

COMPARATIVE ANALYSIS OF TRAFFIC FLOW CHARACTERISTICS IN TURBO-ROUNDBOUT AND CONVENTIONAL ROUNDBOUT: AN APPROACH IN VISSIM BASED TRAFFIC FLOW SIMULATION

Tomal Roy*¹, Puja Saha² Raisa Ferdousi³ and Sadia Mohsin⁴

¹ Student, Ahsanullah University of Science & Technology, Bangladesh, e-mail: tomalroy53@gmail.com

² Student, Ahsanullah University of Science & Technology, Bangladesh, e-mail: pujasahapuja302@gmail.com

³ Student, Ahsanullah University of Science & Technology, Bangladesh, e-mail: raisaferdousi928@gmail.com

⁴ Assistant Professor, Ahsanullah University of Science & Technology, Bangladesh, e-mail: sadia0302.ce@aust.edu

***Corresponding Author**

ABSTRACT

Bangladesh, particularly its capital city Dhaka, experiences chronic traffic congestion in existing roundabouts and intersections because of urban sprawl, underdeveloped road infrastructure, unmonitored expansion of personal transport modes, and a poorly integrated transport system. In response to these challenges, the turbo roundabout, a promising geometric innovation, has already been recognized in developed countries. However, it is still unexplored in our country. This paper aims to assess the performance of the turbo roundabout when it is placed instead of the existing four-legged conventional roundabout. Mirpur-10 four-legged roundabout has been used for the case study, which is infamous for non-lane-based heterogeneous traffic composed of both motorized and non-motorized vehicles, resulting in high vehicular traffic density and prolonged delays. To evaluate potential relevance, an initial correlation has been formed between existing design of turbo-roundabout from European region and the geometric characteristics of Bangladesh. In our study the analysis based on some traffic flow parameters like queue length, travel time, delays, emission of CO and level of service were compared to those of the existing four-legged roundabout using VISSIM microsimulation software. Data was collected on one consecutive days during peak hours. The goal is to understand whether the turbo-roundabout can surpass the existing roundabout & whether its losing performance matrices in oversaturation condition. Bangladesh has witnessed a steady rise in motor vehicle usage, influenced not only by infrastructural growth and increasing convenient buyer to credit, but also by the growing role of motorized transport in informal economic activities and connectivity between regions. Turbo roundabouts improve traffic throughput over conventional junctions, making them a viable answer to this problem.

Keywords: *VISSIM, LOS, Turbo-roundabout, Queue length, Delay.*

1. INTRODUCTION:

The rapid development of industry, population, and economic activity in both developed and emerging nations has resulted in a significant rise in vehicle traffic on highways. Because of the diversity of traffic, many developing countries confront unique obstacles in providing effective transport services. (Kumar & Aggarwal, n.d.). Bangladesh which is a developing country also face this lack of transport management, especially in the capital city, Dhaka. It has a thriving population of 10.2 million only in this city. The transport demand in this city is very high, however the capacity is struggling to keep up. With this big population, people spread across 300 square kilometers, the city has gained a reputation for being stagnant, with average automobile speeds dropping to barely 4.8 kilometers per hour. This has significant effects for the economy, ecology, and standard of living as a trip that should take minutes might take hours. (*Trapped in Dhaka's Traffic: How to Overcome This Crisis? | The Daily Star*, n.d.). Dhaka's commuting dilemma is the result of an excessive demand on private automobiles and a lack of knowledge about reliable public transit. Only seven to eight percent of the city's territory is devoted to highways, and only three percent is used for heavy and public vehicles. A city of this size should devote twenty-five percent of its area to roads. (*To Solve Dhaka's Commuting Crisis, Prioritise Improving Public Transport*, n.d.). So, one can assume that the traffic problem in this small city is much more crucial than any other.

Traffic jam or traffic congestion is a curse. Since most people experience everyday inconveniences including excessive delays, air pollution, and health issues, traffic congestion directly affects our quality of life (Muneera & Krishnamurthy, 2020). It can be said that - lack of public transport, unregulated growth in the number of private vehicles, and poor traffic management as well as the inadequate road infrastructure is the main reason of traffic congestion (Ali et al., 2023). As the demand for transport far surpasses the available capacity, the designated transportation infrastructure remains significantly neglected, resulting in inefficient use of space and causing traffic congestion in Dhaka city. So, a well-designed roadway network can affect the city's traffic congestion by improving the traffic flow & enhancing the transportation efficiency.

Roadway Infrastructure like - Intersections, Roundabout, Overpass, Underpass etc. are the primary element that can reduce traffic congestion. But in some cases, especially in peak hours of working days, both major and minor roads experience a rush in traffic volume which directly affects the capacity of these roadway infrastructure. As Dhaka's population grows, spurred by both natural development and migration from other cities seeking better prospects, traffic congestion will become increasingly severe. To ensure mobility and safety, it will be necessary to pay close attention to essential traffic components. However, in most areas of our city, intersections are manually controlled by traffic police. So, instead of unsignalized intersection a roundabout can be a feasible solution for Dhaka city. Modern roundabouts were first established in the United Kingdom in 1966, and they proved to be a substantial improvement over intersection. (*Roundabout - Wikipedia*, n.d.). Single-lane roundabouts sometimes have challenges in handling high traffic numbers, resulting in congestion during peak hours. To alleviate these issues and enhance traffic flow, multilane roundabouts were implemented. But this infrastructure faces some minor challenges. Research indicates that ordinary multi-lane roundabouts with circular circulation lanes have lower capacity than expected and are more likely to cause traffic incidents (Džambas et al., 2017). For our country, especially for Dhaka city, where the main concern is the capacity of roadway, it can be an issue for present and as well as for future. So, a new solution "Turbo-roundabout" can be a consideration for our city offering a higher traffic throughput. Turbo roundabouts are typically multilane (at least two lanes) with a spiral circulation junction. Traffic flows at the entry, circular roadways, and exit are separated by mountable lane separators. The physical divider between traffic lanes reduces driving speeds, eliminates conflict delays, and modifies rear-end incidents at roundabout entries and exits (Shukurov Ing Andrea Simone & Ing Claudio Lantieri Dott Ing Navid Ghasemi, n.d.). The practice of Turbo roundabout is mostly seen in Netherland region. In recent cases, the turboroundabout are an attraction to the transportation engineers and urban planners for their ability to offer more flexible and convenient alternative of intersection or traditional roundabout.

The objective of this study to evaluate the traffic parameters between the existing roundabout and the newly design turbo-roundabout in respect to Bangladesh using microsimulation software VISSIM. However, this study will also show that, the turbo-roundabout that we choose instead of existing roundabout whether it's feasible or not in that environment.

2. LITERATURE REVIEW:

(Sakib et al., n.d.), analyzed performance metrics of a four- legged heterogenous intersection such as-vehicle travel time, delay, and level of service through VISSIM simulation. The study compared turbo roundabout and conventional roundabout as a replacement of intersection to search for superior performance. Turbo roundabout revealed distinguished accomplishment compared to both the four-legged intersection and conventional roundabout by reducing 29% travel time in intersection and 16% travel time in roundabout, dropping delay by 65% and 43% along with improving the level of service.

(Giuffrè et al., 2012), studied the conversion of a roundabout into a turbo roundabout, and concluded that against a minimal capital (installation of elevated curbs and adjusting the border of the central island) can provide high benefits both for safety (e.g., diminish of conflict points and moderate speeds) and for operational conditions (e.g., effective streamlining for vehicle flows and increasing capacity of roadway).

3. METHODOLOGY:

The study area is the intersection of the Mirpur-10 roundabout in the Dhaka metropolitan region. The study area consists of four link roads that connect to various infrastructures, cantonments, and commercial malls. Dhaka cantonment and Mirpur DOHS are located in the north, Sher-e-Bangla National Stadium in the west, Mirpur-13 and 14 residential neighbourhoods in the east, and Agargao which has, government offices, hospitals, and institutes in the south. This intersection is one of the busiest in Dhaka. Figure-1 depicts the Mirpur-10 multilane roundabout. The existing roundabout was modelled in and simulated in VISSIM software then replace with the selected design of Turbo-roundabout.

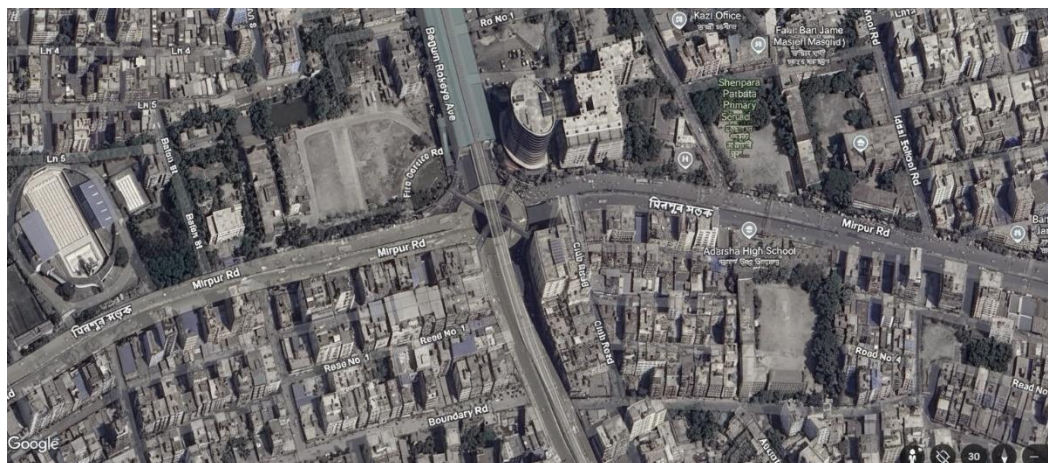


Fig-1: Mirpur -10 Roundabout (study area)

3.1 Data Collection:

Data on traffic flow, including volume, vehicle composition, speed, signal timing, and geometry, are gathered for the chosen roadway. The research area is manually signalized intersection. It is intersected by two roads of two-way two lanes. East-west direction road and north-south direction road both are

assumed major road. The width of each lane is not fixed but average 6m. Vehicle volume data were gathered during peak hours around (9 am to 10 am) for one weekday. Table-1 represents the vehicle composition within the traffic.

Table-1: Vehicle Composition

| | Vehicle Volume (%) | | | |
|----------------|--------------------|-------|------|------|
| | North | South | East | West |
| Car | 33 | 21 | 25 | 32 |
| LGV | 1 | 1 | 2 | 4 |
| HGV | 1 | 1 | 1 | 1 |
| Bus | 1 | 14 | 3 | 19 |
| CNG | 10 | 11 | 11 | 6 |
| Bike | 19 | 40 | 38 | 21 |
| Leguna | 9 | 10 | 10 | 14 |
| Tesla | 13 | 3 | 3 | 2 |
| Bicycle | 13 | 1 | 6 | 1 |

3.2 Building VISSIM Model:

Calibration is the process of adjusting simulation settings to appropriately replicate field circumstances. VISSIM's COM interface enables external calibration via code. The algorithm, a random search and optimisation tool, generates random sets for parameters. Model validation guidelines suggest that GEH values below 5 indicate a satisfactory match (UK Highway Agency). Several simulations were ran with various parameters for confirmation. Figure-2 reveals that the microscopic model's GEH value is 1.43, indicating a well-calibrated model that accurately replicates field traffic conditions.

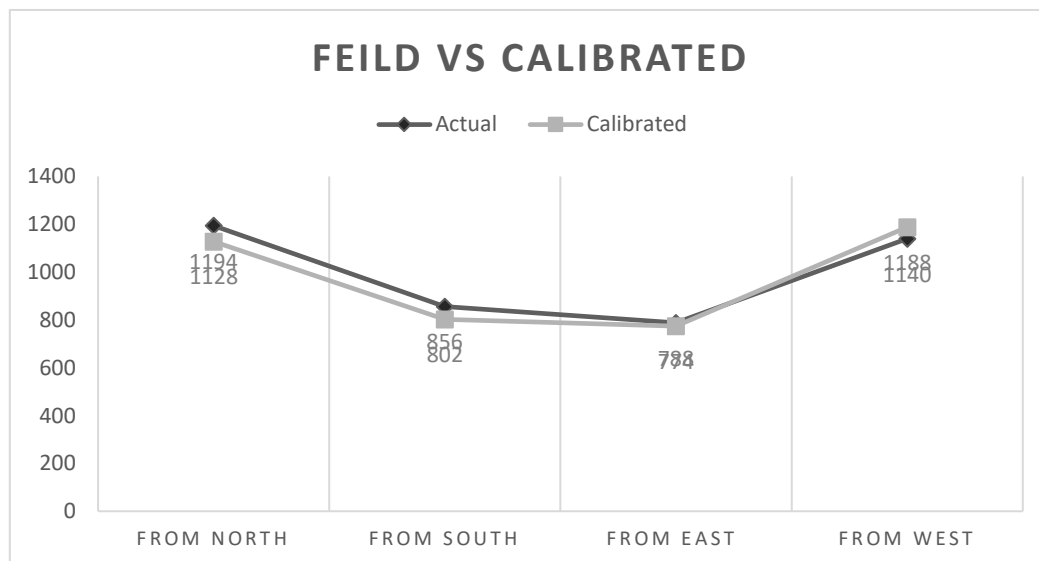


Fig-2: Field and Calibrated Value

The geometric model of the Roundabout was developed in the VISSIM (see Figure-3). Given the diverse vehicle composition in the study area, the vehicle distribution for each approach was obtained from field data and incorporated into the model. Signal control parameters such as- cycle length, green, red & amber timings for each approach were included into the VISSIM. The Calibrated model was then evaluated for its performance at the current Roundabout then it was replaced with a Standard European region Turbo-roundabout (see Figure-4), and their performance was evaluated.

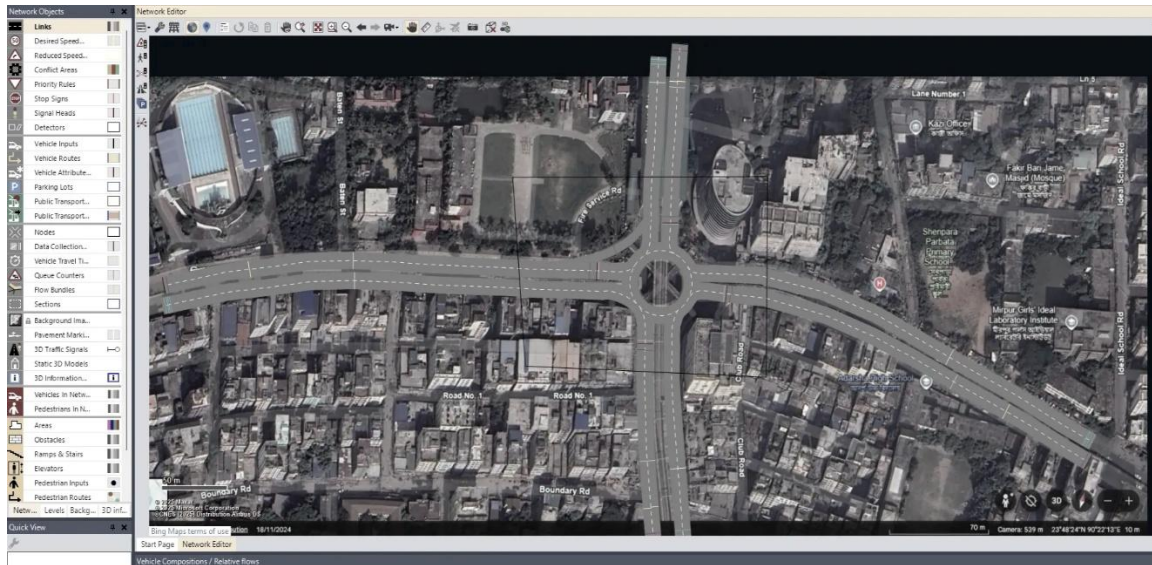


Fig-3: Existing Roundabout Model in VISSIM.

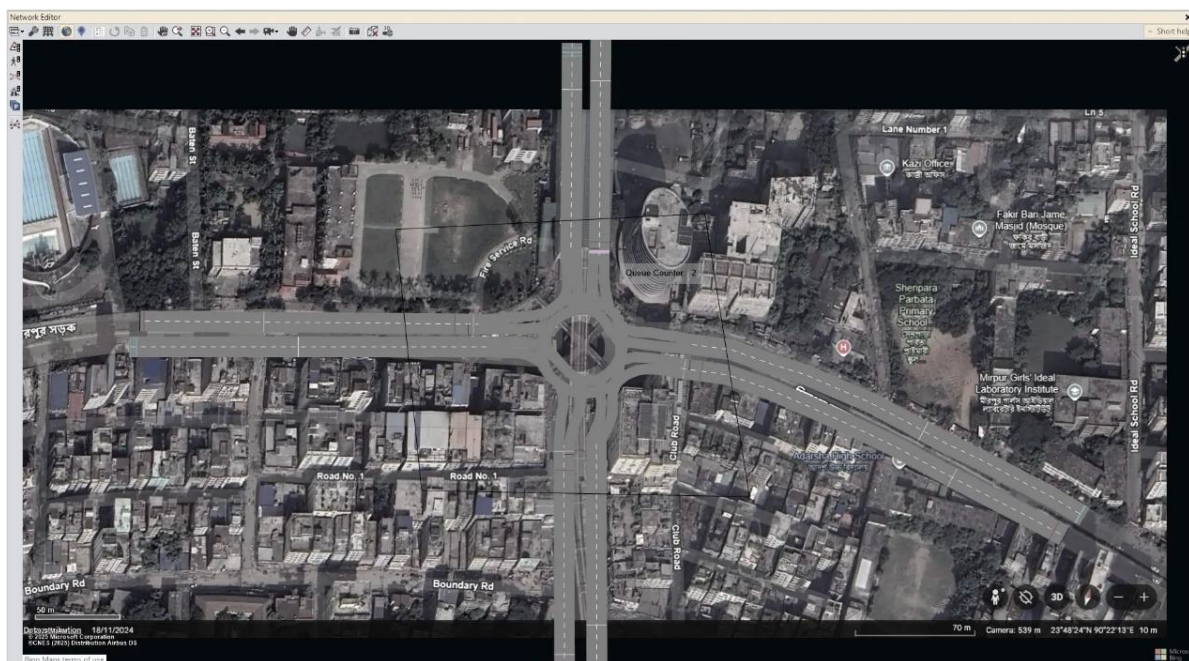


Fig-4: Turbo-roundabout Model in VISSIM

4. RESULT AND DISCUSSION:

The VISSIM simulation results indicate that the recommended turbo roundabout design significantly improves traffic flow efficiency and safety when compared to the present conventional roundabout. This research evaluated both roundabout performances using important characteristics such as vehicle travel time, delay, level of service, maximum queue length and emission of CO. In comparison of both vehicle travel time and delay measurement, turbo-roundabout outshone the most; both results were lowest at turbo-roundabout. Subsequently, level of service was also superior for turbo-roundabout. Considering queue length and emission of CO both proved to be highest for conventional roundabout &

lowest for turbo-roundabout. So, one can say that turboroundabout exhibited superior performance compared to the typical roundabout.

4.1 Vehicle Delay:

The comparison of Vehicle delay is illustrated in Figure-3. For all direction, the delay is decreased is by 57%, when replacing the conventional roundabout by Turboroundabout.

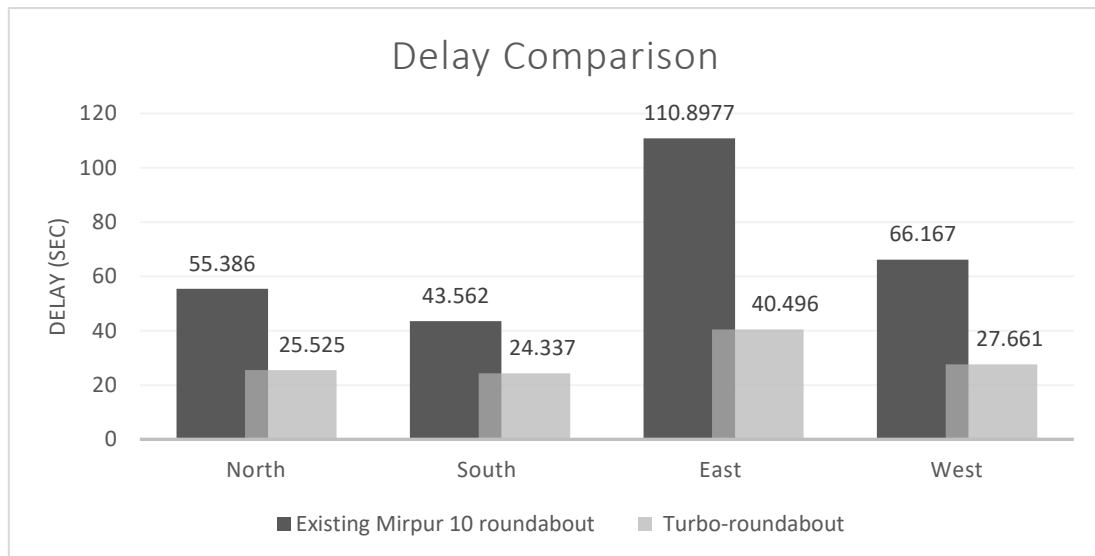


Fig-3: Delay Comparison

4.2 Vehicle Travel Time:

Figure-4 depicts a comparison of vehicle travel time. Using Turbo-roundabout instead of conventional roundabouts, there is a drastic change in the value. For using Turbo-roundabout the travel time decrease by 53%. As the main concern was about congestion on high capacity, it shows that replacing the conventional roundabout can be beneficial for smooth traffic flow.

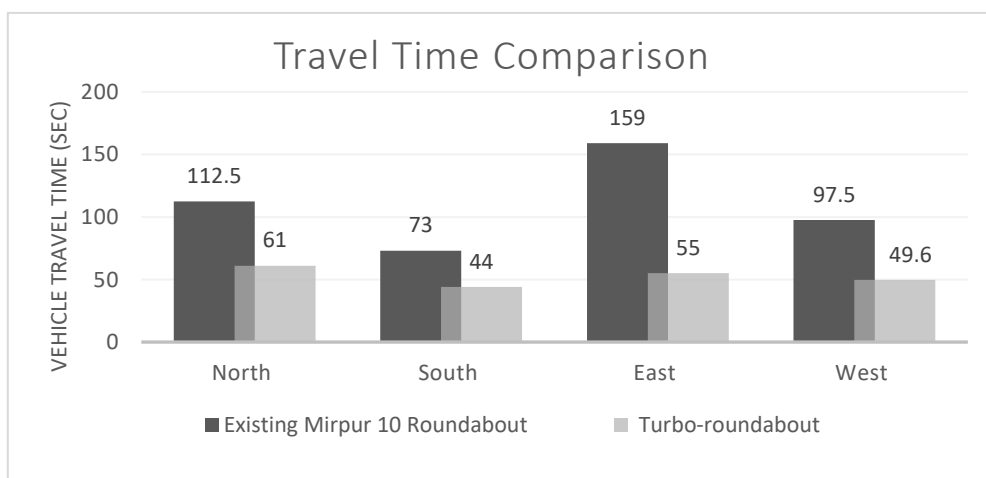


Fig-4: Travel Time Comparison

4.3 Emission of CO:

Figure-5 shows that replacing conventional roundabouts with turbo-roundabouts can result in an approximately 30% decrease in carbon monoxide (CO) emissions. As the air quality is worsening day by day in Dhaka city, lower CO levels will indirectly benefit the climate.

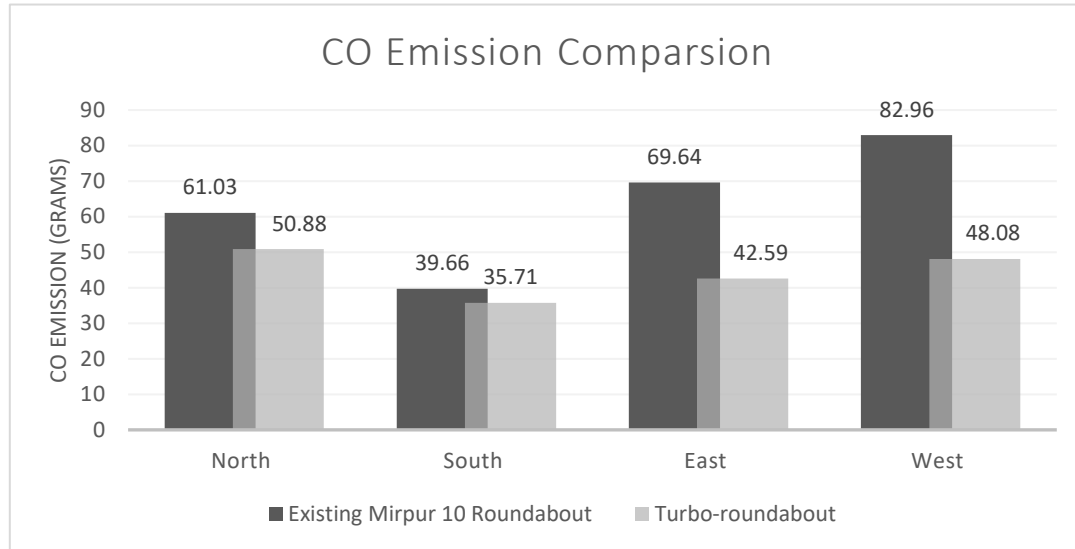


Fig-5: CO Emission Comparison

4.4 Level of Service:

LOS is an evaluative measure that describes the operating circumstances within a traffic stream based on variables such as speed, travel duration, mobility, traffic disruptions, and comfort. The LOS classifications usually range from A (best conditions, unrestricted flow) to F (worst conditions, extremely crowded). Table-2 shows that conventional roundabout is in worst congested situation rather than Turbo-roundabout. By replacing existing roundabout to turbo-roundabout, the LOS improved by A when it was in F & D for some direction.

Table 2: LOS Comparison

| | LOS | | | |
|--------------------------------------|-------|-------|------|------|
| | North | South | East | West |
| Existing Mirpur-10 Roundabout | D | D | F | F |
| Turbo-roundabout | A | A | A | D |

4.5 Maximum Queue Length:

Traffic Queue Length refers to the distance that vehicles queue in front of the detection queue. In this study, we set 4 queue counters for 4 directions. The results for maximum queue length show in Figure-6. For most cases the turboroundabout excels by conventional roundabout. The less queue form, the traffic will be much more smooth.

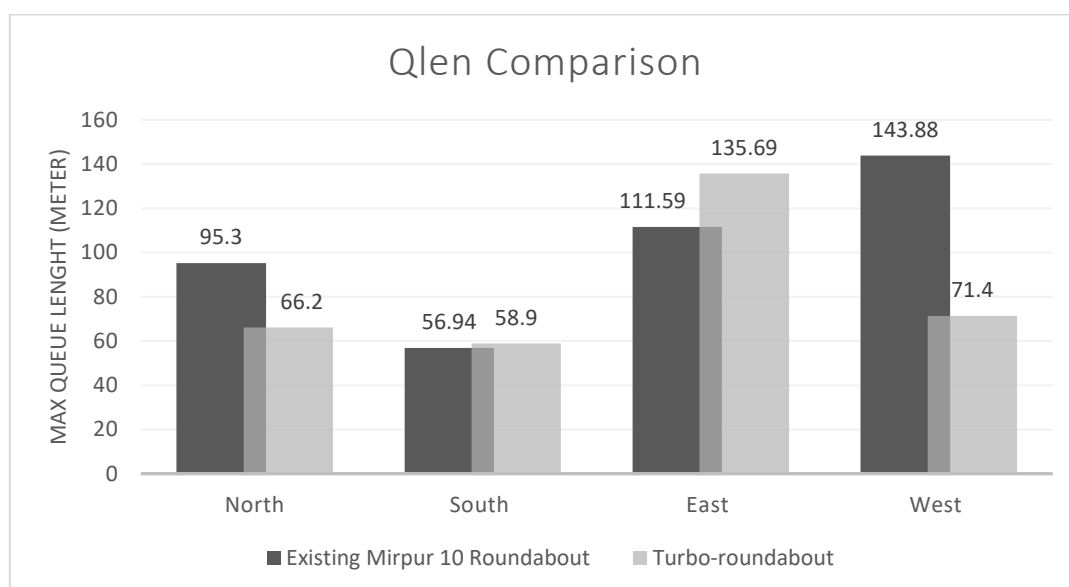


Fig-6: Queue length Comparison

5. TURBO-ROUNDAABOUT FEASIBILITY IN BANGLADESH:

The above study assesses the performance of turbo roundabouts as an alternative to existing multilane roundabouts. However, before proceeding, it is critical to analyse the feasibility of implementing this lane-oriented structure in our situation. In this part, we look at the several types of turbo roundabouts, how to choose the best design, and how European versions compare to traffic conditions and infrastructure in Bangladesh.

There are four conventional turbo roundabouts designs, as described in (Sołowczuk & Majer, 2023). Based on capacity there are - Basic, Egg, Knee and Rotor. In European suburban region limited land availability poses the most significant engineering difficulties. As for the Dhaka city which is a mega city, it possess the same problem. If we consider our study area, almost everywhere is pact with residential and commercial building, also there is a newly made metro station. So, the circulatory portion of turbo-roundabout has to be in proper design as well as the lanes that are connected to it. First let's compare the typical vehicle size with the European region vehicles, based on the parameters- length & width. Table-3 represent the results of our findings.

Table-3: Vehicle Size Comparison of BD and European Region

| Vehicle Type | Bangladesh | | European region | |
|----------------|------------|----------|-----------------|-----------|
| | Length (m) | Width(m) | Length (m) | Width (m) |
| Car | 3.5-4.5 | 1.5-1.7 | 4.0-4.5 | 1.7-1.9 |
| LGV | 4.5-6.0 | 1.7-2.0 | 4.5-7.0 | 2.0-2.55 |
| HGV | 7.0-12.0 | 2.0-2.5 | 12.0-18.75 | 2.5-2.55 |
| Bus | 8.0-12.0 | 2.0-2.5 | 10.0-18.0 | 2.5-2.55 |
| CNG | 2.5-2.6 | 1.2-1.3 | - | - |
| Bike | 1.8-2.2 | 0.6-0.8 | Same | Same |
| Leguna | - | - | - | - |
| Tesla | 1.5-1.8 | 1.2-1.4 | - | - |
| Bicycle | 1.4-1.5 | 0.4-0.5 | Same | Same |

This will give an idea of the basis to develop a turbo roundabout's lanes and determine whether changes to existing lane arrangements are required. By analysing, critical design parameters, such as- inner and outer circular lane radii, circulatory lane width, entry lane width, exit lane width, and entry curve radius—based on European standards, we can effectively compare these with the current design of the Mirpur 10 roundabout to assess the feasibility of implementing a turbo roundabout. Table-3 shows the findings of this study.

Table-4: Lane parameters comparison of existing Roundabout in BD and European region turbo-roundabout

| Parameters | European Region Turbo-roundabout | Existing Roundabout of Mirpur -10 |
|--|---|--|
| Inner & outer Circular Radius | 16 to 25m & 22 to 30m | 15 to 25m & 50 to 70m |
| Circulatory lane width | 3 to 3.5 m per lane | 3 m per lane |
| Entry lane width | 3 to 3.5 m per lane | 3 m per lane |
| Exit lane width | 4 to 4.5 m per lane | 3 m per lane |
| Entry & Exist Curve Radius | 14 to 16m & 16 to 20m | ----- |

Although the values presented are typical for designing turbo roundabouts in the European region, they can vary depending on vehicle sizes and the specific type of turbo roundabout being designed—whether it is an egg-shaped, spiral, or another variant. By evaluating these parameters, it can be concluded that, theoretically, implementing a turbo roundabout at the Mirpur 10 location is feasible with minimal modifications to the existing layout. The key feature of a turbo roundabout is its lane-based system, which relies on clear lane separation. To maintain lane discipline, various physical measures such as horizontal road markings, low raised dividers, higher substantial dividers, or impassable barriers can be employed to guide vehicles along designated paths while preventing lane changes within the roundabout. Another important consideration is driver behaviour—whether drivers can effectively understand and adhere to lane division and turbo roundabout rules. This challenge can be addressed through comprehensive education and clear guidelines tailored to local driving conditions.

6. CONCLUSION:

This research basically focused on two parts, one is to evaluation the performance of Turbo-roundabout a lane-based traffic condition and another part is to understand the feasibility of Turbo-roundabout in Bangladesh region by comparing some design parameter of European region that already have existence.

According to the findings, turbo-roundabouts perform significantly better than conventional roundabouts. This study is interesting in that it assesses the suitability of turbo-roundabouts, which are frequently used in industrialised countries. In the context of the varied traffic situations that are common in emerging nations, where intersections with three or four legs are common. The results highlight Turbo roundabouts' excellent performance in certain traffic situations, especially in places like Dhaka, indicating their usefulness as substitutes for conventional intersections to improve traffic problems. Although Turbo-roundabouts have the potential to improve traffic flow, there are obstacles in the way of their practical replacement of current conventional roundabouts.

On the second part of the study, we try to visualize by comparing some parameters of the European region Turbo-roundabout to our exiting conventional roundabout. Because of their physical lane separation and spiral geometric design, which prevent weaving problems, turbo-roundabouts provide much more safety and operational efficiency than traditional roundabouts. From table-3 and table-4 one

can say, theoretically its possible to establish the turbo instead of mirpur 10 roundabout. In order to ensure sufficient capacity for large vehicles, European design standards (such as those in Slovenia, Serbia, and the Netherlands) employ longer and wider design vehicles (usually trucks up to 16.5 m in length and 2.55 m in width) as the foundation for lane and apron measurements. These vehicles are accommodated by the inner radius and circulatory lane width, and turbo roundabouts frequently have traversable aprons for semi-trailers longer than 22 meters. As the vehicles are not as much larger in Bangladesh, so the lane width can estimate with vehicle size and retrofit to convert the conventional roundabout to turbo-roundabout. This is a small study about feasibility of turbo roundabout in Bangladesh, further study is needed to grasp the full idea of the design sector. Also the simulation in Vissim was done in student version, for an enhance depth evaluation a better version is needed.

7. DECLARATION OF USE OF AI:

No artificial intelligence (AI) techniques, such as massive language models, generative AI software, or automated data analysis platforms, were used in any part of the research process. The author performed all data collecting, simulation modelling (e.g., PTV VISSIM) and manuscript writing manually using standard academic and engineering software.

8. REFERENCE:

- Ali, Y., Rafay, M., Khan, R. D. A., Sorn, M. K., & Jiang, H. (2023). Traffic Problems in Dhaka City: Causes, Effects, and Solutions (Case Study to Develop a Business Model). *OALib*, 10(05), 1–15. <https://doi.org/10.4236/oalib.1109994>
- Džambas, T., Ahac, S., & Dragčević, V. (2017). Geometrijsko oblikovanje turbokružnih raskrižja. *Tehnicki Vjesnik*, 24(1), 309–318. <https://doi.org/10.17559/TV-20151012162141>
- Giuffrè, O., Guerrieri, M., & Granà, A. (2012). Conversion of Existing Roundabouts into Turbo-Roundabouts: Case Studies from Real World. In *Journal of Civil Engineering and Architecture* (Vol. 6, Issue 8).
- Kumar, M., & Aggarwal, P. (n.d.). Traffic Flow Simulation using VISSIM Software. In *Journal of Civil Engineering and Environmental Technology* (Vol. 6, Issue 4). <http://www.krishisanskriti.org/Publication.html>
- Muneera, C. P., & Krishnamurthy, K. (2020). Economic Evaluation of Traffic Congestion at Intersection: Case study from an Indian City. *Transportation Research Procedia*, 48, 1766–1777. <https://doi.org/10.1016/j.trpro.2020.08.212>
- Roundabout* - *Wikipedia*. (n.d.). Retrieved November 15, 2025, from <https://en.wikipedia.org/wiki/Roundabout>
- Sakib, N., Tapu, T. A., Junaed, S., & Sarkar, R. K. (n.d.). *PERFORMANCE EVALUATION OF TURBO-ROUNDABOUT IN HETEROGENEOUS TRAFFIC CONDITION OF DHAKA, BANGLADESH ICCESD 2024_0566_2*.
- Shukurov Ing Andrea Simone, N., & Ing Claudio Lantieri Dott Ing Navid Ghasemi, D. (n.d.). *DICAM Geometrical Design of Turbo Roundabout*.
- Sołowczuk, A., & Majer, S. (2023). *Design Study for the Construction of Turbo Roundabouts Under Constrained Site Conditions*. <https://doi.org/10.20944/preprints202308.0272.v1>
- To solve Dhaka's commuting crisis, prioritise improving public transport*. (n.d.). <https://www.thedailystar.net/opinion/Views/News/Solve-Dhakas-Commuting-Crisis-Prioritise-Improving-Public-Transport-3826296>.
- Trapped in Dhaka's traffic: How to overcome this crisis?* | *The Daily Star*. (n.d.). Retrieved June 8, 2025, from <https://www.thedailystar.net/opinion/views/news/trapped-dhakas-traffic-how-overcome-crisis-3722041>