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AN ASSESSMENT OF ROAD LANDSCAPE BY ANALYSING PEOPLE'S PERCEPTION AND EXPERT OPINION OF KHULNA CITY, BANGLADESH

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ABSTRACT

Road landscape management is essential for a sustainable environment. This study is conducted to show the existing road landscape condition of Khulna city. Both qualitative and quantitative analyses have been done to analyze the existing condition of the road landscape. Urban Landscape Quality Index (ULQI) and Analytical Hierarchy Process (AHP) are used for qualitative and quantitative analysis respectively. In ULQI, the expert's opinion has been compared with the people's perception and 70.6% of similarity is found. From AHP analysis, KDA Avenue is ranked first which indicates that this road possesses the best road landscape and Sher-E-Bangla road is ranked last. The study finds that the road landscape of Khulna city is not in very good condition. For improving the livability and sustainability of Khulna city, investigation of the road landscape both from quantitative and qualitative perspective may establish the basis for future analysis.

Keywords: *Landscape; road landscape; qualitative analysis; quantitative analysis; AHP; ULQI.*

1. INTRODUCTION

Landscape planning and management combine the conservancy of landscape diversity alongwith sustainable use of land resources. As a result, the need for landscape planning and management strategies is growing day by day (Simensen *et al.*, 2018). Landscape and integrated environmental study often go hand in hand as they are considered as a uniform concept (Nega *et al.*, 2012). In recent time 'landscape approaches' have achieved considerable attention in scientific fields as it incorporates integrated land management system (Padonou *et al.*, 2017). Besides, the landscape level is central in specialized scientific studies, e.g. as an organization working with different biodiversity levels. Moreover, landscape management is essential for a sustainable environment and territory and its socio-cultural issues (Jones *et al.*, 2008; Gopal *et al.*, 2016).

Roads are the channels of movement (Fotheringham *et al.*, 1996). Sustainable road indicates multimodal and well-constructed right of way which blends road accessibility with health and a livable environment (Foth *et al.*, 2013). Sustainable roads help to achieve the 3 E's: environment, economy, and equity. Road landscaping develops roads in an ecologically sensitive manner which makes roads sustainable (Singh *et al.*, 2018). Road greens are an essential feature of the road landscape. Trees are planted alongside the roads to provide sheds and shelter for pedestrians (Naderi and Raman, 2005). They also consume greenhouse gasses emitted by vehicles and reduce environmental pollution (Halder and Islam, 2015). Moreover, road greens add a verity in road appearance and protect roads from erosion and damage (Jorgensen and Gobster, 2010).

Roadside plantation not only acts as noise buffers but also cools the environment (Medl *et al.*, 2017). Trees planted on the median decrease onward glare as a result the rate of road accidents lessens (Rehan, 2013). Road landscape also separates pedestrian traffic from vehicular traffic (Mo *et al.*, 2017). Despite all the benefits of the plantation, the number of roadside trees is decreasing due to the rapid expansion of urban cities and industrial areas (Yiling and Ying, 2015). Roadside land encroachment is also a reason for roads losing their aesthetic attire (Said and Samadi, 2016). Moreover, an awareness of people about the benefits of the road landscape is also the main reason for the lack of road landscaping (Gong *et al.*, 2005).

Sustainable road landscape plays an integral part in landscape planning as they link livability with aesthetic visualization of roads (El-Shimy and Ragheb, 2004). By providing road landscape components in a planned way helps to achieve a sustainable road landscape (Sahraoui *et al.*, 2016). Different road landscape components are essential to achieve a sustainable road landscape. Description of some road landscape components are given in Table 1. In Bangladesh, the importance of both road landscape has been gained less emphasis by both government bodies and local people. As people are not concern about the impact of road landscape on the socio-economic development of an area as well as the environmental benefit achieved from road genes is also neglected. Road landscape projects are gaining attention in the capital city of Dhaka. For example, "the Bonsai beautification project" at Airport road in Dhaka city (The Daily Star, 2017).

Khulna Development Authority (KDA) is mainly responsible for development works along with Khulna City (Roy *et al.*, 2018). According to Khulna City Master Plan (2001-2020), the main target of KDA for improving

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roads is to reduce traffic congestion and road accidents. For this purpose. Road signages, road lights, speed breakers, etc. are provided. Moreover, KDA has also run different road improvement projects, for example, the Rupsa Bridge Approach and the Khulna City Bypass road project. In this study, the existing road landscape condition of Khulna city is assessed both qualitatively and quantitatively. Roads are ranked according to their landscape quality. Both experts' opinion and people's perception survey has been done and some recommendations are provided for the betterment of roadside landscapes of the study roads of Khulna city.

Table 1: Description of road landscape components

Element	Description
Sidewalks	Sidewalks ought to be intended to give protected, appealing, intriguing, and agreeable spaces for people on foot by giving all around outlined and facilitated tree plantation, road lighting, and decorations (Foth *et al.*, 2013).
Planters	Planters add texture color and shades to a landscape. They can also emphasize the visual attraction of a place (Zhang and Zhu, 2006).
Road furnishing	They include road lights, dustbins, roadside sitting benches, etc.
Signage	Signage plays an integral part in the urban road landscape as it properly channelizes vehicular and pedestrian traffic (Steinitz, 1990).
Trash receptacles	Trash receptacles are the most used road landscape components. They should be placed strategically to cope with pedestrian demand
Bus shelter	They are provided mainly at road junctions to cover the travelers from climatic events. Proper signs, seats, and waste bins should be provided for the good function of bus shelters (Foth *et al.*, 2013).
Medians	Medians make roads more pedestrian friends by lessening the number of accidents. A well-furnished median can change the aesthetic look of a road (Kamičaitytė-Virbašienė and Samuchovienė, 2013).
Curbs	Curb ramps are essential for disable persons, babies, old citizens as they connect footpaths with roads (Steinitz, 1990).
Crossing	Crosswalks are a basic piece of the person on foot organize. Upgraded crosswalk clearing can make drivers more mindful of the person on foot movement (Kamičaitytė-Virbašienė and Samuchovienė, 2013).
Café spaces	Café spaces give a functioning road facing and common areas for orchestrated and unconstrained social connections. Indeed, even thin walkways can oblige café spaces. (Zhang and Zhu, 2006).

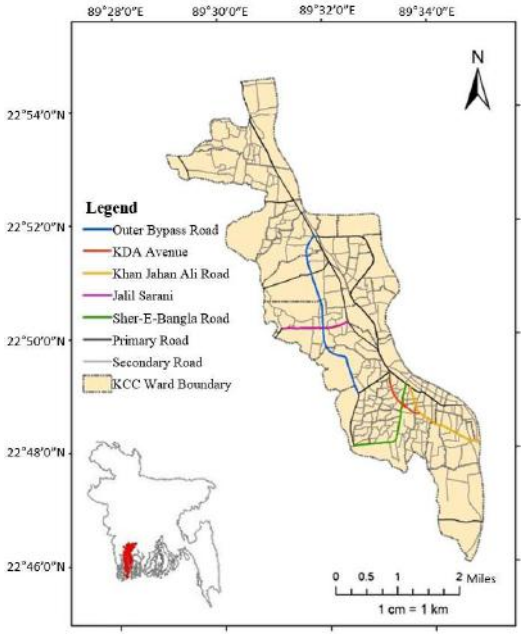


Figure 1: Study road map of Khulna City

2. METHODOLOGY

2.1 Study area

The industrial city Khulna has 1215 roads covering 824.47 km (Khulna City Master Plan, 2001-2020). Due to the limitation of the study all the roads of Khulna city were not incorporated. Only five major roads of Khulna city are chosen as study areas based on their usage and class (e.g. primary, secondary, and tertiary). The selected roads and their starting and ending points are given in Figure 1 and the total length of the study roads are described in Table 2.

Table 2: Selected study roads

Study Area	Start and endpoint	Length
Outer Bypass road	Notun Rasta to Sonadanga Bus Terminal	6.6 km
Khan Jahan Ali Road	Rupsa Ghat Road to Ferighat Road	3.1 km
KDA Avenue	Shibbari Mor to Royal Mor	2.0 km
Sher-E-Bangla road	Gollamari to Power House mor	3.8 km
Jalil Sarani	Boyra Girl's College to Rayer Mahal	2.2 km

2.2 Method

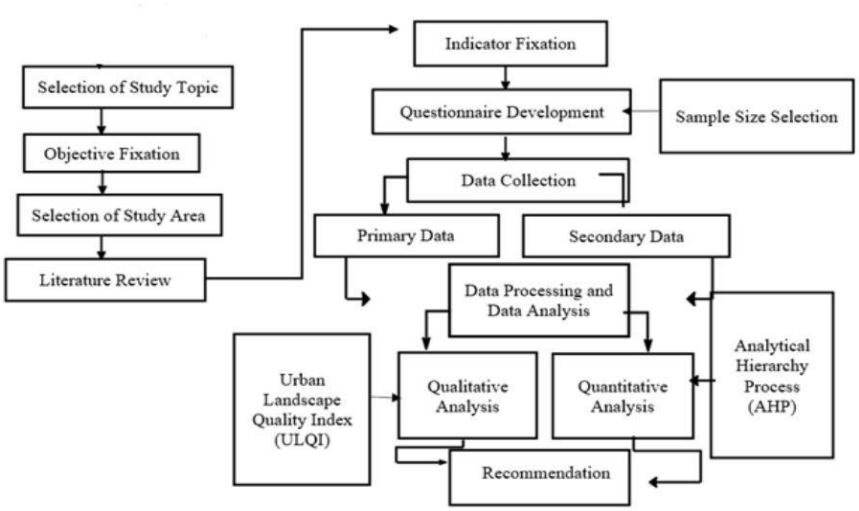


Figure 2: Methodological framework of the study

2.2.1 Indicator Fixation

Seven road landscape indicators are fixed after a rigorous literature review. Sub-indicators are also fixed under each indicator. Selected road landscape indicators and sub-indicators are described in Table 3.

Table 3: Selected road landscape indicators

Indicators	Sub-indicators
Significance of road (C1)	Frequency of use, Connectivity with CBD, Connectivity with landmarks
Cross-sectional elements of the road (C2)	Median, road width, signpost, footpath, visual clearance
Urban infrastructure (C3)	Sitting bench, dustbin, street light, toilet, traffic signal, passenger shed
Green infrastructure (C4)	Park, playground and public garden, median and roadside tree, maintenance of trees, topiary
Surrounding building assembly (C5)	Building density, building color, building age, the architectural quality
Monitoring and maintenance (C6)	Availability of gardener, street cleaner, and waste collector, fencing, and protection of trees
The existing problem of the road (C7)	Indiscriminate waste dumping, waterlogging, footpath encroachment

(Bruni, 2016)

2.2.2 Sample Size Determination

Studying the entire population of an area is not convenient. This is the reason for using sampling which allows us to take a certain number of populations from a large population for statistical analysis. Various type of sampling methods is available which depends on the type of statistical analysis is going to be done. In this study, the Stratified Sampling method has been used (Taherdoost and Group, 2017)

In the stratified sampling method, the entire population is divided into subgroups and the final population is randomly selected proportionally from various subgroups (Shi, 2015). Stratified sampling equation is given below:

$$n_0 = p(1-p)\left[\frac{z^{\alpha}}{d}\right]^2 \quad (1)$$

Here, n_0= sample size, z= value of the corresponding to an area $(1-\alpha)/2$ from the center of the standardized normal distribution, d= error margin, p= proportion one of the two characteristics in the population (when p is unknown, the maximum possible proportion value p= 0.5)

If p has no logical explanation, the sample size can be estimated by letting p=0.5. It is assumed that the error margin is 5% (d=0.05), z=1.96% (at 95% confidence interval). So, the initial sample size is

$$\mathrm{n}_0 = 0.5 * (1-0.5)\left[\frac{1.96}{0.05}\right]^2 = 384.16$$

The sample size is further adjusted by using the following equation,

$$n = \frac{n_0}{1+\frac{n_0}{N}} \quad (2)$$

Here, n= total sample size, n_0= initial sample size, N= total number of buildings beside the road (a total number of 748 buildings and structures are found beside the study roads)

$$\mathrm{n} = \frac{384.86}{1+\frac{384.86}{784}} = 253.81 = 254$$

So, the actual sample size is 254. Due to the lack of manpower, time, and budget, a total of 200 survey is conducted for this study. Sample size of different study roads are described in Table 4.

Table 4: Sample size of different study roads

Road name	Number of structures and building at two sides of the road	Sample size for each road
Outer Bypass Road	103	28
Jalil Sarani	110	29
Sher-E-Bangla Road	195	52
KDA Avenue	139	37
Khan Jahan Ali Road	201	54
Total	748	200

2.2.3 Data Collection

For collecting primary data, a reconnaissance survey, people's perception survey, and an expert opinion survey were done. Data has been gathered from 9 experts who are academics and professionals of universities (Khulna University and Khulna University of Engineering & Technology) and KDA/KCC. Secondary data regarding the number of road lights, waste bins, waste collection process of different study roads, current road beautification projects, and different organizations associated with this, etc. both quantitative and detailed information was collected from different governmental offices, for example, Khulna City Corporation (KCC), Khulna Development Authority (KDA), Roads and Highways Department (RHD).

2.2.4 Data Analysis

Quantitative analysis

A quantitative examination is a scientific and measurable strategy for contemplating conduct and foreseeing results that speculators and administration use in their basic leadership process (Shadparvar *et al.*, 2013). Quantitative analysis provides a numerical result of any situation and a survey is needed to gather a dataset. A previous study with measurable data is generally used for quantitative analysis (Swetnam *et al.*, 2017).

Analytical Hierarchy Process (AHP)

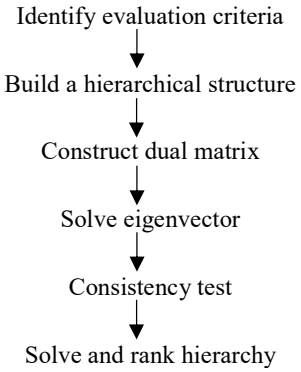


Figure 3: Flow Diagram of AHP

(Liang & Peng, 2017)

AHP is used for complex and unstructured situations where decision making is tough. AHP ranks the various criteria of the situation into a hierarchy and thus decisions are made. Figure 3 shows the overall process for calculating AHP. This method constructs with six steps. AHP is a decision-making method with multiple goals or standards. In this method, complicated and unstructured problems are divided into several groups and organized into hierarchies. AHP is done using six steps. At first, different criteria to evaluate the situation has to be identified and the criteria are arranged into a hierarchical matrix according to their characteristics. If there are n criteria/factors for the following complex situation then a total of $\mathrm{C2n} = \frac{\mathrm{n(n-1)}}{2}$ pairwise comparison is needed (Saaty, 2016).

For constructing the pairwise comparison matrix a questionnaire is made for expert opinion surveys consisting of the criteria/factors affecting the current situation. Experts make comparisons among those criteria and give a score to each criterion using a nominal scale. The nominal scale has a range of scores from 1 indicating "equal importance" to 9 indicating "absolute importance". After the expert option survey, the scores of each factor are averaged and a pairwise comparison is done among those criteria using the average score. For pairwise comparison, a comparison is made between two criteria indicating their relative importance. Using the nominal scale, the relative importance values look like 1/9, . . ., 1/2, 1, 2, . . ., 9. The pairwise comparison matrix A, as shown below:

$$\mathbf{A} = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & . & . & a_{1n} \\ 1/a_{12} & 1 & . & . & a_{2n} \\ . & . & 1 & . & . \\ . & . & . & . & . \\ 1/a_{1n} & 1/a_{2n} & . & . & 1 \end{bmatrix} = \begin{bmatrix} W_1/W_1 & W_1/W_2 & . & . & W_1/W_n \\ W_2/W_1 & W_2/W_2 & . & . & W_2/W_n \\ . & . & . & . & . \\ . & . & . & . & . \\ W_n/W_1 & W_n/W_2 & . & . & W_n/W_n \end{bmatrix},$$

Where aij indicates the cross-comparison of decision criteria i and j. The weight of the criteria is calculated after the pairwise matrix is established. The following equation has been used to calculate the maximum eigenvalue and eigenvector:

$$\mathrm{W_i} = \frac{1}{\mathrm{n}}\left(\sum_{\mathrm{i=1}}^{\mathrm{n}} \frac{\mathrm{a_{ij}}}{\sum_{\mathrm{i=1}}^{\mathrm{n}} \mathrm{a_{ij}}}\right) \quad (3)$$

The eigenvector wi is multiplied with pairwise comparison matrix A to have a new vector Wi′ and then the following equation has been used to get the maximum eigenvalue λ_{max}:

$$W_i' = \mathbf{A} \times W_i = \begin{bmatrix} W_1/W_1 & W_1/W_2 & . & . & W_1/W_n \\ W_2/W_1 & W_2/W_2 & . & . & W_2/W_n \\ . & . & . & . & . \\ . & . & . & . & . \\ W_n/W_1 & W_n/W_2 & . & . & W_n/W_n \end{bmatrix} \begin{bmatrix} W_1 \\ W_2 \\ . \\ . \\ W_n \end{bmatrix} = \begin{bmatrix} W_1' \\ W_2' \\ . \\ . \\ W_n' \end{bmatrix}$$

$$\lambda_{max} = \left(\frac{1}{n}\right)\left(\frac{W_1'}{W_1} + \frac{W_2'}{W_2} + \ldots + \frac{W_n'}{W_n}\right).$$

Consistency index (CI) and consistency ratio (CR) are calculated to check whether there is consistency in the pairwise comparison matrix or not. A consistency test is also done for the entire hierarchy. The following equations are used to calculate CI and CR:

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (4)$$

Where, λ_{max} indicates maximum eigenvalue and n indicates the number of evaluation criteria. According to Saaty (2008) the excellent value of CI < 0.1 and the maximum acceptable limit CI < 0.2. To calculate consistency ratio (CR), the following formula (4) has been used:

$$CR = \frac{CI}{RI} \quad (5)$$

Here, RI indicates a mean random consistency index which is dependent on the number of criteria/factors responsible for the situation. RI value depends on the number of landscape components considered in the study. RI values are given for 1 to 9 landscape criteria in the Table 5.

Table 5: Random Consistency Index (RI) table

Number of criteria	1	2	3	4	5	6	7	8	9
RI value	0	0	0.58	0.9	1.12	1.24	1.32	1.44	1.45

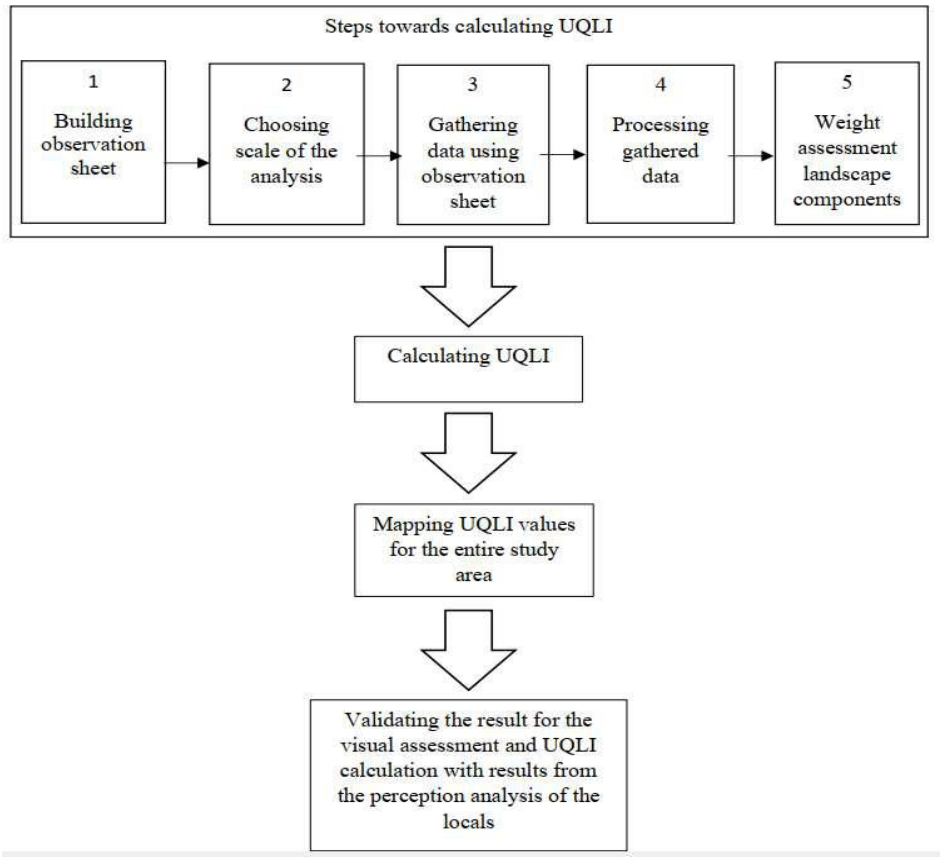
(Liang & Peng, 2017)

Qualitative analysis

The qualitative study incorporates description, attributes, the implication of various criteria or factors of a situation without giving their accurate quantity (Hassan, 2017). It is a scientific strategy to accumulate non-numerical information (Jumeau *et al.*, 2017).

Urban Landscape Quality Index

Urban Landscape Quality Index (ULQI) calculation is a five-step approach (Bishop, 1996). At first, an observation sheet was built for collecting expert opinions. Then the scaling method was chosen which is a five-level Likert Scale (5 means very good landscape condition and 1 means very poor landscape condition). The gathered data was input into a centralized database and finally, weights were assigned. The steps for calculating ULQI is described in Figure 4.



(Gavrilidis *et al.*, 2016)

Figure 4: Flow diagram of calculating ULQI

A map was created using the calculated ULQI score of the entire study area. Another map was also prepared to show the result of the people's perception survey which reflects the perception of local inhabitants of the study area. Both of the maps were compared and the result depicts the similarity and difference between the expert's opinion and people's perception. Seven road landscape components were selected for visual assessments after a rigorous literature review process. Weights were assigned by the experts using a Likert scale ranging from 1 to 5, where the value 1 represents a lower impact of the specific landscape component and value 5 represents a higher impact of the component on road landscape. The following formula has been used to calculate the index:

$$\mathrm{ULQI} = \frac{\mathrm{Tcs}}{14}$$

Where, Tcs is the sum of the score of seven road landscape components and the value 14 indicates the absolute score of the seven road landscape components when all the items included in the seven road landscape components have the value 1 (very good landscape). This coefficient was reached by using the following algorithm:

$$\mathrm{Tcs} = \sum \mathrm{cs}$$

$$\mathrm{cs} = \frac{\sum \mathrm{is}}{\mathrm{n}} * \mathrm{cw}$$

Where, cs is each landscape component's score, is is the score of each item included in each landscape component, n is the item number in each component and cw is the weight of the component. So, the final equation of ULQI is:

$$\mathrm{ULQI} = \frac{\sum \frac{\sum \mathrm{is}}{\mathrm{n}} * \mathrm{cw}}{14}$$

3. RESULTS AND DISCUSSION

3.1 Field Survey Study

The findings from the field survey of the study roads have been summarized in Table 6. The existing condition of the study roads can easily be found by comparing the information in Table 6.

The existing condition of the study road has been physically assessed by analyzing the existing condition of 11 road landscape components. From the field survey study, it can be seen that KDA Avenue possesses all the 11 road landscape components. Road width highest at KDA avenue which is 25.13 meter. 12 small dustbins are also found on this road. On the other hand, it can be seen that Sher-E-Bangla road lacks sitting bench, public toilet, parks, playground, and public garden beside the road. Moreover, the median is not established at this road, and the footpath is also not well defined. The lack of all these components indicates the poor landscape condition of Sher-E-Bangla road.

Table 6: Summary table of road landscape elements of study roads

Components	Road Name									
	Jalil Sarani		Outer Bypass road		Sher-E-Bangla road		KDA Avenue		Khan Jahan Ali road	
	Availability	Quantity	Availability	Quantity	Availability	Quantity	Availability	Quantity	Availability	Quantity
Median	Yes		Yes	1.52m	No		Yes	2.99m	Yes	0.98m
Footpath	Yes		Yes	2.25m	No		Yes	2.66m	Yes	2.01m
Road width	-	20.87m	-	20.87m	-	20.87m	-	25.13m	-	9.84m
Signpost	Yes	4	No		Yes	4	Yes	4	Yes	4
Sitting bench	No		No		No		Yes	8	No	
Dustbin (Small dustbin+ STS*)	Yes	6	Yes	8+15	Yes	6	Yes	12+6	Yes	10+4
Street light	Yes	20	Yes	80	Yes	20	Yes	80	Yes	60
Public Toilet	No		Yes	1	No		No		No	
Traffic island	Yes	2	Yes	1	Yes	2	Yes	4	Yes	2
Passenger Shed	Yes	2	Yes	1	Yes	2	Yes	4	Yes	2
Park and playground	No		Yes	1	No		No		Yes	1

(*STS= Secondary transfer station) (Field survey, 2019)

3.2 Urban Landscape Quality Index (ULQI)

For calculating ULQI, data has been gathered from 9 experts who are academics and professionals of universities and KDA/KCC. They are familiar with the roads of Khulna City. Photographs were shown of different road

sections with landscape features and briefed about the roads. The average weight of each of the seven-road landscape are given in Table 7.

Table 7: Weight assignment by experts for the road landscape components

Road landscape component	Weight	Weight assignment motivation
Significance of road (C1)	2	The nearest road to CBD is found beautifully landscaped than the farthest road from CBD. Roads connected with major landmarks are also properly landscaped. They have an impact on the local landscape but do not occur at all on the roads in a city.
Cross-sectional elements of the road (C2)	4	They are the major elements of the roads that cannot be ignored while building a road. They reflect comfort, safety, frictional resistance, drainage, the function of a road. So, they are major components of the road landscape.
Urban infrastructures (C3)	4	They provide the facility for road users. As such they are considered major components.
Green infrastructures (C4)	4	They provide scenic beauty as well as lessen the air pollution level of roads. As such they are considered a major component.
Surrounding building assembly (C5)	1	The elements included in this component do not represent major landscape elements and cannot influence the general quality at a wider range as they occur only in some areas
Monitoring and maintenance (C6)	2	It is important to monitor and maintain the road regularly to increase its functionality.
The existing problem of the road (C7)	2	The existing problems of roads should be identified and solved to increase its functionality and beauty.

(Field survey, 2019)

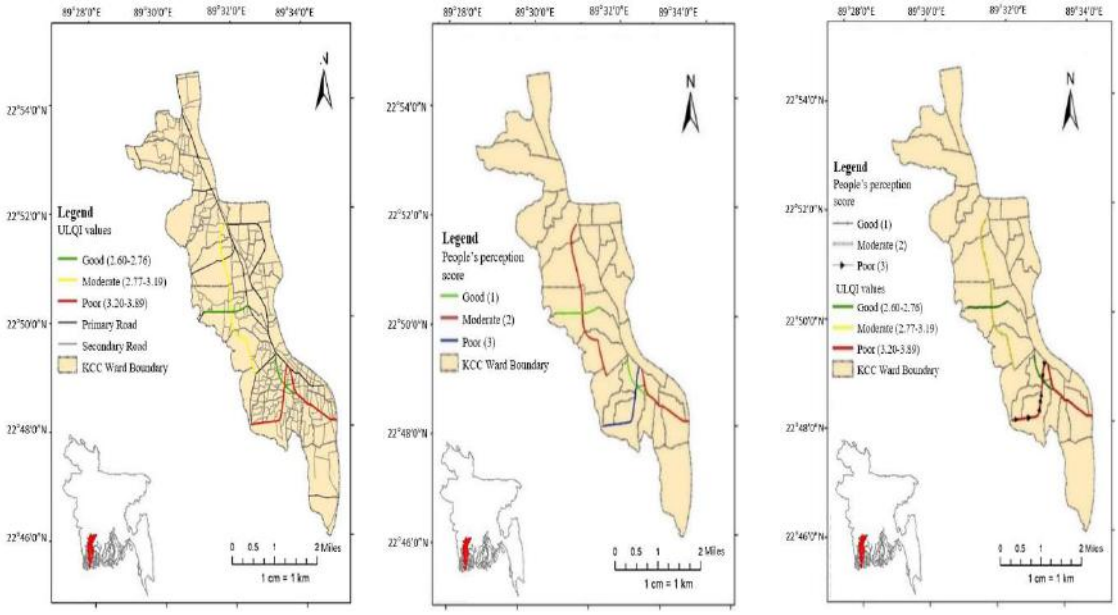


Figure 5: ULQI values of study roads of Khulna city (Top left); People's perception map on road landscape quality of study roads (Top right); Comparison between ULQI values and public perception over the quality of urban landscape (bottom)

Table 8: ULQI values for study roads

Road name	ULQI values	people's perception score
Outer Bypass road	3.19	2
Jalil Sarani	2.76	1
KDA Avenue	2.60	1
Khan Jahan Ali road	3.56	2
Sher- E- Bangla road	3.89	3

Table 8 explains the ULQI scores of the study roads based on the expert opinion survey. The lower value of ULQI shows the good landscape condition whereas a higher value of ULQI shows the poor condition of the landscape. The ULQI value of the study roads ranges from 2.76 to 3.89. KDA Avenue and Jalil Sarani have got the lowest ULQI values as the road landscape components of this road are in good condition than the three other study roads.

As KDA Avenue is situated at the center of Khulna city and KDA office, different offices are situated on this road. The road landscape components of this road are in good condition and are maintained properly. Sher-E-Bangla road has got the highest ULQI value. It is a primary road. Though this road connects Khulna University with different parts of the city, the road landscape component is not in good condition. Different cross-sectional elements like the median, the footpath is missing in this road. Maintenance of this road is also poor.

To visualize the ULQI values in Arc GIS and compare with people's perception, the ULQI values are rescaled from 1 to 3, where 1 indicates good landscape and 3 indicates poor landscape. It is the same scale used in people's perception survey. Figure 5 shows that the comparison between the expert opinion assessment of the road landscape and the analysis based on the landscape quality of people's perception emphasized 70.5% similarity. This means that 147 out of 200 people perceived the landscape quality following the ULQI values. The differences occurred because people's perception is built on personal and subjective criteria. As a developing country, in Bangladesh, the importance of road landscape is not emphasized and people have less concern with the importance and the impact of road landscape on socio-economic and environmental aspects.

3.3 Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is calculated based on expert opinion. At first, data is collected from 9 experts who are academics and professionals of universities and KDA/KCC.

$$C2n = \frac{n(n-1)}{2}$$

The following equation is used to get them a 7*7 pairwise comparisons. Here n=7 as in this study 7 road landscape components have been used (from C1 to C7). A total of 21 pairwise comparisons are done. The pairwise comparison matrix of the component weights are given in Table 9.

Table 9: Pairwise comparison matrix of road landscape components

	C1	C2	C3	C4	C5	C6	C7
C1	1.00	0.60	0.60	0.50	1.20	0.86	1.00
C2	1.67	1.00	1.00	0.83	2.00	1.43	1.67
C3	1.67	1.00	1.00	0.83	2.00	1.43	1.67
C4	2.00	1.20	1.20	1.00	2.40	1.71	2.00
C5	0.83	0.50	0.50	0.42	1.00	0.71	0.83
C6	1.17	0.70	0.70	0.58	1.40	1.00	1.17
C7	1.00	0.60	0.60	0.50	1.20	0.86	1.00

For the pairwise comparison matrix, CI = 0.00015 and CR = 0.0001136 is found out. Here CI < 0.2 and CR < 0.1. So, it can be said that the pairwise comparison matrix has achieved accepted reliability. (Here, RI = 1.32, as n=7 & road landscape components are considered in this study.)

The relative weights of the criteria are given in Figure 6.

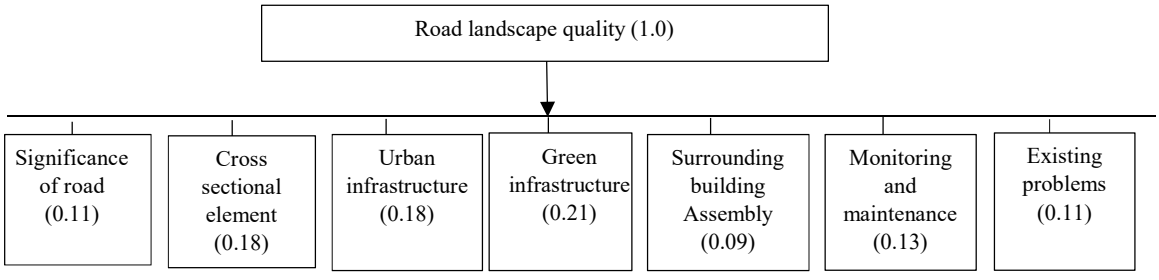


Figure 6: Hierarchy and weights of road landscape components

Table 10: Pairwise matrix calculation result of study roads under each road landscape components

Road name	c1	c2	c3	c4	c5	c6	c7
Outer Bypass road	0.18	0.219	0.186	0.197	0.207	0.181	0.253
Jalil Sarani	0.185	0.231	0.22	0.285	0.199	0.238	0.256
KDA Avenue	0.233	0.244	0.225	0.301	0.238	0.26	0.167
Khan Jahan Ali road	0.22	0.175	0.199	0.101	0.184	0.185	0.142
Sher-E-Bangla road	0.183	0.131	0.17	0.115	0.171	0.137	0.181

Table 11: Relative weights and rank of study roads

Road name	Weight	Rank
Outer Bypass road	0.20	3
Jalil Sarani	0.24	2
KDA Avenue	0.25	1
Khan Jahan Ali road	0.17	4
Sher-E-Bangla road	0.15	5

Table 10 shows the pairwise matrix calculation result of study roads under each road landscape components. After solving these matrices, the weight for each road is found. The highest weight of the road gets the highest rank. Table 11 illustrates that KDA Avenue is in good landscape condition as this road has gained the highest weight from experts. However, Sher-E-Bangla road has ranked last which indicates the poor condition of this road according to the experts' opinion. Both the qualitative (ULQI) and quantitative (AHP) analysis indicated a similar result. In both analyses the road landscape condition of KDA Avenue is good and Sher-E-Bangla road is poor. This can easily be understood from the field survey study. From the field survey, it can be seen that KDA Avenue possesses all the 11 road landscape components; whereas, Sher-E-Bangla road lacks different components, especially the road median and well-defined footpath.

4. CONCLUSIONS

This study was conducted to assess the existing road landscape condition of Khulna city and rank those roads according to their landscape quality. The study finds that the road landscape of Khulna city is not in very good condition as the road landscape components are not in very good condition. Among the five study roads, KDA Avenue and Jalil Sarani are found in good landscape conditions. Sher-E-Bangla road is found in poor landscape conditions. For the people's perception survey, this study considered only the residents living beside the roads and for the expert opinion survey, nine experts related to the urban landscape field are considered. As such the study result can vary if more people and experts are engaged. Different govt. organizations like Khulna City Corporation, Khulna Development Authority (KDA), Roads and Highways Department (RHD), etc. can take initiatives to engage or encourage civil society to be involved in the maintenance and monitoring of road landscape which will greatly benefit the city environment. A high level of landscape quality can increase the productivity of people due to mental relaxation generating overall happiness. The lack of planning, poor city management, social imbalances, and low quality of life standards affect landscape quality. For improving the livability and sustainability of Khulna city, investigation of the road landscape both from quantitative and qualitative perspectives will provide the basis for future analysis.

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