

# A Systematic Integration and Simulation of Transportation Network to Asses Efficiency Maximization: A Case of Benapole Land Port, Bangladesh

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## Abstract

Systematic transportation network and orderly circulation system is vital for the effective functioning of a land port facility. Benapole Port, the largest land port of entry in Bangladesh, located on Bangladesh- India border in Jashore. It handles most of the cross-border trade as well as a large number of passengers and trucks of goods are passed through this point every day. Due to lack of systematic organization and orderly traffic circulation control the port facility is unable to function at its full efficiency, resulting in traffic congestions, processing delay and systematic losses. The key challenge is to resolve the circulation network adequately and systematically to maneuver the cross-border traffic and cargo by the means of providing well organized traffic network, compaction of facilities, dedicated circulation system and smooth process flow of port activities. Through conduction of extensive site survey and in-depth data analysis the fundamental issues and remedial requirements forecasts are identified. By the means of computer aided simulation for comparison between multiple alternatives of traffic network distribution and circulation system the possible most suitable alternative can be assessed. The efficiency of this prevailed circulation system is supported by the results of the simulation, which can be able to optimize the addressed issues, also ensures maximized efficiency of the port functioning. Furthermore, either as a goods or tourists exchange point, Benapole Port has paramount importance and have potential to become a landmark establishment.

**Keywords:** Transportation Network; Traffic Simulation; Circulation System; Land Port; Port Efficiency.

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## **1. Introduction**

Land Port is the border station which controls import and exports as well as border pass. A land port houses the customs and border protection activities. A land port activity mainly dedicated to handle transit and transshipment facility whereas transit concerned with passenger, bus and rail activities and transshipment concerned with cargo and warehouse activities. In Bangladesh, so far 23 Land Customs Stations have been declared as Land Ports. Only 6 of them are currently operated by Bangladesh Land Port Authority (BLPA). Benapole Land Port is one of them and also the largest land port of Bangladesh. Benapole land port is located on Bangladesh- India border in [1]. Benapole land port is the most active port of Bangladesh. It handles more than 80% of cross border trade with India owing to its proximity to West Bengal. About 90% of the imported Indian goods enter Bangladesh through this port. Average 2000 passengers and 600-700 trucks of goods are passed through this point every day. Moreover, Kolkata is connected with Dhaka by road through Benapole. So maximum tourists use this port as their entry and exit point for India [2]. There is significant growth in the cross-border trading resulting in the increase of the volume of handling goods in aspects of import and export. Considerable increase in transit of passenger and transshipment of goods ignited demand of an efficient transport network. Circulation system is a vital element as spine for the smooth flow of transportation as well as the transshipment process of the goods. The processing system should be efficient to handle such a growth in the goods handling for the forthcoming as well as in the current condition of the Benapole Land Port. Benapole land port facilities are not integrated in systematic way as the processing system and facilities are situated in a segregated manner. This lack of systematic order causes delay in the processing of the import and export goods which also affects the port efficiency in significant ways. In the existing condition the main functions are Passenger Terminal, Bus Terminal, Train Terminal and Transshipment Facility along with Truck Terminal. The efficiency of the ports mainly depends on the processing capacity of its trades and circulation of transits. Considering the increase of sub-regional trade and tourism between these two neighboring countries, to ensure efficiency in processing, exchanging and transporting through this busiest port it is necessary to provide a smooth loop and flawless circulation system in Benapole Land Port. Which might be possible by integrating the existing land port with multimodal (rail and bus) passenger and cargo terminal facilities. As the existing condition of circulation and processing in Benapole Land Port is complex and not fully automated or properly organized. The circulation system should be considered as single lane and one way to ensure the smooth flow of the heavy traffic flow. As the port works as a point of entry, so one-way single lane circulation will be more efficient. Roads for different modes of vehicle as bus and truck should be separate as well as their routes to make it more convenient circulation. The functions of the port activity should be integrated in a singular mass to ensure less delay and more efficient processing of goods as well as traffic flow. The study is focused on understanding the existing traffic congestion and processing inefficiency to a smooth and separate route for different mode of traffic and also manage them in a systematic way to ensure maximum efficiency and minimum congestions. The traffic system can be dealt with the approach of multiplex loop of one-way multi-lane system to facilitate and handle the heavy flow of traffic and their circulation system. While systemic functioning delay can be resolved by the approach of single processing window (SPW) system for goods and products processing and handling. Another consideration is functional and systematic organizational integration of port facilities.

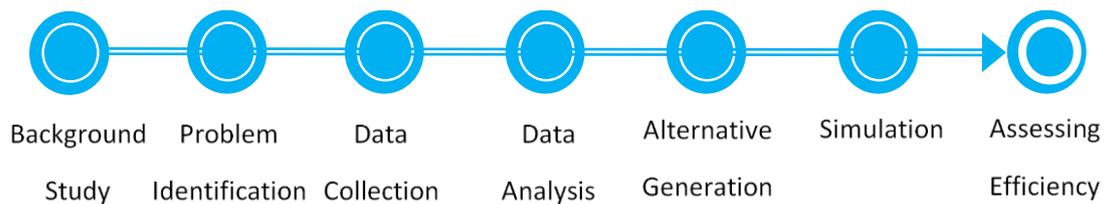
## **2. Literature Review**

According to the act 2001 of Bangladesh Land Port Authority, Bangladesh land port has established recently. Under that authority total 12 land port will be built in various region in Bangladesh and India border. Beanpole is one of the oldest and largest port of Bangladesh along with the other 6 ports which is currently operated by Bangladesh Land Port Authority [1]. Benapole is the most important in the border district of Jessore. Average 2000 Passengers and 600-700 trucks of goods are passed through this point everyday but it was never organized in orderly and systematic way. Such a busy port was always ill managed and neglected. In 1989, the president of Bangladesh visited this port and was very Much dissatisfied with the existing poor condition. According to this order a scheme to develop this port area was taken. The following Govt. also agreed with this plan [3]. Public work department is now engaged in developing a plan of the port under the project of “Bangladesh regional connectivity: Development of Benapole Port” [4] with the funding of World Bank and Asian Bank. Several development projects such as warehouse and road development as well as automation of the port has already on process[5]. The integration of the port facilities and operation along with the concept of multimodal (Passenger, Bus & Train) terminal may increase the development process [6]. The authors in [7] noted on the study of “Understanding Port Efficiency: A CPEC (China-Pakistan Economic Corridor) Perspective”, how the physical infrastructure, logistics superstructure and value-added services contribute in the enhancing port efficiency. The study concluded that physical infrastructure, logistics superstructure and logistics services at a port play a vital role in improving port efficiency. The study further pointed out that adequate port structure and value-added services would significantly contribute to port efficiency and facilitate the smooth clearance of cargo. So, the physical infrastructure along with logistics superstructure plays a vital role in the managements and functionality of a land port activities. Adequate port structure and value-added services aids the efficient and smooth handling and functionality which may result in the efficiency maximization of the overall land port processing and circulation system. Hence the Integration of existing port facilities and the land use of port infrastructure are important to improvement of port efficiency. Benapole Land port started operation under BSBK management from February 2002. Previously it was under management of Mongla Port Authority [8]. The lion share of trade between Bangladesh and India are handled through this port. The present facilities include 35 godowns, 5 open stack yard, 01 transshipment yard and 01 truck terminal yard developed on 65-acre land [9]. The authors in [10] noted on the study “Improving port efficiency: A comparative study of selected ports in India” that the way to measure the efficiency by analyzing variables as storage facilities, number of warehouse and number of cargo handling equipment. So, the output variables are average total turnaround time and average output per day. The total amount of goods received are distributed in ways to total amount of goods cleared and on hold (in processing/awaiting clearance). The total amount of clear goods further distributed in storage and released goods. On the present condition of the Benapole Land Port, there is a certain gap between the amount of received goods and the amount of cleared goods. This lack of handling capacity of the existing facility causes the congestions and leads to delay. Hence the improvement of the existing facilities and the handling as well as storage capacity of Benapole land port may play a vital role to improve its functionality and efficiency. In the recent scheme of the Bangladesh Land Port Authorities development projects the authority wants to improve the transportation and road network of Benapole Land Port. Reference [11] Also focusing on improvement on the efficiency of process flow and integration of port functions. Here for the road network

development and integration of port functions the authors in [12] noted on the study “An integrated model of facility location and transportation network design” that optimization of facility locations and the design of the underlying transportation network is often more cost-effective than adding facilities to improve service levels. So, systematic organization of land port facilities and their integration with the transportation network aids the circulation systems and process flow. The integration functions and circulation can ensure efficient and smooth flow of goods and processing as well as the movements of the transportation means. Improvement in transportation and road network should be considered with the integration of the functioning facilities to maximization of the efficiency of land port activities. Geographically, Benapole is a major point for border trading between India and Bangladesh owing to its proximity to Kolkata. Kolkata, one of the commercial hubs of India, is only 80 kilometers away from the Petrapole-Benapole land border. Benapole is the largest land port and the second largest custom station of Bangladesh as far as the total import volume and revenue collection is concerned. It is situated at the western border of Bangladesh. Most of the import and export trade between Bangladesh and India is done through this port using trucks as the prime carrier. Thus, either as a goods or tourists exchange port Benapole has a great scope to develop. As a result, its function especially, facilities should be housed in a planned way to perform all the tasks more smoothly and effectively. It must be provided for customs both of tourists and goods (export and import). The authors in [13] noted on the study “Performance Evaluation of Multimodal Transportation Systems.” Evaluation of performance of multimodal transportation systems which suggests the effectivity of multimodal transportation system. As the land port handles several modes of transportation for both goods and passenger it is important to process them thoroughly and in an integrated mean at a single time. Multimodal passenger terminal can handle a large number of passengers at a time and direct their flow with several modes of transportation with a smooth circulation system. For this scale of passenger handling in an efficient way, multimodal transportation system is considerable. Based on Drewry’s sample survey on the export trucks arriving and departing from Benapole, more than 39% of goods trucks originated from Dhaka, 32% from Jessore, 18 % from Khulna and 11% from the rest of the country. For goods imported from Inida, more than 82% originated from West Bengal, about 6% from Haryana and about 2% from Andra Pradesh [14]. Bangladesh’s economy maintained a strong growth of 5.8% per/year during the period 2000 to 2009. The economy registered a good growth of about 6.2% in 2008, before decelerating to 5.7% in 2008. This was due to the adverse effects of global recession and the decline of growth in manufacturing and wholesale and retail trade sectors. According to Bangladesh’s Ministry of Finance, GDP growth in 2010 was estimated at 6.0% [2]. The authors in [15] noted on the study “Port infrastructure investment and regional economic growth in China: Panel evidence in port regions and provinces” positive effects of port infrastructure investment are related to the character of the port (land or sea), stage of economic development of the region, international network connectivity, and the spillover effects from adjacent regions. (Song, 2014). So, it clearly suggests that the development of land port facility will positively impacts on regional economy. As Beanpole Land Port holds the major share of national GDP, the efficiency maximization should aid greatly on the increasing economic contribution to the regional and national scale. Based on BLP annual records, the base case cargo volume handled at BLP in forecasted to grow by an average of 4.1% per year from 1.58 million ton in 2010 to 5.41 million ton in 2020 [16]. In view of the volatility in the historical BLP volumes, Drewry has assumed that the political goodwill between India and Bangladesh will continue and that BLP will maintain the same 90% market share on the total Bangladesh land border crossing trade [14].

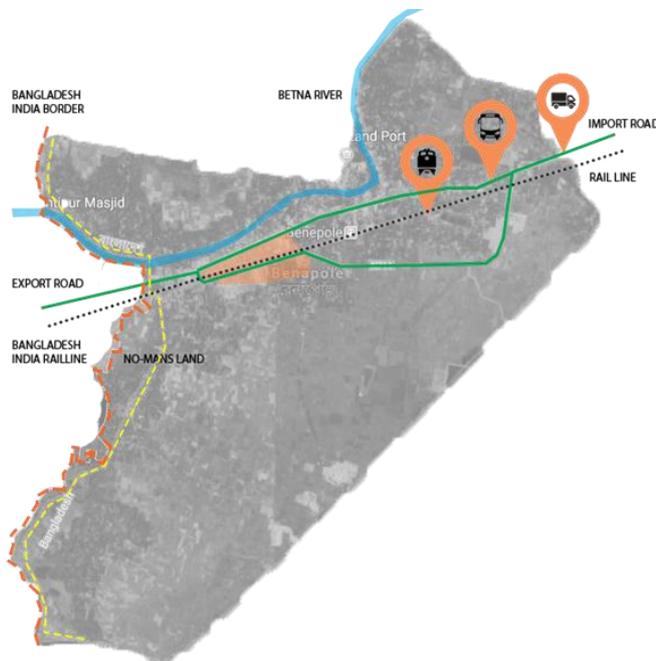
### 3. Methodology

Benapole land port is the most important and most used land port of Bangladesh. Though it handles most of the cross border trades it may not be functioning at its full efficiency. First is to understand the context by background study and identify the problems that the current condition arises. Secondly by data collection and in-depth site survey understanding the reasons that causes these problems. Thirdly after the reasoning the study may further guide to develop possible suitable alternatives of those problems. Fourthly computer aided simulation will be conducted with the prior analyzed data inputs on these alternatives of road networks. Finally, the functionality of these alternatives can be evaluated by the simulation results and the efficiency improvement can be assessed.



**Figure 1:** Methodology (Source: By Author)

### 4. Site Area



**Figure 2:** Benapole Land Port Map (Source: By Author)

Bangladesh has an extensively long border with India. Among its limited land ports with India Benapole is most important. Everyday huge number of people and tons of Goods are exchanged through this border. It must be noticed that the lion shares of export and import business is done by land and especially by this point. More over

Kolkata is connected with Dhaka by road through Benapole. So maximum tourists use this port as their entry and exit point for India.

#### 4.1 Existing Condition of Benapole Land Port

Benapole Land Port site is divided with multiple functional activity and different types of Land Use throughout the whole site. Major Land Use portion consists of warehouse, cargo and transshipment portion. The international passenger terminal consists of a very small portion of overall land use of the total functional land coverage. Another major coverage area consists of administration facility as immigration and customs facility, customs house, tax office and admin office etc. Bus terminal is located on the opposite side of the international passenger terminal building. There are dedicated two truck terminals designated as Indian Truck Terminal (TTI) and Bangladesh Truck Terminal (TTB) in the functional land area of Benapole Land Port site. As Benapole Port is the largest land port of entry in Bangladesh, it handles more than 80% of cross border trade with India and about 90% of the imported Indian goods enter Bangladesh through this port. Average 2000 passengers and 600-700 trucks of goods are passed through this point every day [2].

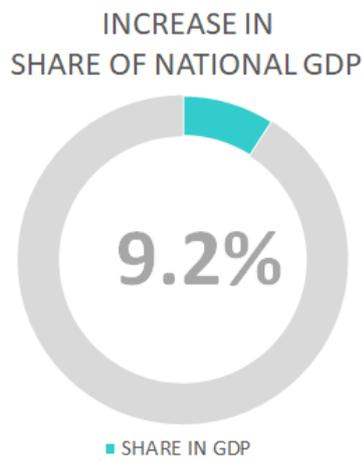


Figure 3: Existing Trade Condition (Source: By Author)

In the revenue sector Benapole Land Port holds the maximum share which is almost 63% of total revenue earned by all the land ports of Bangladesh which are operated under Bangladesh Land Port Authority. Whereas all the other five ports in total earns the remaining portion of the total revenue [2].



**Figure 4:** Existing Revenue Share (Source: By Author)



**Figure 5:** Share in GDP (Source: By Author)



**Figure 6:** Handling Capacity (Source: By Author)

In the commodity handling capacity, the Benapole Land Port handles most of the cross-border trade commodity as well as it impacts in the growth of the National GDP the most among all the other Land Ports.

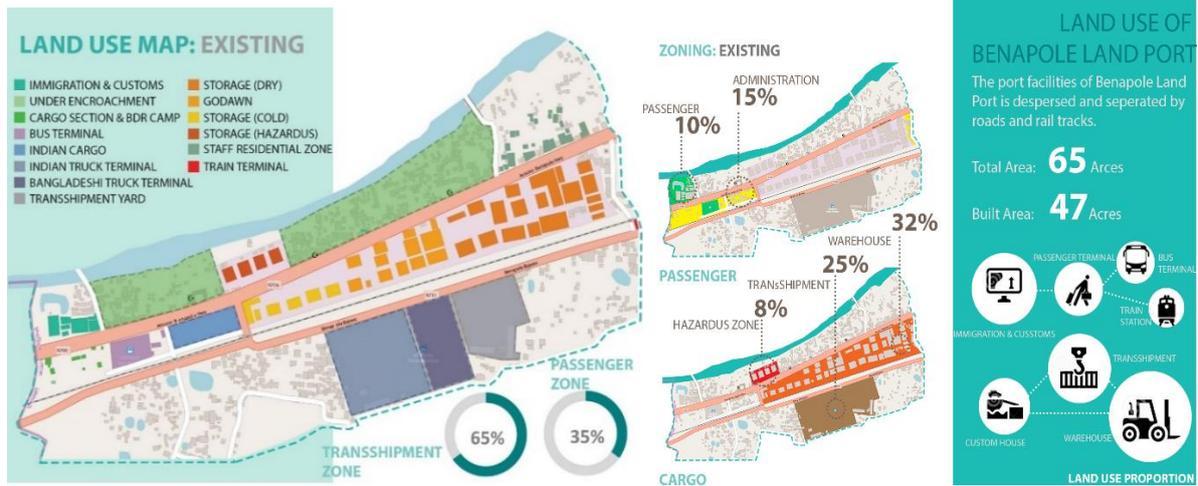
As the amount of transshipment is increasing, on the coming years this will have positive impact on the national economy if the handling capacity can be increased with that pace and the port can function with adequate efficiency.

#### ***4.2 Activities of Benapole Land Port***

All activities of Benapole Land Port are concentrated in two major sectors as Passenger & Cargo section. Major functions are Passenger Terminal, Bus Terminal, Train Station, Truck Terminal, Transshipment, and Immigration & Customs. Major activities of Benapole Land Port are divided into cargo and passenger sections. While cargo section holds the major percentage of 68% and passenger section holds the other 32% of total functional activities of Benapole Land Port [9]. In the section of passenger, the whole section can also be subdivided into departure and arrival segments. The departure segment is major segment by holding the 56% of the whole activities of the passenger section while arrival holds the 44% of the total section [9]. Similarly, by the segmentation of cargo section there are 29% activities dedicated to export segment whereas other and major 71% of activities are dedicated to the import segments [9].

#### ***4.3 Land Use of Benapole Land Port***

The land use of Benapole Land Port area is distinguished by two major sectors. The largest sector is the cargo sector and the other sector is the passenger sector. The connection that holds these two sectors together is the administration sector. The cargo section holds the major percentage of land use share in the existing Benapole Land Port site. It holds the major facilities like truck terminal for Bangladeshi and Indian trucks, transshipment yard, loading unloading yard, storage, godowns, warehouses etc. There are several warehouses for import and export products and goods as well as several yard for loading, unloading and transshipment purpose. Terminal areas for cargo are divided into Indian Truck Terminal and Bangladeshi Truck Terminal area. There is another yard which contains a large portion of area in the existing land of Benapole Land Port is the imported vehicle yard. Passenger Terminal area holds the immigration and customs facility for its administrative functioning and bus terminal for the mode of transportation of the passengers dedicated to arrival and departure purpose. The total area of existing Benapole Land Port is 65 acres of land. The fringe areas are under encroachment for the further extension of the Benapole Land Port facilities which is currently out on the lease basis to the civilians for temporary settlement and business purpose [17].

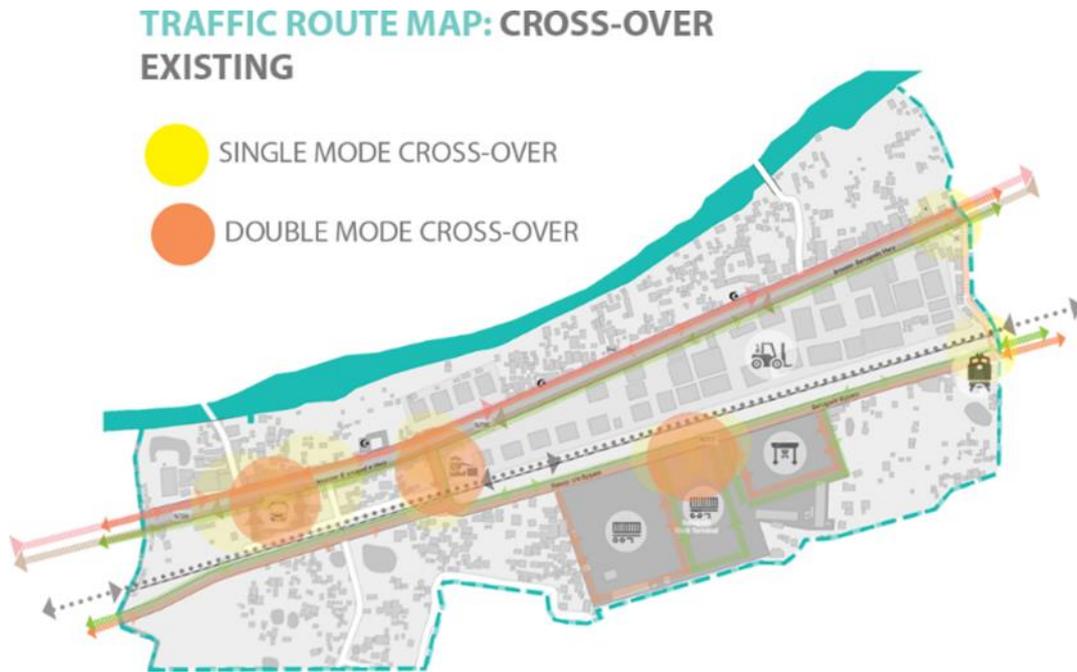


**Figure 7:** Land Use of BLP (Source: By Author)

North side of the side is enclosed by the Betna River. The other side which is south side is the location of Soto Achra Village of local people which has a very small number of population and minimum temporary settlements. Thus, the south side is the side of possible future extension of the Benapole Land Port area. Among the existing 65 acres of land area the built area is 47 acres. Among this area the cargo section holds the major portion. The total area of cargo section can be subdivided into three major portions among which warehouse portion holds 32% of the total cargo area. The transshipment area holds another major portion of 25% and remaining 8% area is dedicated to the hazardous zone [17]. In the area of passenger section there can be found sub division of passenger portion and the administration portion. Here the administration portion holds the major portion of 15% while the other 10% is dedicated to the passenger portion.

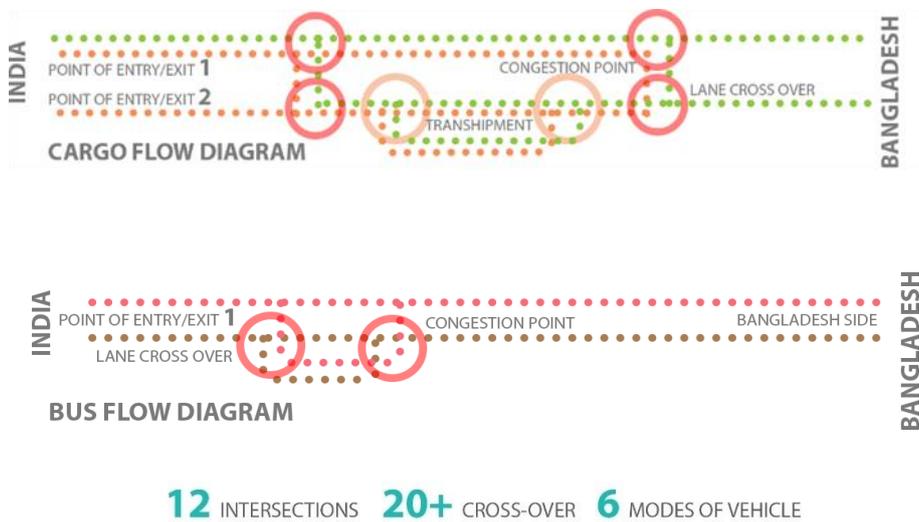
#### 4.4 Connectivity and Circulation of Benapole Land Port

The connectivity of Beanpole Land Port is concentrated in three different modes which are mainly Cargo, Bus and Rail. Passengers are mainly use road and rail as their modes of transportation. In road the buses and cargos are major types of vehicles along with some private modes of vehicles. As there are different modes of vehicles with different modes of transportation activity there the congestion occurs as the result of lacking and maintaining proper and systematic transportation network. There is no separate lane or route for the different modes of transportation system. This causes traffic congestion and lag in connectivity flow due to multiple cross-over and intersections between different modes of vehicles.



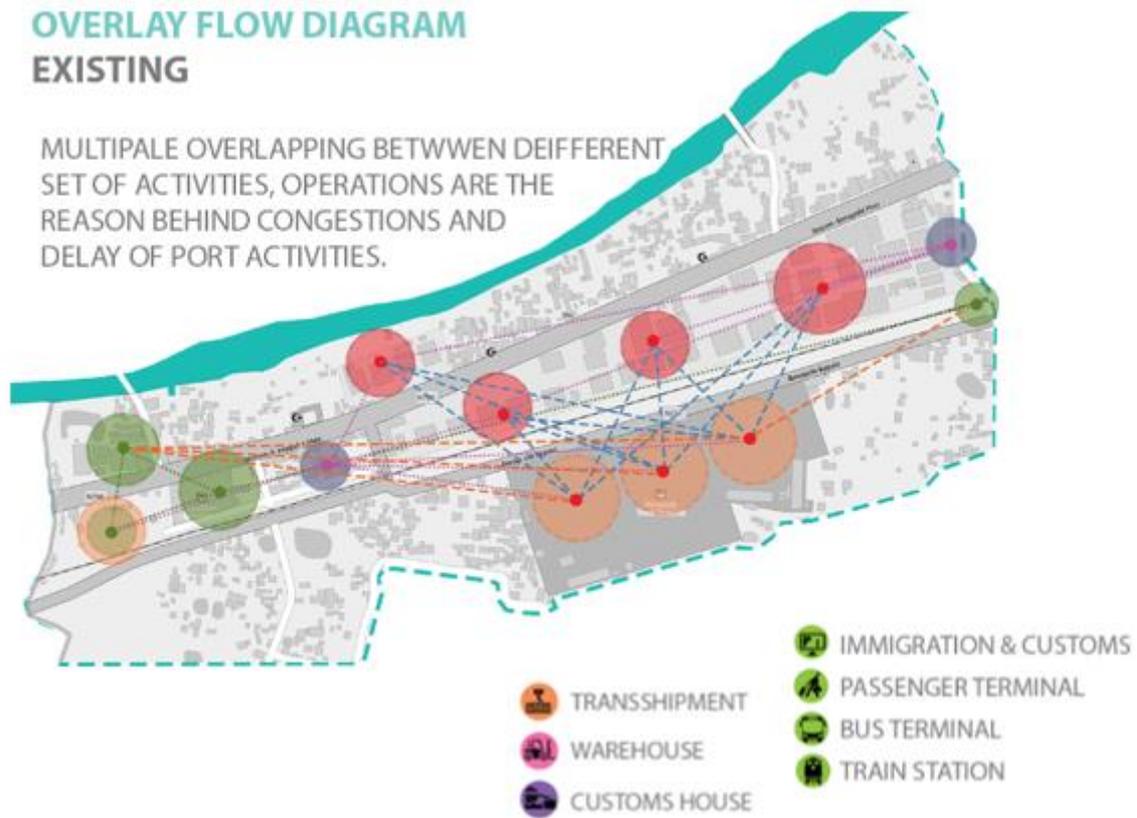
**Figure 8:** Existing Route Cross-over Map of BLP (Source: By Author)

The existing circulation flow diagram of Benapole Land Port indicates the circulation routes of different modes of vehicles and their points of intersections and cross-over which is the reason behind congestions and delay of the circulation and processing at the Benapole Land Port.



**Figure 9:** Existing Circulation Flow Diagram (Source: By Author)

In case of Cargo activities which includes product, handling and processing system, overlapping and organizational placement causes the delay in processing and non-sequential circulation system causes the increase in delay as well as increase in travel distance of products handing and processing.

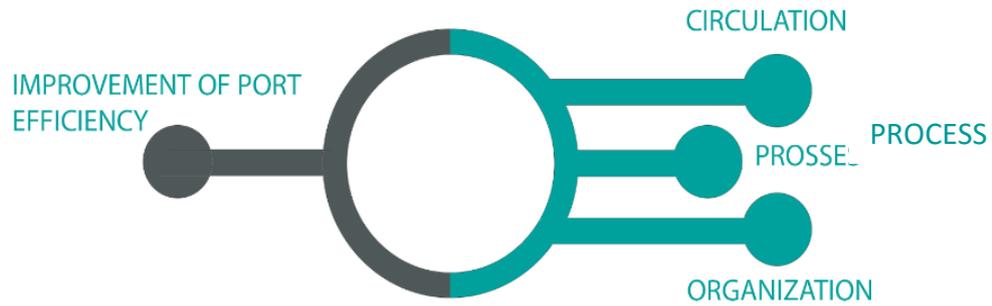


**Figure 10:** Existing Circulation Overlay Flow Map of BLP (Source: By Author)

This circulation overlay diagram indicates the multiple overlapping between different set of a operations which are the reason behind congestions and delay of port activities

### 5. Transportation Network Alternatives

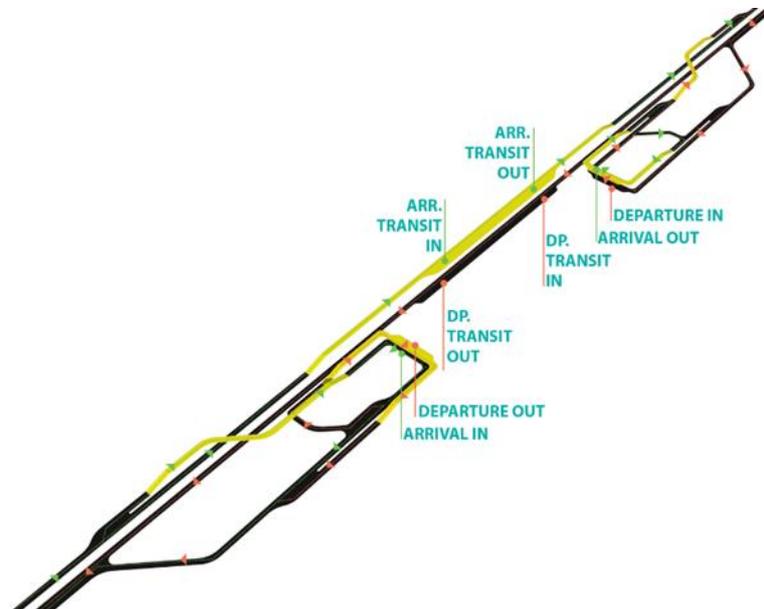
In Benapole Land Port, to ensure the smooth circulation among all modes of traffic as well as circulation of passengers and authorities personals the circulation can play a vital part also for the improvement in the Benapole Land Port's functional efficiency. Organization of different functions of Benapole Land Port can be the key element to improve its functionality. Integration and interconnection among the key functions are important to make sure the improvement in the efficiency. The interconnected one stop and single window process flow can make improvement in the circulation and integrated functions as it will make it a whole entity To improve the efficiency of Benapole Land Port in sense of circulation flow and product processing system it is important to bring the entire facility and its complex operation as well as circulation under a systematic integration system. Three major aspects can be initialized as the parts of this systematic organization. First of them is the circulation which is the vital part to make this whole facility running and it should be smooth and clear to make that run at its full extent and in an efficient manner.



**Figure 11:** Scopes of Alternative Efficiency Improvement in BLP (Source: By Author)

Secondly the organization of the facilities is directly related to the circulation system. It should be organized in a way that complements and directs the circulation in the same time to make the circulation and organization both efficient and smooth for the means of accessibility and processing. The organization of facilities and circulation of traffic, product and passengers can be achieved through the design approach and functional integration but the third and final part which is process should also be interpret in the system as policy and operational level to ensure and maximize the functionality in the organizational and circulation parts. Only then the whole facility can be at its full extent of efficiency.

## 6. Circulation System



**Figure 12:** Traffic Circulation Module I (Source: By Author)

Circulation is mainly divided into two major parts: passenger traffic circulation and cargo traffic circulation. There are several modes in the passenger traffic circulation, such as bus, private vehicle, auto rickshaw, train, etc. Whereas the cargo traffic can be divided into wagon train, truck, freight, etc. To ensure the most suitable possible

alternative circulation and transportation network there are 3 different circulation system with alternative organization and routes put side by side in comparison to establish the most efficient one.

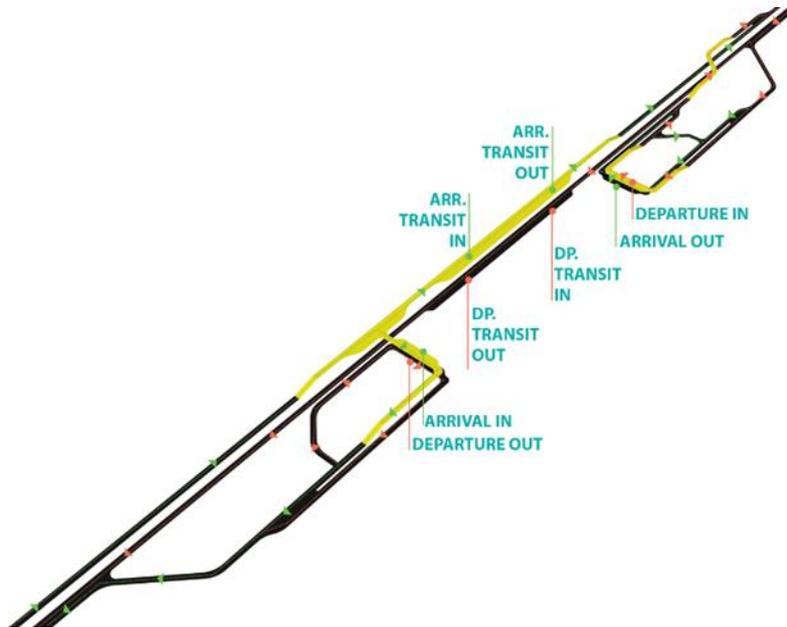


Figure 13: Traffic Circulation Module II (Source: By Author)

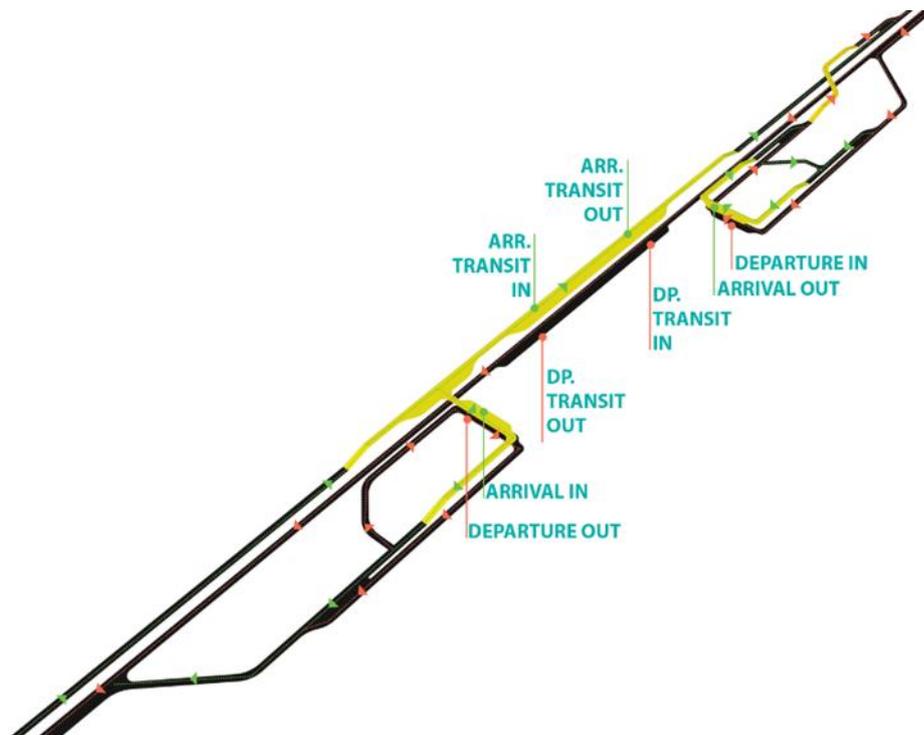


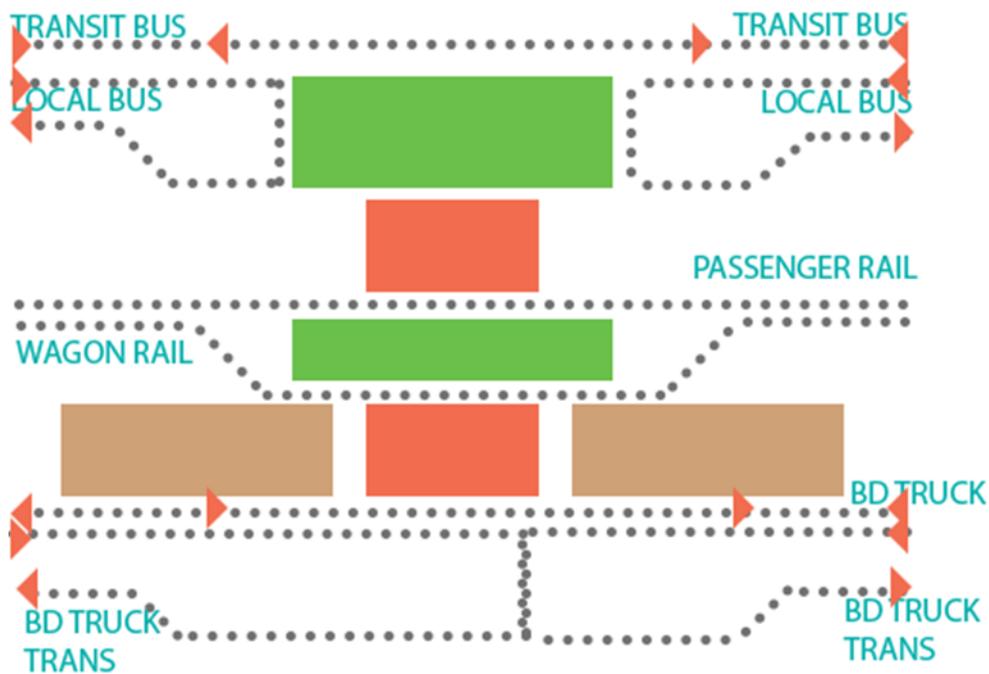
Figure 14: Traffic Circulation Module III (Source: By Author)

To make circulation free of congestion here the approach is to make separate route for separate purpose and traffic modes with the consideration of multilane one-way dedicated roads each for arrival and departure. For a single transit like arrival or departure there is the need of loops to make a clear in and out route for a single

transportation mode. Each single mode serves the purpose of both arrival and departure. As when it comes to the facility as the medium of transporting the departing passenger it leaves as the medium of arriving passenger away from the facility. Another consideration is the provision of parking facility for cars and bus depart for the local and shuttle buses. This circulation has to be in the loop connection as the buses or cars may have to go back to pick up point for a certain level of interval. This whole circulation is connected with the organization of the arrival and departure facility. The departure area should be on the ground level and the arrival at the upper level as the arrival area requires direct connection with parking area. After trying three different modules for circulation it can be determined that the circulation system with dedicated upper level for departure and arrival at dedicated lower level with the transit and local both mode for each transit at the same level (Circulation Module II) is most suitable in consideration to the circulation efficiency and design approach.

### 7. Organization

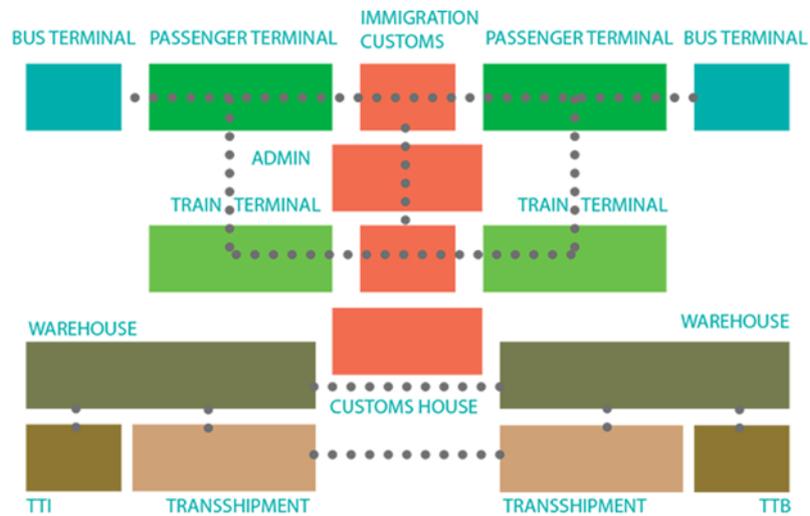
Organization of different functions in an integrated way along with the designed and designated circulation will help to interconnect and integrate all the functions. Organization should be in the manner that derived from the circulation itself and functional arrangements. Facilities of Benapole Land Port can be divided into major three parts as the passenger segment which holds the arrival and departure facility of each transit. The passenger segment is divided into two parts of local and transit segments. At each transit there should be availability of parking facility along them and in the middle of arrival and departure segments there is the placement of immigration and customs facility



**Figure 15:** Basic Circulation Deriving Organization (Source: By Author)

Another part is the train terminal which should be positioned along the passenger terminal and there should be

connection between both terminals to facilitate interchanges provisions. So, it is the most suitable position of administrative facility to be located in between these two terminals. Further the train terminal should be divided in the segments of arrival and departure separately. These basic circulations complementing the organization and placements of functions in a systematic and orderly manner which supports the sequential activities of the products, passengers as well as traffic to reduce the congestions and ensure an effective and efficient circulation system and process flow. These suggests the organization of the major functions and port activities in an orderly manner to support and merge with the main circulation system and traffic network.



**Figure 16:** Organization Diagram (Source: By Author)

This organization leads to further segregation of each sectors. In case of the passenger terminal the suitable arrangement can be found from the previous three trail circulation-oriented organization

From the comparison between three alternatives it is clear that best systematic organization is to arrangement of departure and arrival in separate levels along with arrival transit in horizontal separation with arrival level and departure transit wing with horizontal separation with departure level, while whole departure and arrival facility is in vertical separation.

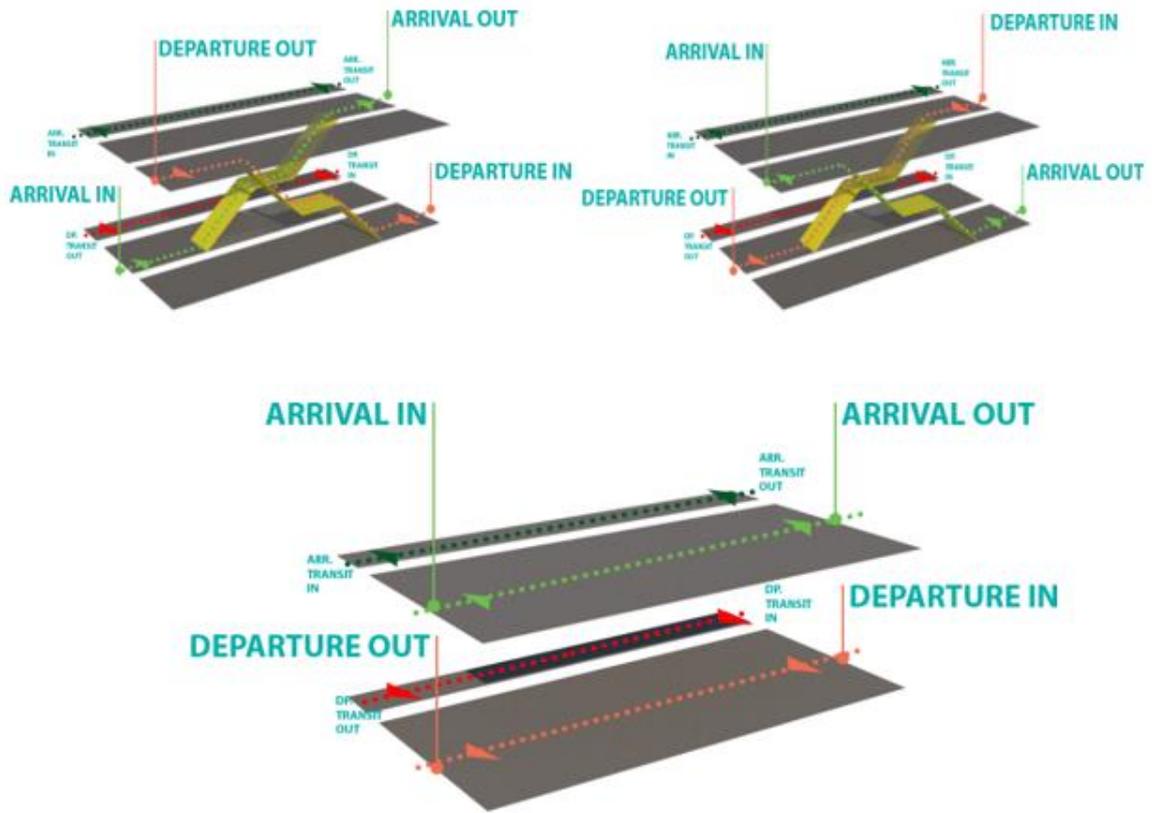


Figure 17: Passenger Circulation Alternatives (Source: By Author)

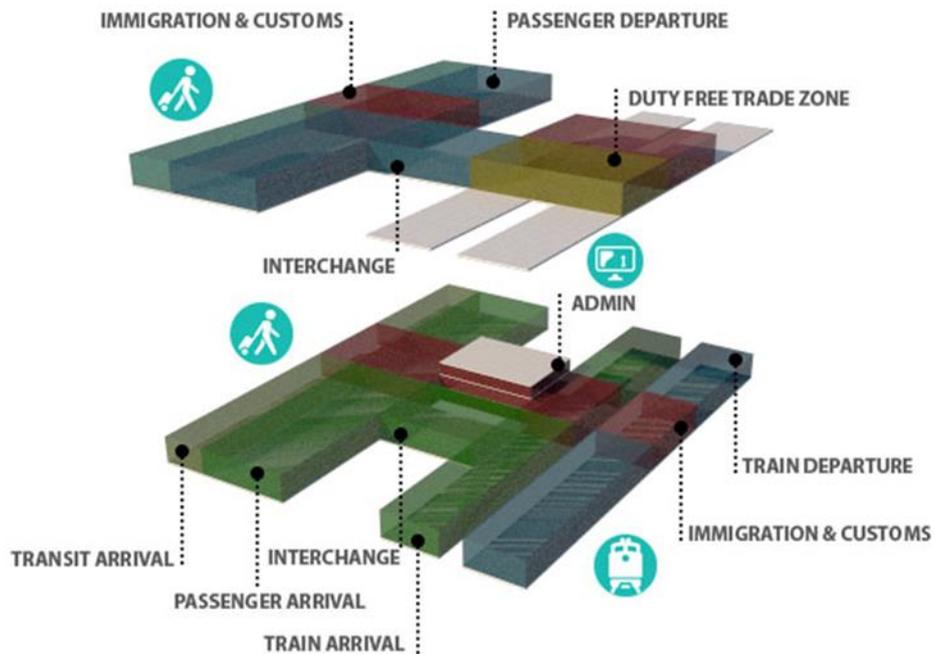
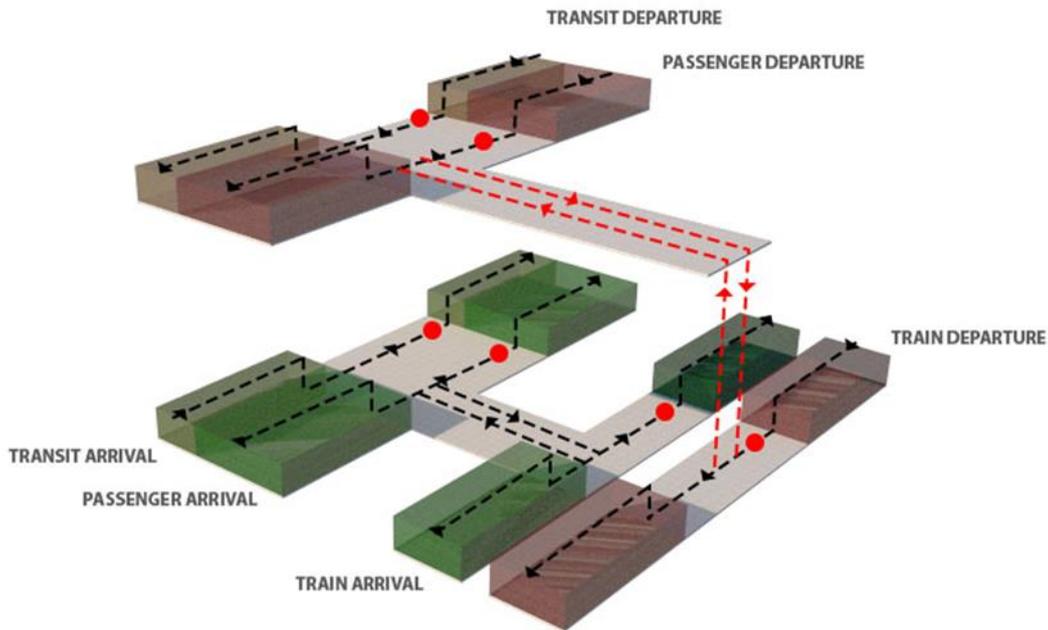


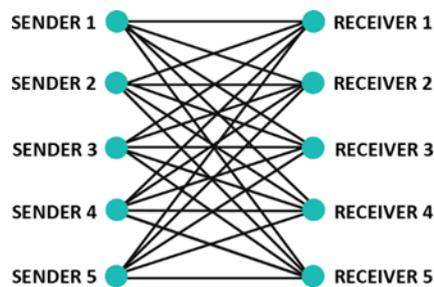
Figure 18: Functional Zoning (Source: By Author)



**Figure 19:** Passenger Circulation (Source: By Author)

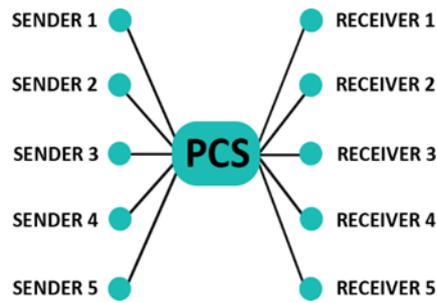
### 8. Processing System

The system of processing product as unloading, storing, transshipment, C&F (clearance & forwarding), recording, and taxation is currently very complicated and goes through very lengthy procedure which cost a large amount of time in sense of delay and causes inefficiency. These can be minimized by the application some systematic procedures and managements. Port community systems (PCSs) can address these and similar challenges. PCSs are neutral and open electronic platforms that optimize, manage, and automate seaport and airport logistics processes through single submissions of data, enabling intelligent and secure information exchange between public and private stakeholders.



**Figure 20:** Traditional Operating System (SCPs) Source: By Author

PCSs enables the simplification, standardization, and acceleration of information exchange among supply chain participants (SCPs). They are also responsible for increasing the efficiency of interactions between the various private SCPs and government bodies such as customs and maritime and port authorities in authorizing, monitoring, controlling, and verifying port processes.



**Figure 21: PCS Operating System (Source: By Author)**

In the single window operating system, the whole process is cabled in a single station with a background operating system which results in a system of processing with more efficiency in means of time and organizational managements. These PCSs and Single window operating system can help to establish a more efficient and smooth process by integrating the circulation and the organization in a more complementary way.

### **9. Simulation of Transportation Network**

Different circulation routes can be formed as an approach to find out the most suitable and efficient circulation system for the Benapole Land Port facility. By which the circulation system module can be formed. Among them after comparative analysis of the modules some determinations can be made. The final resultant of these determinations for the best suitable circulation system can be backed by computer aided simulation of the circulation system. The simulation can give the insight of the possibilities of these circulation systems to work as well as their efficiency in a scientific and systematic way. This simulation can show the numbers of the functionality and the feasibility of the alternative circulation system for the Benapole Land Port facility with their outmost possible efficiency. The simulation conducted with the computer aided simulation software Anylogic 8.5 PLE. Amongst the tree circulation module, the better performing option determined by the simulation. For this Simulation all three modules are generated as digital models. The Circulation routes then gets mapped on the digital model according to the design In this model the parking, stoppage and intersections are placed in a representing manner of ratio to the actual design load. Then the car source (for bus and private vehicles) created with the data and attributes that represents the future traffic load that this circulation system has to uphold. The entries of traffic load are the collections of data from the physical survey of the existing traffic condition by the author. These collective data further processed to estimate the future traffic load for the Benapole Land Port up to 2040.

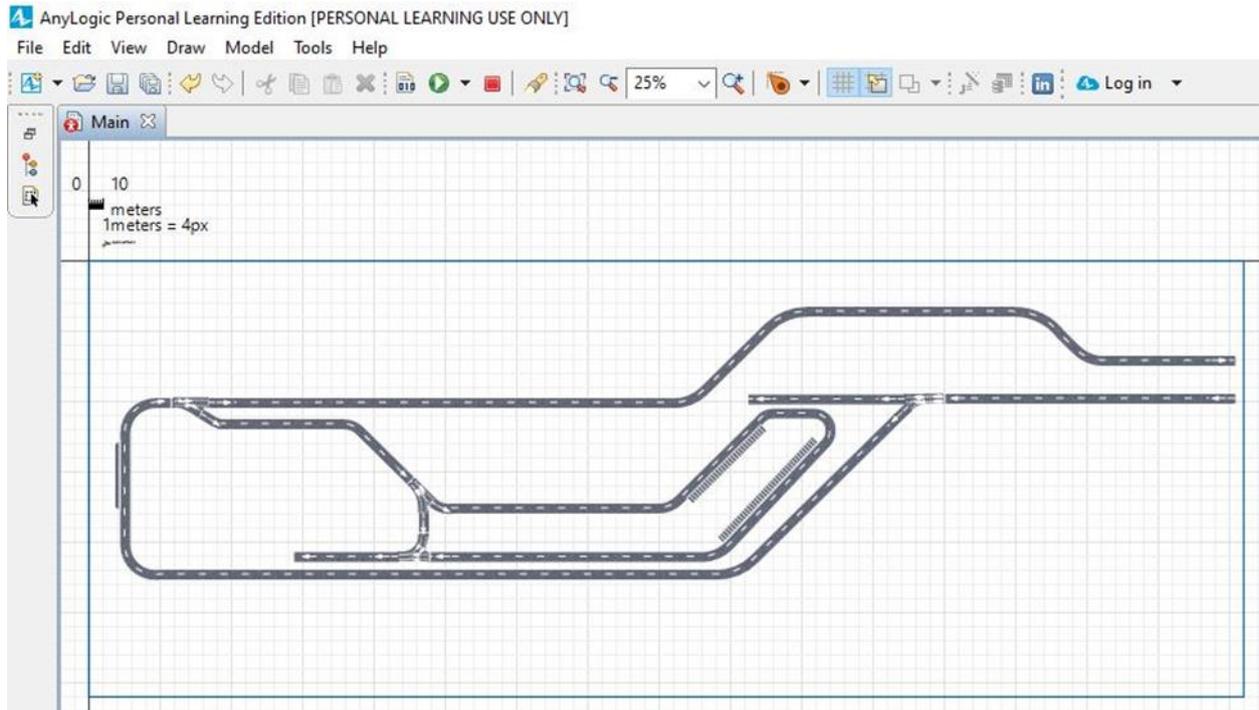


Figure 22: Digital Model of Circulation Module in AnyLogic (Source: By Author)

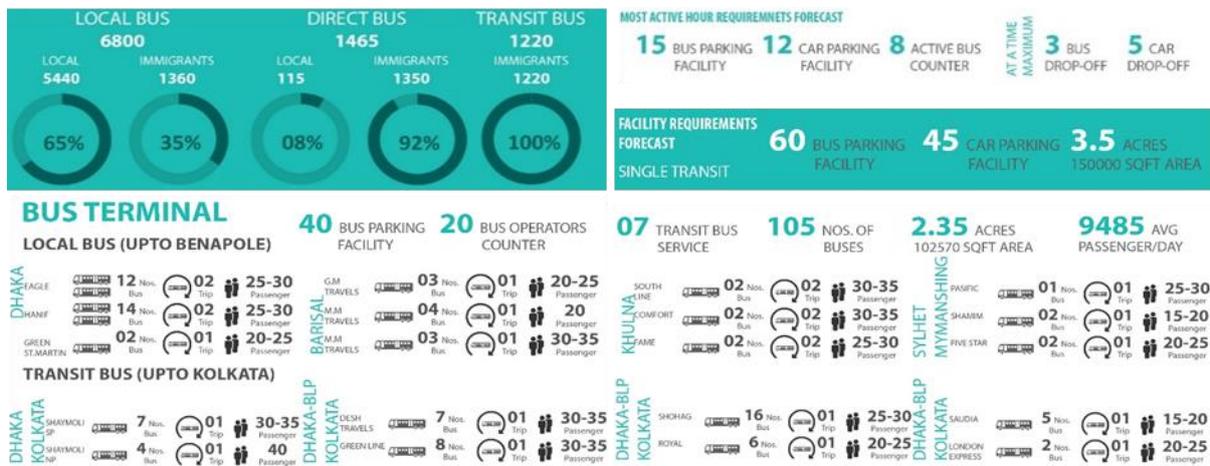


Figure 23: Traffic Data and Estimated Traffic Load (Source: By Author)

Next phase is for required data inputs in the source attributes as car amount at a time, car speed, car parking requirements at a time, car stoppage for required number of cars at a time etc.

The screenshot displays the configuration interface for a simulation source. The top section is titled 'carSource - CarSource' and includes the following settings:

- Ignore
- Arrivals defined by:  (dropdown)
- Arrival rate:  per hour (dropdown)
- Set agent parameters from DB:
- Limited number of arrivals:

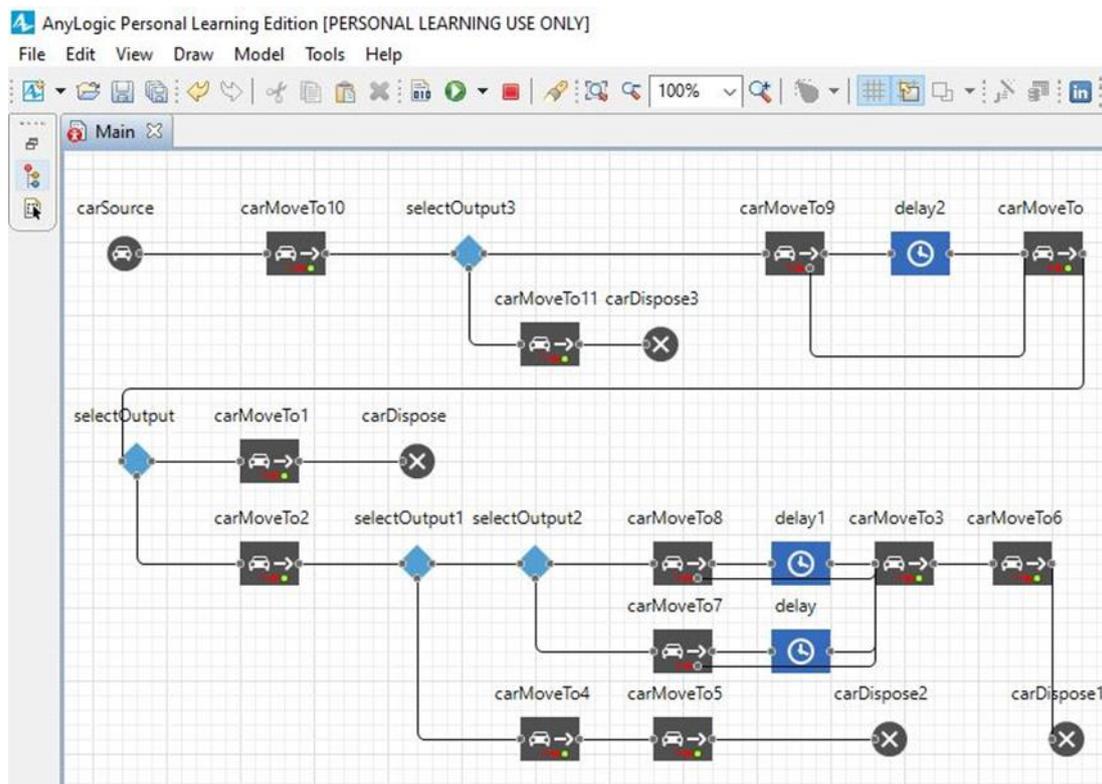
The bottom section is titled 'Car' and includes the following settings:

- New car:  (dropdown)
- Length:  meters (dropdown)
- Initial speed:  kilometers per hour (dropdown)
- Preferred speed:  kilometers per hour (dropdown)
- Max acceleration:  meters per second<sup>2</sup> (dropdown)
- Max deceleration:  meters per second<sup>2</sup> (dropdown)

**Figure 24:** Source Data Input in Anylogic (Source: By Author)

After completion of the source data inputs in all sources of bus and cars for arrival rates, parking numbers, stoppage delay, parking delay and departure, parking waiting time, stoppage waiting time then the next phase is programming the flow chart for the simulation to be conducted. The circulation flow programming maps the flow of traffics, there routes, stoppages and parking, delay and waiting etc. It controls the speed and numbers of buses and cars according to the estimated required numbers. This programming is the key to conduct the final simulation. It controls and processes the whole simulation as per the source inputs which represents the physical and practical values of traffics and circulation system of the Benapole Land Port according to the estimated conditions. The simulation of circulation modules shows the efficiency and effectivity of each of three circulation modules. These modules represent the circulation routes for the transportation system. The input of traffic numbers is followed by the demand of current increasing rate. Here the simulation is conducted for 120 traffics per hour rate and for 24 hours of time frame with the estimated traffic values for 2040. The simulation shows the effectivity of the parking spaces and stoppage spaces provided in the modules. The simulation also shows the congestion rates based on the cross-overs and intersections between traffics in the designed circulation network. The lower the congestion rate the better the circulation system will work for a smooth circulation flow of traffics. For the 24 hours simulation on the three different modules with the same variables inputs the module II handles the traffics more smoothly as it shows less traffic congestions on the routes as well as the parking facility and stoppage spots shows less congestions than the other two modules. Less congestion results in less delay and smooth circulation for the transportation network. The simulation clearly indicates that the circulation module II with the complete separation performs better. In circulation module II where, dedicated upper level is for departure and arrival at dedicated lower level with the transit and local both mode for each

transit at the same level (Circulation Module II) is the circulation network with the lowest congestion rate.



**Figure 25:** Circulation Flow Programming in AnyLogic (Source: By Author)

This simulation indicates that by rethinking the circulation system and transportation network it is possible to minimize traffic congestions and delay in the Benapole Land Prot facility. These also gives insight of the effectivity of this circulation system to perform with the estimated traffic loads of the upcoming years up to 2040. However, the inputs of the variables for the traffic are predicted for the future based on the current condition and the rate of increase, which can only be predicated and in future the actual numbers and conditions may vary from the predictions. Also the rate of increase in transshipment and the transportation may depend on the future national economy, political condition between cross boarder countries and globalization conditions. As the simulation runs in the context and traffic loads for 2040, the capacity of this circulation system clearly indicates its efficiency to perform as per the required ranges. With the minimum rates of congestion this will ensure flowless and smooth circulation of traffics which will result in the maximization of efficiency for the Benapole Land Port.

**10. Conclusion**

The Benapole Land Port also considered as the landmark of Bangladesh Border among the all other ports throughout the border between Bangladesh and India. It has its prestige as well as importance for its use and stands along the time and in the frame of the cross-border trades between Bangladesh and India. As the most important and most used land port among all other land ports it stands alone in the handling of major portion of goods and products cross border trade also the most used land port for the crossing of passengers between

Bangladesh and India through several modes of transportation. With the increasing amount of traffic, the port facilities are not being able to function at its full efficiency while the problems arise like congestions, delay and economic loss. A systematic integration of transportation network can help this land port to not only manage the system more smoothly but also reduce the congestions and traffic hustle. More flawless transit and transshipment facilities can also be accommodated with the integration of a suitable transportation network. By the means of computer aided simulation, evaluation of different types of transportation network is possible. From these evolutions the possible suitable transportation network with their impact in efficiency maximization of Benapole land port is assessed. Thus, from an ultimate chaos, the simple decision of designing the place can bring order and flow. Benapole land port should be function at outmost efficiency because of its importance of services both in passengers and port facilities.

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