw and only rickshaws evaluation will be same for residence. Finally consider to improve environmental impact of banned rickshaw and found that when environmental impact have to improve up to 0.82 for banned rickshaw then banned rickshaw and only rickshaws evaluation score become same and the score will be 0.73. Figure 7(d) shows the U-evaluation when banned rickshaw and only rickshaws evaluation will be same for residence. Table 9 shows the evaluation factors score for different alternative before and after improvement, found that when Dhaka city government try to build consensus with residence for traffic congestion management in central Dhaka and want to find the situation in which condition banned rickshaw and only rickshaws evaluation will be same for

Table.9 Evaluation factors score for different alternative before and after improvement

		Safety	Travel time	Economical Impact	Environmental Impact
Banned rickshaw	Before		0.73	0.63	
	After	0.67	0.80	0.71	0.82
Only rickshaw	Before	0.75	0.27	0.37	0.75
	After	0.33	0.20	0.29	0.18

residences, then for government to improve banned rickshaws safety and environmental impact will be very difficult or impossible and difficult but possible way for government to improve travel time or economical impact of banned rickshaw.

7. CONCLUSIONS

The analysis results got from Fuzzy AHP analysis for government is to ban rickshaw from main road and promote efficient public transportation but residences only rickshaw for the central part of Dhaka city. There is a conflict between government and residence opinion, so it is very important for government to build consensus for traffic congestion management in central Dhaka. That's why this study try to find out the situation in which condition banned rickshaw and only rickshaws evaluation will be same for residence. In this situation both alternatives importance will be same for residence. So they can choose any alternative liberally.

The present study has been investigated the effect of improving condition of banned rickshaw to build consensus at the situation when banned rickshaw and only rickshaws evaluation will be same for residence.

Government faces different types of public issue, so build consensus becomes very important for them. From this study, in the same way government can find out the evaluation factor is possible and easy to improve of their preferred alternative. In order that, governments preferred alternative and residences preferred alternative will be same important for residences.

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