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Identifying User Satisfaction Level of Road services: A Focus on Rajshahi City Bypass Road, Bangladesh.

Mohammad Mahmudul Hasan[1]*, Asif Alam[1], Abdul Mohaimenu Mim[1], Anutosh Das[2]

[1]*Graduate Student, Department of Urban and Regional Planning, Rajshahi University of Engineering and Technology, Kajla-6204, Rajshahi, Bangladesh.*
[2]*Lecturer, Department of Urban and Regional Planning, Rajshahi University of Engineering and Technology, Kajla-6204, Rajshahi, Bangladesh.*

Abstract

The entire nation of Bangladesh depends highly on on-road transportation than other alternative routes and this sector plays a vital role in the country's overall communication. In the present competitive scenario of any country, every sustainable development of infrastructure, especially in road services depends on effective management of the road user's needs and expectation. Each and every service provider or concerned organization need to understand and meet the road user's requirement. In order to perceive the road user's demand, the present study initiates a survey to key out the drivers of user satisfaction, estimate present satisfaction levels and capture the various issues that determine the future road service requirement of a newly constructed road in Rajshahi. The study especially focuses on the quantitative methods to represent the database. Formulating a mathematical model like Factor analysis and linear regression, the evaluation criteria are employed to identify the road user satisfaction level. The criteria's weights are obtained through the Analytical Hierarchy Process (AHP) method for understanding the future road service requirement. The Data collection procedure is equipped with expert opinion and structured questionnaire with a sample of 250. The stratified random sampling method is used in this research. Five complex variables namely Comfort, Safety, Amenities, Roadside Signage and Emergency services are considered to discover the overall satisfaction level in Rajshahi City Bypass Road. The study concluded with an interesting finding that road user comfort has a high impact on the overall satisfaction level among other factors considered in this study. To evaluate the future needs and expectations of better road infrastructure development, Expert gives the first priority to the safety of road user. This study will assist the policymaker for future priority basis sustainable decision making and the methodology adopted herein can be replicated globally.

* Corresponding author. Mob.: +880-1521-477554.
  E-mail address: mahmudulhasanripon.mh@gmail.com

1. Introduction:

Transport is an important component of economic activity in all countries, but it is especially more in developing countries. Having no explicit focus on future requirements, improvised considerations are driving the transport developments in Bangladesh as well as a sustainable basis (Assignment point, 2017). The unplanned combination of rapid urbanization and motorization has been a key causal agent of numerous transport problems in Bangladesh. It deteriorates accessibility, service levels, safety, comfort, operational efficiencies etc. (S.M. Sohel Mahmud, n.d.). In the twenty-first century, the business environment conditions are probable to be more explosive. The organization is betting heavily on this development, but it is necessary to recognize whether their services are improving due to this or not (Agarwall, 2008). Every service provider needs to know whether their services satisfy their users or not. Therefore, in measuring the level to which a service provider satisfies users' needs and expectation, one of the most popular methods is measuring the user's satisfaction (Morris, 1998).

According to the Master Plan of Rajshahi Metropolitan area, the Rajshahi city bypass has said as a major east-west corridor of traffic flow that serves as to divert traffic flow from the city center. The Master Plan instruct the Rajshahi Development Authority including several agencies to develop this corridor utilizing the road links, improve the geometric design and provide adequate infrastructure services (Ministry of Housing & Public Works, 2004). All of these initiatives were incorporated in Master Plan so that the through traffic can move faster without any interruption and divert the traffic flow that may enter to the city center resulting congestion, increasing of Vehicle Operating Cost (VOC), travel time delay and so on. Kadiyali (2003) stated this benefits as benefits to traffic on another road whither improvements to a corridor road may cause a reduction in traffic on other roads (and railways), thus resulting in lesser congestion. There also be arise some problematic criteria that should mitigate evaluating road user demand.

A huge number of commuters are traveling every day which affects the economy of the Rajshahi. The neighborhood people generally feel relaxed to live in the suburban area for a better environment. Suburban commuters typically compromise the transportation disutility resulting from higher journey time and cost for less housing cost and a better environment. If the transportation system is not affordable, suitable and properly justified the needs and expectations for the suburban commuters, then the disutility overshadows their influenced economy on Rajshahi. Consequently, they are more likely to choose their residence in the main city near to their working place. In the near future, it will turn the Rajshahi city as clogged and overpopulated.

Researchers all around the world have conducted many types of research and used several procedures among which some become popular. Identifying the customer satisfaction level and ranking the factors influencing that satisfaction, some study focuses on telecommunication industry employing AHP (Jahantigh, 2015). Chunmei (n.d.) used the analytical hierarchy process (AHP) to examine the importance of the influence factor for the Customer Satisfaction Degree in the airline transport sector. The proper understanding of various factors that affect user evaluation and satisfaction with a public service is extremely required for high-quality performance (Agarwal, 2008). Indeed, the road transportation sector represents the positive correlation between the road service and satisfaction level. Whither, the more uphold the road service infrastructure, the better the road user satisfaction. Thus, in order to serve better road services to the users, identifying the needs and expectation of that services and their present satisfaction level is predominant.

No study has conducted yet examining the road user satisfaction to perceive how the services of road infrastructure are going on. Hence, a study is conducted to capture the satisfaction level conducting Road User Satisfaction Survey (RUSS) in the Rajshahi City Bypass road. The findings of the survey are expected to be used in addressing the concerns of various stakeholders. The survey will serve as a benchmark to track stakeholders' satisfaction and future expectations with various initiatives aimed at improving the road network condition. The research captures satisfaction levels among various stakeholders and road users and also priority issues for future road infrastructure improvement. This study will help the Public Work Department (PWD), Roads and Highway Department (RHD) & other service provider agencies to develop their services according to the road user demand.

1.1. Study Area Profile:

Study area Rajshahi city bypass road is selected for this study purpose. Because it is a newly constructed road and plays a vital role in communicating the people of Chapai Nawabganj with Rajshahi and other districts. Every day,

about thousands of people come from chapai Nawabganj to the Rajshahi city for working purposes and getting medical treatment. This road plays a vital role to decrease their travel time and easily accessible to reach their destination. The length of the city bypass road is 5 kilometers.

This road is always busy in the maximum time of the day. Every hour, about three thousand passenger use this road (Field Survey, 2017). So it can be easily said that this road is one of the busiest roads in Rajshahi. The people of Chapai Nawabganj not only use this road for coming to Rajshahi City but also going the capital of Bangladesh. It takes about five to six hours by using this road to reach the capital from Chapai Nawabganj (Wikipedia, 2017). So we select this city bypass road to estimate the road users' satisfaction level as well as the future road service requirement.

Figure 1.1 (a) Location of RMA in Rajshahi District and (b) location of the study area, RCC, and RCBR
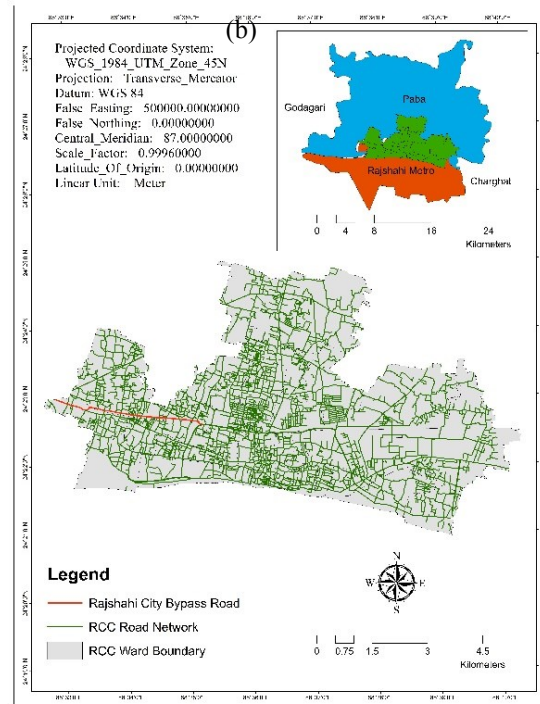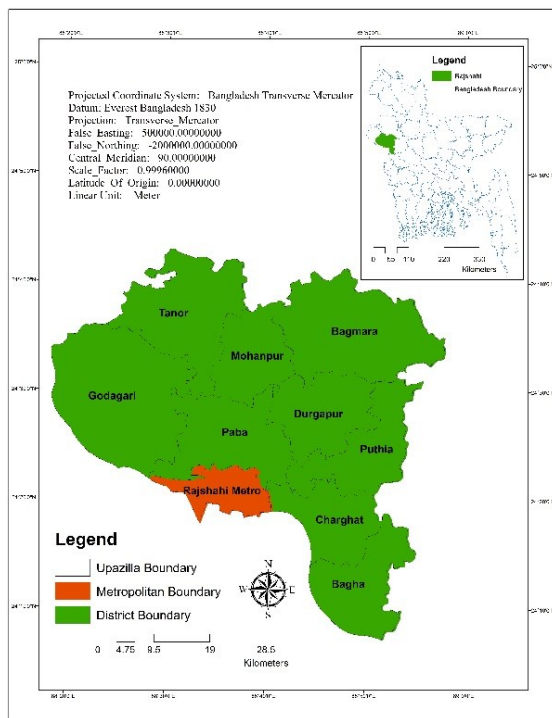
2. Literature Review:

2.1 The concept about the road services:

Generally, road services are the facilities which are provided by the road. These can be the road surface condition, carriageway and pedestrian width, road surrounding environment, road crossing facility, security, safety, public toilet, refreshment facility, parking facility, lighting, road signage and emergency services. Every services either road infrastructure or any other, the quality of that services impact much more on satisfaction. Quality of service is one of the performance indicators under the effectiveness category. It is composed of accessibility, Amenity, comfort, convenience and safety (Agarwal, 2008). The performance measure is classified by Allen (1974) into three categories: quantity of service, quality of service which are further divided into user and non-user measures. Comfort, safety, amenity etc. are user measures. Where pollution and environmental issues are non-user measures.

2.2 Satisfaction level and Analytical Hierarchy Process (AHP) in road service context:

Trip satisfaction can be considered as a type of road user satisfaction. This often results from the services provided by the road infrastructure and also related to the user reaction to the services. In this research, road user includes passenger, pedestrian, and cyclist. In addition, Cardozo (1995) has revealed that satisfaction is a level of customer approval when comparing a service's perceived performance with his or her expectations. It is based on information from all previous experiences with the service provider.

Since satisfaction level demarks the road user requirements to any entity, it is inevitable to understand further on how it can identify the existing satisfaction level and which factors affecting road users' satisfaction level with Rajshahi City Bypass Road Services. Similarly, any ulterior requisite road services that can provide a smooth planned transportation system, are also important for any sustainable transport planning. Hence, criteria based expert opinion is always compatible to weight those requisite road services. Many of the researchers have used a multi-criteria decision-making process to identify various issues that can determine future road service requirement. Jahantigh (2015) identified various factors that influence customer satisfaction using existing resources as well as technical experts' opinion. To disclose the satisfaction level Jahantigh (2015) used several techniques like analytical hierarchy process and TOPSIS algorithm which weight the related factors. Mahmoud (2006) weighted and ranked the factors affecting user satisfaction and road service requirements in the automotive industry using the Analytical Hierarchy Process (AHP). Analytical Hierarchy Process is one of the most efficient decision making and weighting methods, which was first presented by Saaty (2008). This technique is based on a pairwise comparison matrix that is also developed by Saaty (2008). Basically, it expresses a complex decision-making problem as a sequential step-up hierarchy structure, compute the comparatively weightiness measurement of diversified decision-making behaviours, scheme, and decision-making object under the different rule and the whole rule, and then rank them according to the measurement, providing decision-making evidence for the decision-makers (Wang et. al, 2007). Therefore, the AHP model is a compatible technique to understand the multiform road user demand or requirement. A new approach can imprecise ranking of customer requirements which is based on the conventional AHP (Kwong & Bai, 2002). Consequently, in this research, use of Linear Regression Analysis (LRA) has established a new model to capture the present satisfaction level and a multi-criteria decision-making technique like Analytical Hierarchy Process in weighing the road user requirement.

2.3 Significant factors of Road User Satisfaction (RUS):

Road user satisfaction is affected by various factors of road services. Among these variables some have significantly affected the user satisfaction level; for instance, comfort, emergency services, and safety aspects. Hence, the criteria for road services were chosen from various literature reviews and justified through the pilot survey. Kadiyali (2003) stated that comfort and safety represent the quality of services offered by a transport facility. Though these are difficult to value, they are important aspects since many road users are prepared to use a longer route just to derive in comfort and safety. Suthathip Suanmali (2015) shows that the highway conditions are the most significant factor affecting road users' satisfaction. Better road surface condition is also important for higher convenience where it decreases the travel time of the road users. Another study is conducted by (Marketing and Development Research Associates, 2007) in the Himachal Pradesh in where most of the respondents feel that parking facilities and public toilets are most important issues which significantly impact the road user satisfaction level in Himachal Pradesh. Wardhana (2011) reveals in his study is that road user satisfaction level is significantly affected by the road infrastructure. Ettema (2013) indicated that experience of road conditions, socio-demographics has an impact on travel satisfaction. In addition, roadside furniture including another amenity, road signage etc. of road services can improve the road user satisfaction. One of the studies is conducted by *Karnataka State Highway Improvement Project* (2004) where respondents are asking to give their satisfaction level on the basis of a 5-point Likert scale. The result found that quality of road surface and roadside signage has the high satisfaction level. Least satisfaction was found in air and noise pollution. Found that the road users in the UK are mostly satisfied with their quality. In summary, it can represent that good road services can retain and increase the level of satisfaction of road users.

This research on Rajshahi City Bypass road for the identifying road user satisfaction level of road service different relative factors are evaluated. This is a comfort, safety, amenity, roadside signage and emergency services. It can be

an important part of supporting logistics for making economic security for Rajshahi as well as Bangladesh can be replicated globally.

3. Methodology:

The study holds a twofold objective firstly, to identify the present satisfaction level of road user and secondly, to capture the various issues that determine the future road service requirement. Therefore, two separate model has evaluated to carry out the result.

3.1 Sampling Design:

For the Road User Satisfaction Survey sampling design is mandatory and the approach methodology is already depicted in the literature review section. Before the calculation of the sample size, it is needed to find out the total population in the study area. So the population for the RUSS is divided into 4 criteria. These are the passenger of the Fast Moving Vehicle Type (FMVT), the passenger of the Slow Moving Vehicle Type (SMVT), Cyclist and Pedestrian. The detail sampling procedure is given below:

Table 3.1: RUSS Sampling Design

Fast Moving Vehicle Type (FMVT)			
Vehicle type	Vehicles of Rush Hour (x)	Carrying capacity per vehicle (y)	Total passenger (Z=x*y)
Car	184	5	920
CNG	24	8	192
Bus	152	50	7600
Total	360	63	8712
Slow Moving Vehicle Type (SMVT)			
Vehicle type	Vehicles of Rush Hour (x)	Carrying capacity per vehicle (y)	Total passenger (Z=x*y)
Easy Bike	2040	5	10200
Rickshaw	1760	2	3520
Total	3800	7	13720
Cyclist			
Vehicle type	Vehicles of Rush Hour (x)	Carrying capacity per vehicle (y)	Total passenger (Z=x*y)
Bi cycle	1000	1	1000
Motorcycle	352	2	704
Total	1352	3	1704
Pedestrian			
1000 Person			

(Source: Authors, 2017)

For the overall calculation of the population size, sampling calculation is needed. After conducting the pilot survey, two types of trip generation behavior was found. One is the maximum traffic flows between 6.00 A.M to 10.00 A.M and 4 P.M to 8 P.M considering the rush hour that contains all types of vehicles and pedestrians. And another is minimum traffic flows between 6.00 P.M to 6.00 A.M that contains only freight transport. In this research, the sampling is designed considering rush hour.

The total amount of the population is 25136. By taking a 95% confidence level and 5 confidence interval the sample size comes out 382. In our study, for the time limitation, we take the sample size of 250. These samples are collected

using a random sampling method. Using the volume count and standard vehicle carrying capacity, it is found that 35% or 87 sample is required to take from fast-moving vehicle, 50% or 125 samples are required to take from slow-moving vehicle, 10% or 25 samples is required to taken cyclist and rest 5% or 13 sample is required to take from pedestrian. Hence, the ratio is-

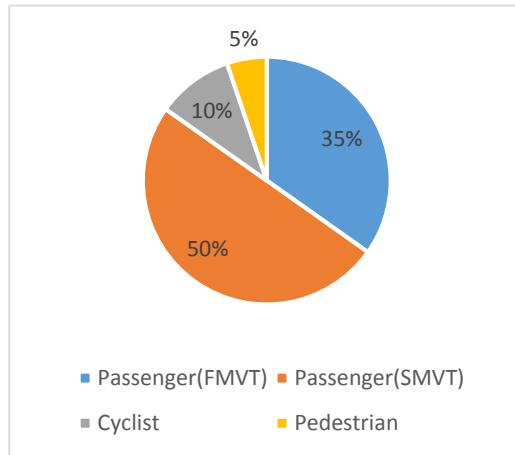SMVT: FMVT: Cyclist: Pedestrian = 87: 125: 25: 13.

Figure 3.1: Overall distribution of the study sample

(Source: Authors, 2017)

3.2 Survey Method:

In the previous sampling design section, the detail sampling procedure is design for 250 samples. The respondent was select within the sampling ratio as demonstrated in sampling design section. In this study stratified random sampling method was used for collecting the road user satisfaction data. For this purpose, a pilot survey is conducted on 25 October 2017, till the whole rush hour time duration at a selected point in the study area. Afterward, the survey database was fine-tuned for the detailed survey. A detailed survey was conducted from November to December in the year 2017. This survey was conducted for collecting the satisfaction database of 250 respondents. The whole study area is divided into several parts for the convenience of the survey. Therefore, a survey of seven-hour duration was conducted in the location between city bypass more to Bohorom pur. Then an eight-hour duration survey was conducted in Bohorom pur, Court station, and Kashiadanga. And the rest area was surveyed within ten-hour duration time.

3.3 Survey Data Analysis method and representation:

The main aim of this study is to identify the road user satisfaction level for the road services like comfort, safety, amenities, road signage and emergency services. The justification for selecting these criteria are already mentioned in the literature review section. For calculating the satisfaction level of a road which is appropriate for this calculation was chosen named Rajshahi city bypass road.

For the purpose of ranking the hierarchy of the major dimensions, Kendall's W test was used. Suppose that object i is given the rank $r_{i,j}$ by judge number j, where there are in total n objects and m judges. Then the total rank is given to object i is-

$$R_i = \sum_{j=1}^{m} r_{ij} \qquad\qquad\qquad (1)$$

The mean value of these total ranks is-

$$R = \frac{1}{n}\sum_{j=1}^{m} R_i \tag{2}$$

The sum of squared deviations-

$$S = \sum_{j=1}^{m}(R_{ij} - R)^2 \tag{3}$$

Kendall's W defined as-

$$W = \sum_{j=1}^{m} \frac{12s}{m^2(n^2-n)} \tag{4}$$

(M.G Kendall, 1939)

5% level of a significance test is conducted for this purpose. Significance test represents whether the research is statistically significant or not. The significance test is always based on hypotheses. These are a Null hypothesis (H_0) and the alternative hypothesis (H_a).

H_0: There is no significant agreement among the respondents on the ranking of different attributes.
H_a: There is a significant agreement among the respondents on the ranking of different attributes.

Kaiser-Meyer-Olkin (KMO) and Bartlett's test is also conducted in Statistical Package for Social Sciences (SPSS V20) software for testing the appropriateness of factor analysis. The test measures sampling adequacy for each variable in the model and for the complete model. A value of less than 0.6 indicates the sampling is not adequate and that remedial action should be taken. Again the values 0.8 and 1 indicate the sampling is adequate meritorious (Barbara A. Cerny, 1977). The bartlett's test measures the correlation of variables. A probability of less than 0.05 is acceptable (Bartlett, 1937). The Hypothesis formulated is as follows:

H_0: (Null Hypothesis): There is no significant correlation between the variables.
H_1: (Alternative Hypothesis) There is a significant correlation between the variables.

The survey data on road user satisfaction on pre-mentioned criteria were collected from a different type of road user of the Rajshahi city bypass road and are used to calculate the overall satisfaction. With the help of rotational component matrix using factor analysis in Statistical Package for Social Sciences (SPSS V20) software, the coefficient of each complex variable or factor is calculated. From this matrix, the factor 1 (Amenities), Factor 2 (Safety), Factor 3 (Comfort), factor 4 (Road signage), and Factor 5 (Emergency services) is identified perceiving the related weight of their corresponding variables. After unstandardized coefficient (B value) calculation from linear regression analysis conducting in SPSS software, an equation is established between the overall satisfaction and the five-factor amenity, safety, comfort, road signage and emergency services. The equation for the overall satisfaction level is given below,

Overall Satisfaction = Constant + a* F1 + b* F2 + c* F3 + d* F4 + e* F5 + f* F6.   (5)

Where,
F1 = Comfort
F2 = Safety
F3 = Amenity
F4 = Road Sign
F5 = Emergency Services
a, b, c, d, e = Weighted co-efficient.

Analytical hierarchy process (AHP) method is used to fulfill the second objectives that are to determine the priority issues for future road service development. Several expert opinions are conducted in this research to assign a relative weight that affects the road service issues. They are Professor Dr. Abdus Sobhan (Department of civil engineering, RUET), Engineer Md. Monsur Ali (Assistant executive engineer of LGED), Engineer Md. Shofiq Uddin (Department

of Roads and Highway, Rajshahi), Urban Planner Azmeri Ashrafi (Rajshahi Development Authority) and so on. Their valuable weighting intensities are judged with some step of the pairwise comparison matrix. Those are column addition, normalized matrix, priority matrix, original judgment and priorities and the calculation of consistency ratio. Bhushan, Navneet, Rai, and Kanwal (2004) proposed a methodology of deriving AHP that can be explained by the following step by step procedure:

Step 1: Firstly, to prioritize the road user requirement, all requirements have to be structured into different hierarchical levels. Affinity diagram, tree diagram, and cluster analysis can be used for this purpose. Figure A2 in the appendix section represent the three-level hierarchy of road user requirement of this research. The goal is road user requirement, criteria are safety, comfort, amenities, road signage and emergency services and sub-criteria represent 18 attributes. Hierarchy indicates a relationship between elements of one level with those of the level immediately below.

Step 2: Data are collected from experts or decision makers corresponding to the hierarchical structure, in the pairwise comparison matrix on a qualitative scale as described below. Experts can compare the criteria as equal, moderate, strong, very strong and extreme strong as described table 3.2 below.

Table 3.2: Saaty's pairwise comparison scale

Verbal judgment Numeric value	Numeric value
Extremely important	9
	8
Very Strongly more important	7
	6
Strongly more important	5
	4
Moderately more important	3
	2
Equally important	1

(Source: Saaty, 2008)

Step 3: The pairwise comparison of various dimensions evaluated from step 2 are rearranged into a square matrix. The diagonal elements of the matrix are 1. The criterion in the ith row is better than criterion in the jth column if the value of the element (i, j) is more than 1; otherwise, the criterion in the jth column is better than that in the ith row. The (j, i) element of the matrix is the reciprocal of the (i, j) element.

Step 4: The principal eigenvalue and the corresponding normalized right eigenvector of the pairwise comparison matrix give the relative importance of the various criteria being compared. The elements of the normalized eigenvector are termed weights with respect to the criteria or sub-criteria and ratings with respect to the alternatives.

Step 5: The consistency of the matrix of order n is evaluated. The comparisons of this method are subjective and the AHP tolerates inconsistency through the amount of redundancy in the approach. If this consistency fails to reach a required level, then answer to comparison was re-examined. The equation for the consistency index (CI) and consistency ratio (CI) is given below,

$$CI = (\lambda_{max} - n)/(n - 1) \tag{6}$$

$$CR = CI/RI \tag{7}$$

Where lambda max is the weighted average of the priorities and n is the number of comparing elements. Random Consistency Index (R.I) value is changed with the changes of n in the value is taken from. The RI values are shown table in 3.3. Saaty (2008) suggests the value of C.R should be less than 0.1.

Table 3.3: Random Consistency Index

Order	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	1.52	1.54	1.56	1.58	1.59

Source: Saaty (2008)

Step 6: After the consistency calculation, the variable is ranked according to their priorities. From this calculation, the second objective priority of various issues of future road services requirements is calculated.

4. Research Analysis, Findings, and Proposed Framework:

4.1 Satisfaction Level of Various Dimension of Rajshahi City Bypass Road Services:

The present work seeks to suggest a hierarchical framework of the major dimensions having an impact on the quality of the road services of Rajshahi City Bypass Road and hence the overall satisfaction level of the road users. Ranking the hierarchy of the major dimensions with the first objective, the non-parametric Kendall's W test was applied. Before the test it would like to check, is there significant agreement in ranking assigned by different respondents? Taking 5% level of a significance, the test is conducted. So, it should need to test the hypothesis. The hypothesis is-

H_0 : There is no significant agreement among the respondents on the ranking of different attributes.
H_a : There is a significant agreement among the respondents on the ranking of different attributes.

As shown in table 4.1 the degrees of freedom are 17 and Chi-square value is 1051.929. The significance of this W should be tested through the table value of χ^2. Now from the table value, the value of Chi-square come out 27.59. Since the calculated value is not less than the critical value limits, the null hypothesis (H_0) is rejected. That means there is a significant agreement among the respondents on the ranking of different attributes. It means that the research can step forward.

Table 4.1: Test Statistics of significance

N	250
Kendall's W^a	.248
Chi-Square	1051.929
df	17
Asymp. Sig.	.000
a. Kendall's Coefficient of Concordance	

(Source: Authors, 2017)

After ranking the attributes that affect the customer satisfaction level shown in table 4.2 the lighting condition of the Rajshahi City Bypass Road (RCBR) is ranked as the highest satisfaction level by the road users. Because the ample amount of lighting post exists on both sides of the road (figure 4.1 a). The road surface condition almost found in highly satisfied condition by the road users. Since this city bypass road carried out the traffic flow outside the city without a permit to enter the city center, the surface condition must be in well-conditioned for smooth traffic flow. Emergency telephone services and accident management are another most important for road users. In case of an emergency or hazardous situation, this service creates a predominant role because of a lot of uncertainty. The most of the users get access to this facility and so, these attributes have third and fourth highest ranks. Figure 4.1 (b) demonstrate the existing emergency telephone service condition. Rain shelter or Stoppage facility is essential for road services. It prevents the uncomfortable condition of the road users. But unfortunately, it is found in a very dissatisfied condition.

Table 4.2: Rank of variables

Variables	Mean Rank
Lighting	12.98
Surface condition	12.34
Emergency Telephone Services	11.20
Emergency Accident management	11.20
Adequacy of road signing	10.95
Feeling safe	10.66
Road Environment	10.48
Quality & Visibility of road signing	10.27
Positioning road signing	10.27
Security	10.18
Journey time reliability	9.94
Width	9.73
Width Pedestrian	8.71
Parking Facility	7.73
Refreshment Facility	7.38
Medical Facility	7.34
Road Crossing Facility	6.66
Rain shelter	2.99

(Source: Authors, 2017)

Figure: 4.1: Satisfaction Rank of the Road services in Rajshahi City Bypass Road; (a) Lighting (b) Emergency services

(Source: Field Survey, 2017)

In order to analyze the effect of these dimensions on road user satisfaction with the services of the Rajshahi City Bypass road as a whole, firstly reducing the number of statements to a smaller number of variables is necessary. For dimension reduction Factor analysis was undertaken for this purpose. Now, for the appropriateness of factor analysis for the set of variables, Kaiser-Meyer-Olkin (KMO) and Bartlett's test was conducted. KMO test is a measure of how suited the data set for the Factor Analysis. The test measures sampling adequacy for each variable in the model and

for the complete model. A value of less than 0.6 indicates the sampling is not adequate and that remedial action should be taken. Again the values 0.8 and 1 indicates the sampling is adequate meritorious (Barbara A. Cerny, 1977). The results are shown in table 4.3.

Table 4.3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.822
Bartlett's Test of Sphericity	Approx. Chi-Square	1084.125
	df	153
	Sig.	.000

(Source: Authors, 2017)

Since the KMO value is 0.822 it indicates the sampling is adequate for factor analysis. The bartlett's test measures the correlation of variables. A probability of less than 0.05 is acceptable (Bartlett, 1937). The Hypothesis formulated is as follows:

H_0 : (Null Hypothesis): There is no significant correlation between the variables.
H_1 : (Alternative Hypothesis) There is a significant correlation between the variables.

From the above table 5.3, since the significance level comes out 0.000, the KMO value is significant at 5 percent. Hence, the alternative hypothesis is accepted which denote that the factor analysis is appropriate.

4.2 Identification the Factors and Variables under Each Factor:

Now, among the 18 variables to judge road user's perception about the quality and services of Rajshahi City Bypass Road Services Factor Analysis is undertaken. The extraction method was selected as the Principal Component Analysis (PCA). This procedure uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables (Herve Abdi, 2010). In this research paper, the PCA method is done by eigenvalue decomposition of a data covariance or correlation matrix. The fixed number of factors is 5 instead of using Eigenvalue. Maximum iterations for convergence were taken 25. The rotation method was taken as Varimax. Table 4.4 shows the rotated component matrix obtained on the basis of factor analysis. So, the variables under each of the factors are identified as below:

Factor 1: 0.681* (X9) +0.727* (X10) +0.712* (X11) +0.198* (X12) +0.057* (X13).

Factor 2: 0.471* (X5) +0.278* (X6) +0.538* (X7) +0.367* (X8).

Factor 3: 0.490* (X1) +0.647* (X2) +0.187* (X3) -0.044* (X4).

Factor 4: 0.111* (X14) +0.866* (X15) +0.890* (X16).

Factor 5: 0.430* (X17) +0.665* (X18)

Where, Factor 1: Amenity, Factor 2: Safety, Factor 3: Comfort, Factor 4: Road Signage, Factor 5: Emergency Services. On the basis of the highest factor loadings for the particular factor, the variables in the factor have been selected.

Table 4.4: Rotated Component Matrix[a]

Criterion	Component				
	1	2	3	4	5
Journey time reliability (X_1)	.210	.094	**.490**	.137	.284
Width of Carriageway (X_2)	-.019	.196	**.647**	.033	-.061
Width Pedestrian (X_3)	-.060	.060	**.187**	-.144	.688
Surface condition (X_4)	.195	.093	**.546**	.030	-.075
Road Environment (X_5)	-.052	.471	**-.044**	.111	.563
Feeling safe (X_6)	.455	**.278**	.189	.118	.336
Security (X_7)	.520	**.538**	.036	.112	.101
Road Crossing Facility (X_8)	.611	**.367**	.075	.056	.058
Refreshment Facility (X_9)	**.681**	.033	.177	.232	-.004
Medical Facility (X_{10})	**.727**	.123	.255	.093	-.155
Rain shelter (X_{11})	**.712**	-.045	.101	-.028	.167
Parking Facility (X_{12})	**.198**	.589	.243	.052	.098
Lighting (X_{13})	**.057**	.760	.124	.200	-.066
Quality & Visibility of road signing (X_{14})	.162	-.039	.590	**.111**	.125
Adequacy of road signing (X_{15})	.128	.192	.156	**.866**	.102
Positioning road signing (X_{16})	.137	.135	.112	**.890**	.010
Emergency Telephone Services (X_{17})	.264	.326	.439	.088	**.430**
Emergency Accident management (X_{18})	.200	-.194	-.142	.222	**.665**
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 7 iterations.					

(Source: Authors, 2017)

4.3 The Effects of Various Factors on User Satisfaction level of Rajshahi City Bypass Road:

After identifying the factors above, it is necessary to find out the effect of those factors on the overall satisfaction of road user with Rajshahi City Bypass road services. So, for this purpose regression analysis was undertaken with the five-factor scores. The dependent variable is taken as overall satisfaction and the independent variables are taken as those five factors.

The value of the adjusted R squared was found to be 0.553 which shows that the model is worthwhile to fit (Table A1). It explains 55.3% data points fall within the line of the regression equation. The adjusted R squared tells the percentage of variation explained by only the independent variables that actually affect the dependent variable (Glen, 2017). The significance of the F- value came out to be 0.000 that means the model is statistically significant at the 5 percent level of significance. The unstandardized and standardized beta values and the significance levels of t-tests for the significance of individual independent variables are given in table 4.5. It is seen from the table that all variables are statistically significant in the model at a 5 percent significance level. It is found that the B values for all the variables are positively related to the dependent variable. Again from the standardized beta values, it found that comfort has the maximum effect on overall satisfaction, then emergency services, safety, amenity and road signage respectively.

Table 4.5: Coefficients of criteria

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.

		B	Std. Error	Beta		
1	(Constant)	4.148	.030		140.346	.000
	Factor 1- Amenity	.184	.030	.264	6.220	.000
	Factor 2- Safety	.228	.030	.326	7.702	.000
	Factor 3- Comfort	.307	.030	.439	10.352	.000
	Factor 4- Road Signage	.061	.030	.088	2.071	.039
	Factor 5- Emergency Services	.301	.030	.430	10.150	.000
a. Dependent Variable: Overall Satisfaction						

(Source: Authors, 2017)

So, the overall satisfaction of Rajshahi City Bypass Road Services = 4.148 + 0.184 * (Amenity) + 0.228 * (Safety) + 0.307 * (Comfort) + 0.061 * (Road Signage) + 0.301 * (Emergency Services).

4.4 Proposed Model of User Satisfaction with Rajshahi City Bypass Road Services (RCBRS) As A Whole:

The standardized beta values give the coefficient that affects the overall satisfaction. The higher the rank value of the beta coefficient, the stronger the effect of overall satisfaction.

Figure 4.1: Proposed Model of Road User Satisfaction

(Source: Authors, 2017)

The estimated increase in overall satisfaction with Rajshahi City Bypass Road Services for every unit increase or decrease in these variables is given by the beta values of the respective variables. Thus, if satisfaction with comfort
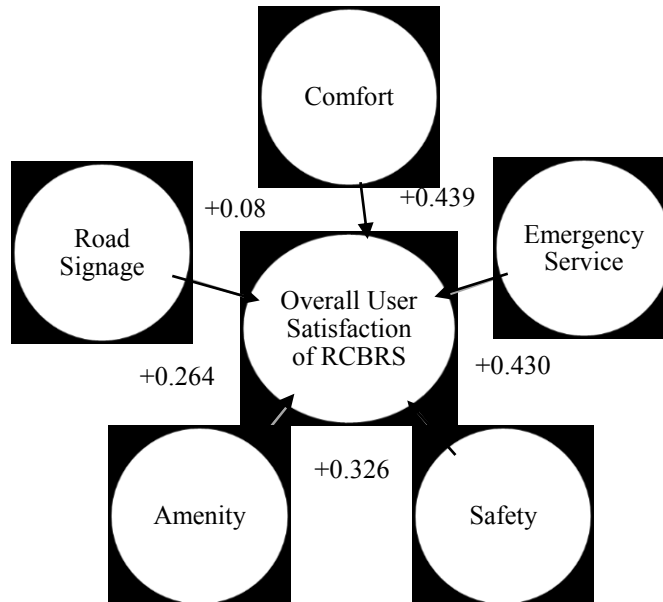
(0.439) increases by one unit, overall satisfaction is estimated to increase by 0.439. Similarly, with the decreases the

satisfaction of safety by one unit, overall satisfaction is then estimated to decrease by 0.326, when other variables remain unchanged.

4.5 Priority Analysis of Various Issues affecting the Future Road Service requirement:

After conducting the satisfaction level, finding out the priority issues are essential. Hence, Expert opinion survey was conducted to assign the relative weight as mentioned earlier. The pre-mentioned step by step procedure is demonstrated as below to obtain the priority issues:

4.5.1   Weighting and normalizing the Criteria Using Pairwise Comparison Method for AHP:

Table 4.6: Pairwise comparison method for AHP

Pairwise Comparison 9 Point Continuous Rating Scale					
Criteria 1/9 1/7 1/5 1/3 1 3 5 7 9 Less important Equal important More important					Eigen Values
Road Services	Comfort	Safety	Amenity	Road Signing	Emergency Services	
Comfort	1					0.038408
Safety	7	1				0.416196
Amenity	3	0.333333	1			0.149699
Road Signing	5	0.333333	0.333333	1		0.112492
Emergency Services	5	0.333333	3	5	1	0.283206

Consistency Ratio: 0.087 (acceptable)

(Source: Authors, 2017)

The first step of the AHP method is making a pairwise comparison matrix of all the factors (Table 4.6). Here, all the factors are compared to each other for intensity judgment. The comparison is taken by the fundamental scale of absolute numbers from Saaty (2008). Here, on the left side, each of the criteria is one by one compared with each criterion listed on top as which one is more important with respect to the goal of selecting the best job (Saaty, 2008). Such as from above table comfort is compared to itself and hence the compared value is one or equally important. Again, when safety is compared to the comfort, safety is assigned as seven (7) or very important with respect to Rajshahi City Bypass Road Services. The present scenario of road crossing facility shown in figure 4.2. This represents how much priority is needed for this safety aspect. So, these criteria are gone topmost priority. However, by this process, every criteria are compared to each other. If the comparison value seems less important, it is assigned as the left side of the unity or as a reciprocal. Like amenity is less important for safety, so it is assigned as one third (1/3). Then all alternatives priorities obtained are combined as a weighted sum to establish overall priorities of the alternatives. The Eigenvalues give the priorities of the criteria. After all, in the sensitivity analysis, it has found that the consistency ratio (c.r) is below the 0.1 which indicates the decision making is acceptable.

Figure 4.2: Present Road crossing scenario in the study area.

4.5.2 *Weighting and Ranking Every Criterion*:

The pairwise comparison matrix is conducted in each of the criteria with respect to each criterion. The relative weight shows the importance of present needs in the Rajshahi City Bypass Road Services. In comfort road surrounding environment is more important (0.43) to the road services. Then width, surface condition and assured journey time respectively. Then, in the safety aspect, the priority of the road crossing facility is more (0.5) than the others criterion. That means this service is urgently needed in the present road services in Rajshahi City Bypass Road. In amenity, the major need is rain shelter or stoppage facility which weight is 0.37. The quality of road signage is found in poor condition (figure 4.3 D1). Hence, this criterion has a high weight. Which indicates the assurance of proper quality and visible of road signage. Emergency services are one of the most important terms or need for better road services. But in the Rajshahi city bypass road, the emergency accident management services are found in very negligible condition (Source: Field Survey 2017). Hence it carries a heavy weight, which is badly needed.

Table: 4.7: Relative weight of the criterion

Criteria	Criterion	Weight	Rank	Consistency Ratio	Acceptance
A. Comfort	Assured Journey Time	0.097	A 4	0.081	Yes
	Carriageway and Pedestrian Width	0.3	A 2		
	Surface Condition	0.17	A 3		
	Road Surrounding Environment	0.43	A 1		
B. Safety	Feeling Safe	0.18	B 3	0.07	Yes
	Security	0.05	B 4		
	Pedestrian Barrier	0.26	B 2		
	Road Crossing Facility	0.5	B 1		
	Public Toilet	0.27	C 2		
	Food/Drinks	0.04	C 6		
	Medical Facility	0.1	C 4		

C. Amenity	Rain Shelter/ Stop facility	0.37	C 1	0.079	Yes
	Parking facility	0.16	C 3		
	Lighting	0.05	C 5		
D. Road Signage	Quality & Visibility Road Signage	0.59	D 1	0.046	Yes
	Adequacy of Road Signage	0.16	D 3		
	Positioning Road Signage	0.25	D 2		
E. Emergency Services	Emergency Telephone Services	0.16	E 2	0	Yes
	Emergency Accident Management	0.84	E 1		

(Source: Authors, 2017)

After evaluated the relative weight from the table 4.6, the rank of the parameters based on their weight is demonstrated in table 4.7 and 4.8. The rank of following issues/aspects determines the priorities of future road service development. Therefore, the topmost rank is safety and the weight is 0.41696. It means that the safety issue/aspect of the Rajshahi City Bypass Road Services is needed highly in future than any other parameter (figure 4.3 B1) including feeling safety, security, pedestrian barrier, and road crossing facility according to their priority rank.

Figure 4.3: Top Priority Wise Present scenario of Road services.

(Source: Authors, 2017)

Table: 4.8 Rank of the Effecting Criteria

Road Services	Weight	Rank
Safety	0.416196	1
Emergency Services	0.283206	2
Amenity	0.149699	3
Road Signing	0.112492	4
Comfort	0.038408	5

(Source: Authors, 2017)

The growing motorizes vehicle govern the intensity of an accident that is major concern issue nowadays. Hereby, the emergency services need to consider with effective care for safe road service development in the present and future. The research also found that the roadside amenities need as a third priority as it aims to improve the road safety as adequate resting facilities for road users will provide time to recover from travel fatigue. The present scenario of roadside amenities (Figure 4.3 D1) is found in a very insufficient and abhorrent condition (Field survey, 2017). Therefore, a green infrastructure and available traffic aid along the roadside can bring the planned and inclusive road network in future as it is a major route that diverts a significant portion of traffic away from the inner city. Since the road user comfort is found in the desirable condition in Rajshahi City Bypass Road, it assigned as less important (Field Survey 2017).

5.   Conclusion and future research:

The study has captured the present road service satisfaction level of the Rajshahi city bypass road and carried out the future road service requirements. The basic premise of this study has been that the satisfaction level of Rajshahi city bypass road is strongly influenced by the road user perceptions regarding their satisfaction with various dimensions of road services. A reference framework has established for understanding and describing the importance of a different variable in affecting road user's satisfaction with Rajshahi city bypass road services. This research has proposed a model with the help of linear regression analysis that can identify and predict the overall satisfaction level based on five criteria. The model perceives that the overall satisfaction level will increase or decrease with the changes in the single unit value of those pre-mentioned criteria. The interesting finding is overall satisfaction is highly affected by the road user comfort parameter. The Beta value for comfort has derived as 0.439, which means with the change of one unit in comfort the overall satisfaction will change 0.439 while other parameter remains unchanged. That is to say, if another relevant parameter can develop, the road user satisfaction level will increase significantly. Satisfaction level for the various road services was collected from the different classes of road user. The mean rank of satisfaction analysis indicates that lighting is in the most satisfactory condition of Rajshahi city bypass road. The continuous sequence of mean rank satisfaction is a surface condition, emergency telephone service, emergency accident management, Adequacy of road signing, feeling safe, road environment and so on. The rank of road crossing facility, rain shelter is found in the most dissatisfied condition as these facilities are absent or less in quantity.

The requisite road user requirement has derived by analytical hierarchy process (AHP) equipped with expert opinion. AHP is particularly helpful for 1) evaluating complex multi-criteria alternatives, 2) determining the priorities of the elements at each level of a decision hierarchy and 3) adjusting the priorities to determine future road user requirement. All road user requirements have structured into different hierarchy level. The method perceived that the weighted rank of safety is in the highest position, Emergency service is in the second position, Amenity is in the third position, road signage is in fourth position and comfort is in the fifth position. Concern authority needs to emphasize safety and emergency service issues while providing road service facility. These findings would appear to be generalizable to other cities as well since the dimensions remain less or more the same. In conclusion, it can be express that individuals often perceptions about particular aspects but it is the total configuration of all these aspects that determine overall road user satisfaction of Rajshahi City Bypass Road.

The current study is associated with the one route of Rajshahi which can help to take economic decision making for every service provider. The sample of this study was based on the respondents of the specific geographic area. The

study, therefore, is limited to the extent that the sample cannot be projected for the whole city. Moreover, the transportation survey always costly, time consume and require a large amount of manpower. Therefore, only the rush hour was considered in this research. That's why, the urban planners, transport planners, researcher, scientist need to consider the whole road network condition through the whole time duration for the Rajshahi district. Thus the findings will more helpful for sustainable economic decision making of the road users.

Acknowledgments

Appendix A.

A.1. Proposed Model Summary:

Table A1: Statistical fitness of proposed Model

Model	R	R Square	Adjusted R Square	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
1	.749	.562	.553	.562	62.495	5	244	.000

A.2. Three level hierarchy of road user requirement:

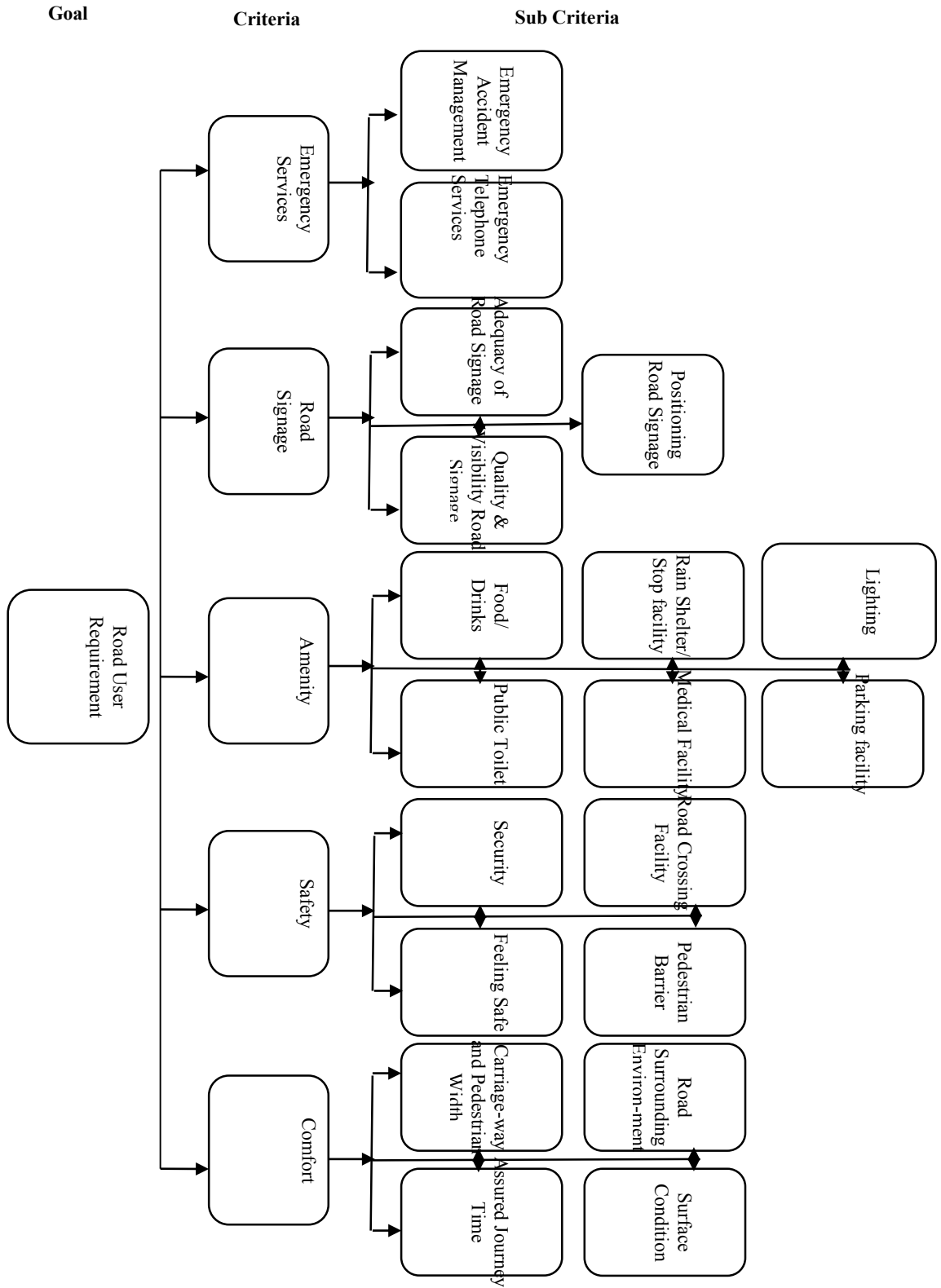**Goal**　　　　**Criteria**　　　　　　　　　**Sub Criteria**

Figure A1: Three level hierarchy

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