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Urban Transformation through River Restoration Model: An Empirical Analysis on the Buriganga in Bangladesh

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Abstract:
The purpose of the study is to develop comprehensive sustainable river restoration model in the process of urban transformation to ensure clean water supply, get rid of environment pollution, take prompt action against river encroachment and develop alternative river transportation channel to solve the problem of traffic jam in Dhaka city. The research is mainly based on primary data generated from interview to environmentalists and engineers. It has been evidenced from the study that mega projects of government regarding restoration of the river Buriganga have been failed significantly where a sustainable solution is urgent need. The paper suggested that the proposed comprehensive river restoration model should be implemented by Bangladesh Army for successful project implementation. The study will support policy makers to design a clean and healthy city from a polluted city through cost effective transformation process.

Keywords: *The Buriganga, environment pollution, urban transformation, river restoration*

1. Introduction

In the southern part of the north region of Bangladesh, the Buriganga is located near the confluence of the upper Meghna and the Padma rivers. Some upstream canals and rivers like Jamuna, Dhaleswari, Turag, Tongi Khal and Karnatali influence the flow and hydrology of the Buriganga. The Buriganga was renamed from one branch of the Ganges river which flowed into the Bay of Bengal through the river Dhaleswari and lost its connection over time with the primary flow of the Ganges. In early seventeenth century Mughals had set up their region in Dhaka considering the economic value, beauty and prime location of the river Buriganga. Since then, the river attracted the Chinese, British, Portuguese, Arab and French traders and admirers as the main waterway for trading. Gradually, the river has become chemically dead due to run off of poisonous waste from industry, free flow of sewage from millions of homes, direct dumping of waste from local people and encroachment.It has become death hazard due to not having any oxygen in water, no habitat for fishes, horrifying spectacle of black greasy water, pungent smell etc. However, water cycle in the Buriganga would find some relief as all the tanneries have been forced to fully shift from Hazaribagh to Savar newly established tannery village in April 2017 after several deadlines of relocation, penalties, disconnection of utilities, and unemployment of labors. Tanneries of Hazaribagh used to dispose about 40000 tons of waste into the river per day (Financial Express, April 11, 2017). According to the opinion of water resource and climate change specialist Ainun Nishat, policy makers will response if people raise their voice from public awareness for the right cause to tackle problems of the Buriganga with technically sustainable solution (The Daily Star,January 01, 2016).

From the literature review it has been evidenced that restoration of the Buriganga is economically and socially justifiable (Alam, K, 2008) but no model has been found to resolve the problem of the river yet. Bhowmik A.K. (2008) has only identified some reasons for the Buriganga pollution and some measures of the government but he did not design any detailed comprehensive plan or model to take measure against the causes. However, he proposed establishing ETP for each and every industry that uses the river. As most of the previous literatures focused on only the identification of the causes of the Buriganga pollution, it has become significant to draw out technically sustainable solutions for the problems. Proposed comprehensive model has been undertaken to bring out approaches to solve the problems of the Buriganga pollution with technically sustainable urban river restoration process.

The research paper has been designed in the following manner where section 2 justifies the study. Section 3 depicts the objectives of the study. Section 4 describes the research methodology in light with model development, research design and data collection. Section 5 consists of literature review. Empirical analysis and findings have been shown in section 6 through model development. Finally, section 7 concludes the study with key findings and recommendations. Further research direction has been outlined in section 8.

2. Rational of the Study

2.1. Relationship of the Objectives to Current State of Knowledge on the Subject

Several efforts from the public and private sectors to restore the river Buriganga have been failed in last 15 years incurring huge cost. That is why; it is highly required to develop a comprehensive model to solve the problems with technically sustainable solution of the problems. Hence, a compact sustainable river restoration model has been proposed based on centralized tunnel with ETP and WTP, waste management outside tunnel and social awareness against river grabbing. Review of several literatures show that researchers mainly conducted research based on the water quality of the Buriganga where model-based solution has not been found or proposed yet. The study will provide insights to the policy makers to work with restoration of the dying river Buriganga in Bangladesh.

2.2. Relevance of the Proposed Study to National Priorities

- Public health and quality of life of around 1.18 crore (census 2011) people of Dhaka are under threat due to increasing level of water pollution resulting from industrial waste along with manmade waste.
- Regional bio diversity is under threat due to pollution, water logging problems, erosion and grab of water body and wetland around Dhaka.
- According to the latest (2017) SDG index prepared by United Nations Sustainable Development Solutions Network as a progress report, Bangladesh scored especially low in the SDG 9 that takes industry, innovation and infrastructure into consideration and SDG 11 which considers sustainable cities and communities (Financial Express, July 10, 2017).
- As Dhaka is located on the riverfront of the Buriganga, a technically sustainable solution of urban river restoration may bring significant urban transformation. If the proposed river restoration project is successfully implemented taking attention towards removal of water pollution and connectivity with other rivers then it can play vital role as alternative transportation channel surrounding Dhaka city to get rid of traffic jam.
- The result of the study would help to better understand and way out the technically sustainable solution of the problems of the Buriganga pollution that have been remaining unsolved since long.

3. Objectives

The general objective of the proposed research project is to study the present status of the dying river Buriganga in Bangladesh and finding out comprehensive model based technically sustainable and feasible solution of the problems of the river in the process of urban transformation through river restoration model. There are some specific objectives in order to achieve the main objective, which are:

- To extend the current knowledge regarding the status of the Burignaga and connected rivers surrounding Dhaka.
- To investigate root causes responsible for the Buriganga pollution.
- To construct and develop compact urban river restoration model for tackling the root causes of the Buriganga pollution.
- To identify and propose alternative river transportation channel through restoration of the dying rivers surrounding Dhaka to minimize the traffic jam of Dhaka city.

4. Methodology

4.1. Model Development

A technically sustainable urban river restoration model has been constructed and proposed in the process of urban transformation taking consideration into expert opinion from the environmentalists and engineers. The model mainly focuses on i. Centralized ETP and WTP, ii. Waste management, iii. Social awareness and iv. Alternative river transportation channel.

The idea of the proposed model has been initiated from the model of Thames Tideway Tunnel as the situation of the Thames in London in 1858 was as the Buriganga today. The Thames was polluted by tannery industry long ago. People simply used to throw their waste in the nearest streams which were washed away into Thames. At a time, waterways were covered over gradually and finding a complete new solution had to be found as Thames became polluted. Hence, interceptor sewers system was developed under embankments in the London to capture sewage from the lost rivers before it reaches the Thames. The sewerage system is still working perfectly and maintained properly as successful model of the Thames restoration.

4.2. Research Design

4.2.1. Area

The study has been taken place in Dhaka. Dhaka is the largest city covering an area of 1464 square kilometer. It is capital of Bangladesh which is 4th most densely populated city (Wikipedia) in the world with a population of around 1.18 crore (census 2011) people. The climate of Dhaka is hot, humid and wet and it is within the monsoon climate zone. Average annual temperature of the city is 25-degree C where 80 percent of annual average rainfall of 1854 mm takes place between May and September.

4.2.2. Data Collection and Procedures

The research is based on primary data only. Data has been collected from environmentalists and engineers serving in different universities, research firms and other organizations associated with the issue of river and environment pollution.

5. Literature Review

According to the perception of amiddle- aged local boatman Salauddin of Shyambazar, the Buriganga looks like a large pen drain rather than a river passing through a city (Newage, January 31, 2016). Nobody can use the water or take a dip (Newage, January 31,2016). Commmodore Mohammad Mozammel Haque, Chairman of Bangladesh Inland Water Transport Authority opinedthat due to bad smell, one cannot even stand beside the water of the Buriganga where drinking the water of the river is out of question (Newage, January 31, 2016). River Water Quality Report 2016 of Department of Environment shows thatthe level of dissolved oxygen in the Buriganga river becomes nil at all points during the dry season (January to May) where demand for biochemical oxygen is very high (Newage, January 31, 2016). In 2010, Bangladesh Inland WaterTransport Authority (BIWTA) extracted 8.44 lakh cubic meter waste from riverbed of the Buriganga and one kilometer of Turag river and it found that the waste can be 12 to 13 feet high on the riverbed (Newage, January 31, 2016). Around 700 industries, 42 outlets, 12 markets and 1100 families are staying beside the Buriganga and damping waste daily along with Dhaka Water Supply and Sewerage Authority as of the opinion of a senior project officer (Newage, January 31, 2016).Dr. M. Maksudur Rahman, Professor of Dhaka University, suspects that as 80 percent water of WASA comes from underground, the consequence can be devastating if polluted water from the Buriganga seeps into underground (thethirdpole.net, August 04,2015).

Dhaka WASA is trying to reduce dependence of around 1.18 crore people on ground water by bringing water from the Meghna river. Effluent Treatment Plants (ETPs) are not available in most of the industries in Bangladesh but it has been made mandatory by law. Ainun Nishat highlighted that even, WASA seems major polluter as domestic sewer line and storm sewer line are connected in Dhaka (The Daily Star, January 01, 2016). He also opined that no fish can survive in the Buriganga during dry season because the dissolved oxygen level comes down to zero where required level is 4 ppt for aquatic life (The Daily Star, January 01, 2016). As river does not only carry water but sediments, dredging the Buriganga will not provide durable solution because incoming sediment will fill up the dredged channel during following monsoons (The Daily Star, January 01,2016). The condition of river Thames or the Rhine was as bad as Buriganga today, but it was possible to bring the rivers' normal condition through cleaning effluent due to proper enforcement of law (The Daily Star, January 01,2016). In 2015, government of Bangladesh has taken step to dredge a 162 kilometre –long channel from the Jamuna River to the Burigangariver to flush out the pollution of the river which has been turned into a stagnant sewer. The project will cost US$ 200 million as estimated (the thirdpolenet, August 04, 2015). The water will be diverted from Bangabandhu bridge on the Jamunariver through the Dhaleswari-Pungli-Bangshi- Turag- Burihanga river system. Old Brahmaputra river flows from India to Bangladesh and the Jamuna river is the main distribution channel of the river. According to the opinion of eminent water expert AinunNishat, it is wiser to clean up the Buriganga rather than diverting water from the Jamuna as it does not seem a long-term solution (the thirdpolenet, August 04, 2015). According to the research of Institute of Water Modelling in 2014, it has been found thatdiversion of around 300 cubic metres per second of water or one tenth of the total water flow of the Jamunariver can restore the Dhaka's river system (the thirdpolenet, August 04, 2015).

As of the opinion of environmentalists, when the problems of encroachment and pollution go against the interest of vested quarters, successive governments are inevitably backed out (Newage, January 31 2016). Due to continuous encroachment, the Buriganga has been virtually reduced to a narrow channel of polluted slime as per flouting of high court and government directives (Newage, January 31 2016).In June 2009, government was directed by High Court to restore the Buriganga and other three rivers flowing by Dhaka after evicting all illegal structures of encroachers as of Landmark Order of HC, 2009 (Newage, January 31 2016).According to the opinion of Sharif Jamil, Joint Secretary of Bangladesh PoribeshAndolon, government did not take any strong initiative to free the river from encroachments in spite of the order of High Court (Newage, January 31 2016). Local encroachment, sign boards, advertising sale of plots inside the river, huge slums, shanties, boat –building factories and dockyards have sprung up on both the sides of the river specially at Kamrangirchar and Bosila areas. According to the information of officials of BIWTA, BIWTA evicted 125 illegal establishments and received 7.17 acres of land from the river bank. Besides, it has established an eco-park and walkway recovering river land from encroachers (Newage, January 31, 2016).

Before full relocation of tannery to Savar in April, 2017, toxic waste and sludge from textile, dying, printing, pharmaceuticals and washing industries, waste from medical and households, plastic, oil, dead animals and sewage were also major pollutants of the Buriganga besides waste of tanneries. Now, other sources except tannery industry is polluting Buriganga. Poribesh Bachao Andolon Report 2016 shows thatfrom Hazaribaghtanneries, around 21000 cubic metre untreated toxic waste was released every day into the Buriganga (Newage, January 31, 2016). Local Environmental Group, PoBA found thatabout 90000 cubic metres untreated industrial waste including 21000 cubic metre waste from Hazaribagh tanneries containing heavy metals and sulfuric acid had been dumped in to Buriganga every day before tannery relocation (thethirdpole.net, August 04,2015).According to chief justice Singha, relocation of tannery to savar will not make any sense if Dhaleswari gets polluted to save the Buriganga as tannery wastes are being dumped in Dhaleswari (bdnews24.com, April 10,2017). Even, effluent treatment plants in Savar have not been in operation fully till now.

The boundary of urban river cannot be depicted as administrative area in the process of river restoration due to openness of urban rivers. Diagnosis of river health, river restoration scenario optimization, river ecological trend prediction, target and indication system of river restoration system should be involved in urban river restoration planning (Zhao, Y.W., Yang, Z.F. and Xu, F, 2007). Unplanned tannery industries, over population, solid and domestic waste disposal, land grabbing and encroachment, water quality degradation etc. are the reasons for Buriganga pollution. Hence, controlled waste disposal, dredging river and planed drainage system are required as remedial against the pollution of the river (Zhao, Y.W., Yang, Z.F. and Xu, F, 2007). (Kibria, M.G., Kadir, M.N.,Alam, S., (2015). Alam, K. (2008) have found that the benefit cost ratio of restoration of dying river in Bangladesh, named the Buriganga is 4.35 which demonstrates that the restoration is not only environmentally imperative but also economically and socially justifiable.

Bhowmik, A.K. (2008) has identified in his research paper that the major source of pollution of the Buriganga was Tannery industry in Hazaribagh. Some measures of government have been highlighted for relocation of tanneries such as Hazaribagh tannery relocation project (HTRP) undertaken by Ministry of Industries in 2003worth over Tk. 1.75 billion however the decision has been taken in 1993. Bangladesh Small and Cottage Industries Corporation (BSCIC) had been assigned to implement the project with entire cost of the government. The research paper has proposed some measures such as providing Effluent Treatment Plant or undertaking relocation for each and every industry that use the river for their sewerage purpose or located on the bank of the river and introducing Water Treatment Plant at each connection point of the Buriganga and Khals. Further research directions of the paper have suggested to conduct research on the impact of Hazaribagh tanneries relocation to Saver area on the Buriganga, the Buriganga reviving process and water quality improvement as the paper of Bhowmik did not constructed any model to cover these issues significantly.

6. Analysis and Findings

Comprehensive urban river restoration model has been developed that is consists of 4 sub models together. Salient features of the proposed urban river restoration model are as follows:

6.1. Centralized ETP and WTP

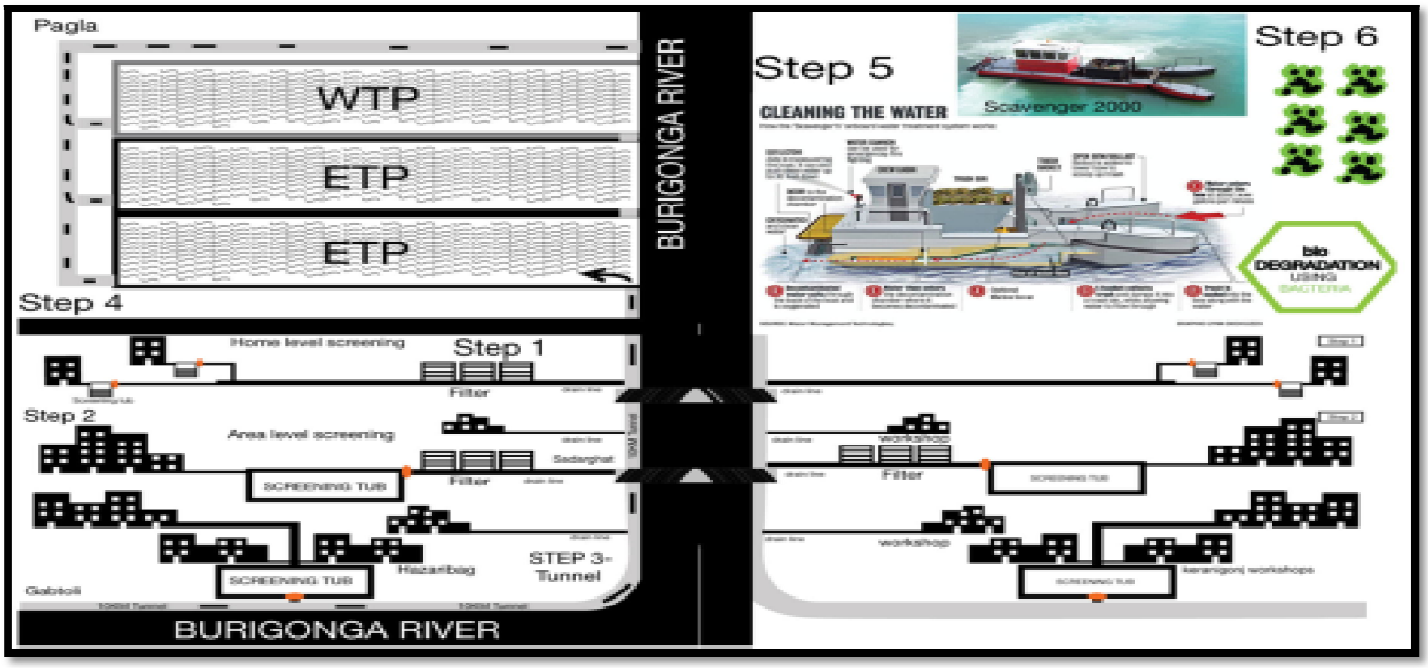

Figure 1

At first, home level screening has to be ensured for proper waste management in the areas surrounding the Buriganga. With each and every house surrounding the river Buriganga, screening tub has to be set up with the pipes through which waste can pass to the river directly. All the waste except liquid waste will pass to the central drainage system through home screening process and waste like polythene will be separated at the home level to ensure no blockage in the process. Cleaners will take the waste from the tank regularly with other homemade wastes. The liquid waste will pass to the central tunnel through drain line after filtering to crack any remaining hard item. After home level screening, area level screening will take place before passing the liquid waste to the centralized tunnel through screening tub. Area level screening will be established by the concerned ministry of the government where home level screening will be set up privately by the dwellers staying beside the river. Area level screening tubs will be connected with the 10-kilometer-long straight centralized tunnel of both the sides of the river under the street or embankment. The centralized tunnel has to be established specially from Gabtoli to Pagla as this 10 km area mainly pollutes the river Buriganga. Centralized tunnel will go through Hazaribag, Sadarghat, Keranigange and other areas beside the river. This centralized tunnel will be connected with the centralized ETP and WTP which will be established at Pagla. Centralized ETP and WTP have to be established at both the sides of the river. The liquid waste will be treated in the setup to pour into the river through ETP and used by the people through WTP.

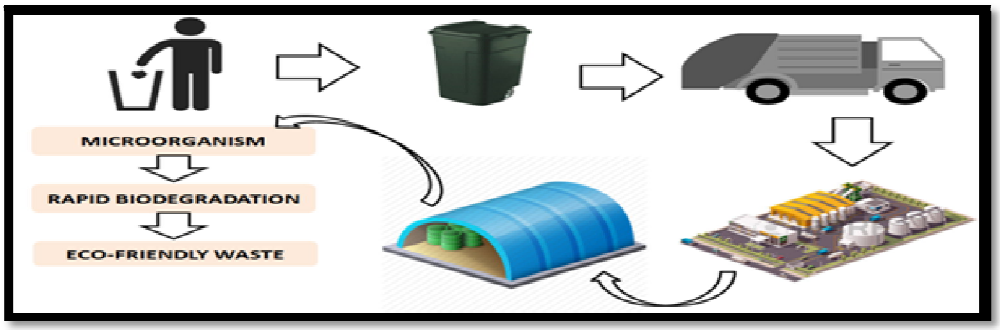

Figure 2

6.2. Waste Management

The proposed waste management model seems user centric approach. It focuses on managing the waste that is thrown here and there outside the drainage system. The drainage system should not be open to through waste and make blockage in the process rather it should be covert. In this model a uniform container of waste will be provided to each home, outlets, market and other parties staying surrounding the river Buriganga to keep waste. Waste carrying vehicle will come daily and take all the wastes from the people surrounding the river. People will keep their waste in the given container mandatorily that can be easily kept closed so that no smell comes outside. There will be no scope of throwing waste here and there. Magistrates will visit suddenly in the area to investigate whether the people are keeping the waste in the containers or throwing these here and there. If no waste is found in the container the container holders have to explain the reason. If it is proved that waste has been thrown into any other place outside the container or into the river Buriganga then people will be penalized through mobile court. Hence, at a time no waste will be disposed into the river Buriganga directly. The waste carrying vehicle will let the waste far from the town to dispose where a centralized dustbin has to be constructed where bacteria plant can be established to compost the waste quickly including plastics applying bacteria which has been found in developed countries.

6.3. Social Awareness (Map the Grab)

Figure 3

Several billboards will be constructed in the prominent places of Dhaka as Sahabag so that people can know about the encroachment situation of several areas of the river to take measures and movements against grabbing of the river. A platformhas to be developed through opening webpage in internet.org where there will be option for the local people to put dot with the suspension that encroachment of river is taking place in any area of the river. If the number of dot exceeds 100 then it will be considered seriously and will be shown on the bill board as shown in the given figure. Hence, concerned people will know about the issue and take initiative through movement pressurizing the concerned authorities to take prompt action to get rid of river encroachment.

6.4. Alternative Water Transportation Channel

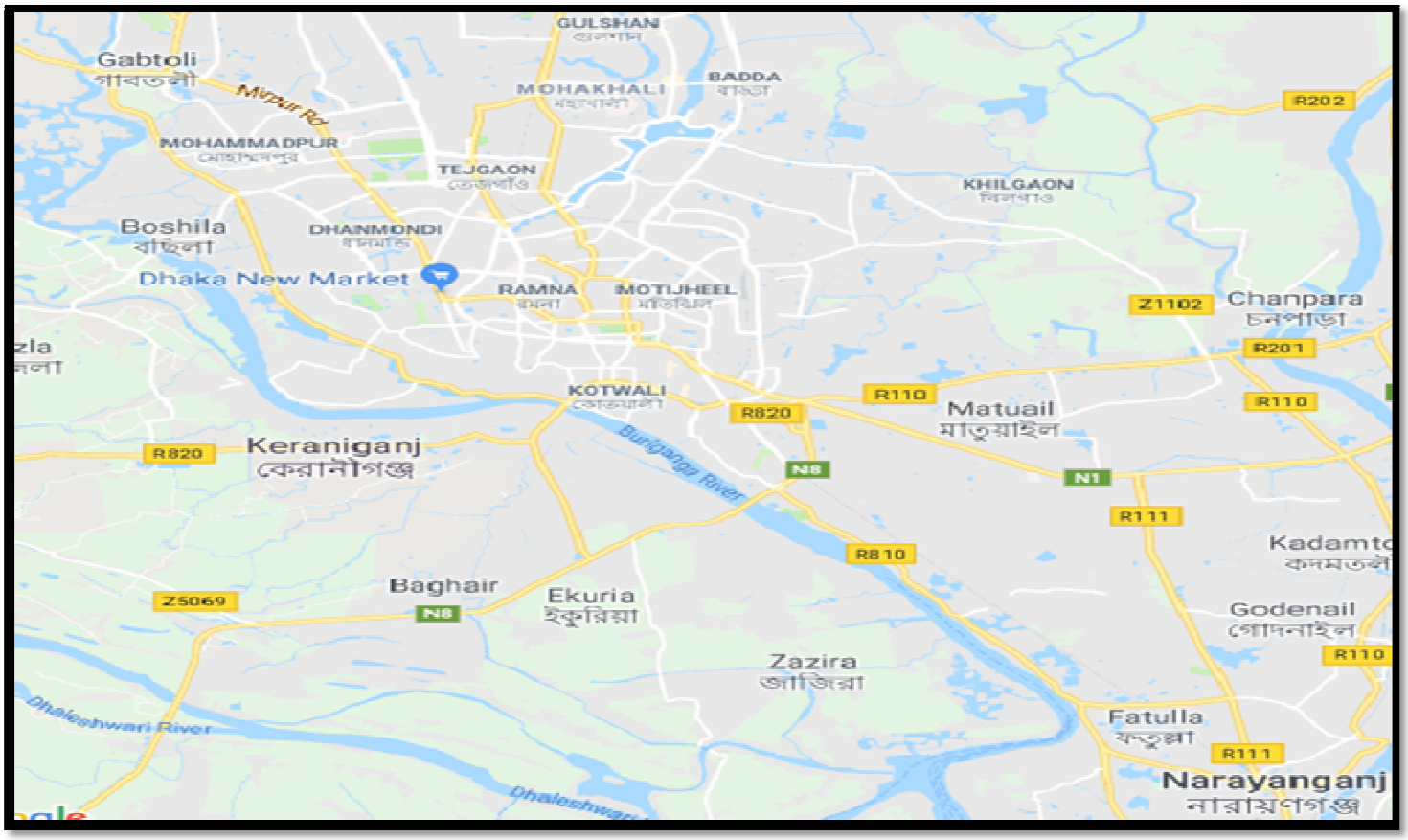

Figure 4

Government of Bangladesh has taken step to dredge a 162 kilometre –long channel from the Jamuna River to the Buriganga river to flush out the pollution of the river in 2015 with estimated cost of US$ 200 million (the thirdpolenet, August 04, 2015). The water flow is expected to be diverted from Bangabandhu bridge on the Jamuna river through the Dhaleswari-Pungli-Bangshi- Turag- Burihanga river system.Through the implementation of government project regarding bringing flow of water from Jamuna river, some dying rivers and canals surrounding Dhaka and connected with the Buriganga can be restored. The rivers and cannels can be used as the alternative transportation channel to bring the problem of traffic jam in Dhaka as minimum as possible. If the river Buriganga can get flow from the Jamuna, both the Buriganga and the dying river Turag will get life. The water transportation vehiclesas water boat, speed boat etc. will cover the area from Pagla to Tongi through Gabtoli. The water transportation channel for the both sides of the river will cover the areas of Pagla railway, Dholeshshor, Shyampur terminal, Buriganga Eco- Part, Postogola Cantonment, Chor Mirerbagh, Char Klaihanj, Ispahani Residential Area, Sadarghat, Zinzira, Goljarbag, Babu Bazar Boat Terminal, Muslimbag, Islambag, Shahid Nagar, Nazargan, Barisur, Nurbag, Huzurpara, Kholamora Boat Terminal, Panchdona, Ati Bazar, Hazaribag, Washpur, Boshila, Ramchandrapur, Dhaka Uddan Housing, Rupali Shoilot, Rupali Shoikot and Kotbari. As the Buriganga is connected with the Karnatali River and Turag River from the point Kotbari ,the proposed water transportation channel will cover the areas of Aminbazar Truck Terminal and Kaundia through Karnatali River and Bara Bazaar Para, Harirampur, Palapara, Jahurabad, Dia- Bari, Nobaberbag, Tamanna World Family Park, Birulia Bus Stand, Dhaka Boat Club, Binodpur, Rustampur, Ashulia Landing Station, Bhadam, Jamaldia, Bhatuliya, Bishwa Ijtema Maidanand, Machimpur, Tongi Bazar, West Abdullahpur, Uttara and Rajabari through Turag River.

7. Conclusion and Recommendation

Centralized ETP and WTP in Pagla for the polluted area of the Buriganga is the urgent need to ensure clean water in the river. Besides, proposed user centric waste management model can be useful tool to collect waste from homes and shops that through waste here and there surrounding the Buriganga and dispose these through centralized dustbin at a remote area from Dhaka city. To get rid of river encroachment, social awareness and protest from citizen can play vital role to pressurize the concerned authorities to take prompt action against powerful river encroachers. Depicting and developing alternative water transportation channel surrounding Dhaka using the water flow of Jamuna River can bring revolutionary change to minimize the problem of traffic jam, carbon emission and dust in the mega city Dhaka. Besides, thiswater transportation channel can generate employment for huge unemployed people especially formal boatman and fishers living beside the Buriganga. It has been evidenced that different mega projects of government to restore the Buriganga have been failed significantly. Hence, the proposed restoration model should be implemented by Bangladesh Army as they have already completed some mega projects in Dhaka successfully.

8. Further Research Direction

Further research can be conducted on theproposed model developing one multiple regression model of feasibility study of the proposed models with the risk factors (Firmansyah, B.A., Veronika, A. and Trigunarsyah, B.,2006). Fitted regression model can be constructed from the following regression model after data input in software:

$$Y = \alpha_0 + \beta_1 T + \beta_2 P + \beta_3 R + \beta_4 S + \beta_5 \mathrm{E}_1 + \beta_6 F + \beta_7 \mathrm{E}_2 + \in_i \ldots. \text{ (i)}$$

Where,

Y	Feasibility Study
T	Technical and Technological Aspect
P	Political Aspect
R	Regulation and Policy Aspect
S	Social and Cultural Aspect
E1	Environment and Spatial Plan Aspect
F	Financial Aspect
E2	Economic Aspect

Table 1

Primary data can be generated from environmentalists through structured questionnaire to conduct feasibility study with risk factors for the proposed restoration model to determine the highest risk factors that have to be given treatment first before the others. Each risk factor will contain multiple statements that will be scaled with 5-pointLikert scale from Strongly Disagree (1) to Strongly Agree (5). Each factor will construct each independent variable where total seven independent variables will be constructed. Factor analysis and structural equation modeling tools can be used through SPSS. Factors of multiple statementscan be determined as independent variables of the model based on factor loading (importance).

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