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IMPACT OF PADMA MULTI-PURPOSE BRIDGE ON RE-ROUTING SOUTHWESTERN REGION'S CONNECTIVITY TO DHAKA

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ABSTRACT

The Padma Multi-purpose Bridge (PMB) is a milestone project of Bangladesh. The PMB connects the southwestern districts with Dhaka and has reduced travel time and distance. The objective of this research is to explore how the traffic from 21 southwestern districts has been rerouted from the previously taken route, Paturia-Aricha. Using Dijkstra's Algorithm and Google API data, the shortest path and quickest path to Dhaka are estimated before and after the opening of the PMB on 26 June, 2022, for 21 districts. The outputs are mapped in GIS. Besides comparing the shortest path and quickest path before and after the PMB, an analysis is made on how some districts prefer the quickest path over the shortest path. Finally, a map shows the influence zone of the PMB on rerouting the traffic from 21 southwestern districts.

Keywords: *Padma Multi-purpose Bridge; traffic; regional connectivity; Southwestern region; Dhaka.*

1. INTRODUCTION

Bridges are important infrastructure reducing physical barriers in a riverine country like Bangladesh. There are numerous rivers in Bangladesh, and many of those run from the north to the south, eventually reaching the Bay of Bengal. In Bangladesh, there are 213 rivers, and 20 significant bridges have been built over them (Jalil & Mia, 2021). Millions of people are dependent on rivers for the production of their agricultural outputs as well as the transportation of goods and commodities from one region to another. On the other hand, rivers act as a barrier to communication between the different parts of the country since they geographically separate the areas. The inability to link the different parts of the country with one another is exacerbated by the absence of bridges.

The Padma River serves as a natural boundary between the rest of Bangladesh and the southwest region of the country. Before the bridge was opened, the only way to travel between the two locations was to take an alternative route through public transport using the Paturia-Aricha ferry. However, the number of passengers that could be accommodated on such ships was fairly low, and the waiting periods at the ferry port varied from two to more than ten hours. There are around 60 million people who live in the 21 southwestern districts that are physically separated from the rest of the country by the river Padma. The Padma Multi-purpose Bridge (PMB), more commonly known as the Padma Bridge, is one of the most complex and challenging constructions that have ever been constructed in Bangladesh. It crosses the Padma River and is 6150 meters in length (Hafsa *et al*., 2022).

Prior to the commissioning of the PMB, transportation connectivity between the southwestern region and the capital, Dhaka, primarily relied on inland waterways. The southern region was connected to Dhaka via two inland waterways: Mawa-Kathabari and Paturia-Goalundo (Ali *et al*., 2022). Nearly one million vehicles and 21 million passengers traverse the Padma River annually at the Paturia-Goalundo and Mawa-Charjanajat crossings. Daily, approximately 58,000 individuals were documented traversing the river by vehicle or passenger ferry, commonly referred to as a launch (Sourav *et al*., 2022). The Paturia site previously utilized a fleet of 22 boats that operated continuously for 24 hours across five river terminals. Conversely, the Goalundo site comprised three river terminals (Ali *et al*., 2022).

The southwestern region's transportation dynamics have shifted considerably since the Padma Multi-purpose Bridge (PMB) opened. There's now significantly less reliance on water-based transport, accompanied by a notable surge in road traffic. According to a Japan International Cooperation Agency (JICA) accessibility study, the bridge is expected to handle 21,300 vehicles daily, a figure projected to climb to 41,600 by 2025. Consequently, waterway transport infrastructure, such as vehicle and passenger ferries in the southern areas, is declining as travelers increasingly opt for the convenience of using the Padma Bridge over lengthy ferry queues. This preference has led to a substantial increase in the number of buses operating on Dhaka-southwestern routes compared to previous times (Rashid *et al*., 2023). Furthermore, research by Jalil and Mia (2021) and Ali *et al*. (2022) indicates that the bridge cuts travel times by about 2 hours for cars and buses and a remarkable 10 hours

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for trucks, leading to daily fuel savings of 681,600 liters. A passenger survey also suggests that over 65% of air travelers are willing to switch to road or rail transport once the PMB is fully operational (Sohag & Rokonuzzaman, 2016; Sourav et al., 2023).

In terms of its magnitude, expense, and socioeconomic implications it will have, the project itself is a significant achievement. Sheik Hasina, the former Prime Minister of Bangladesh, inaugurated the beginning of work on the Padma Bridge on December 12, 2015 (Editor, 2022). The Padma Bridge is essential to the development of the southern region of Bangladesh in several different ways. The Bridge construction has brought plenty of benefits to the people living in the southwestern region of the nation. With the completion of the Padma Multi-purpose Bridge (PMB), the travel time from the southwestern area to Dhaka and beyond was significantly reduced. The bridge provides a direct connection to Bangladesh's two major seaports, Mongla and Payra, as well as the tourism zone that is located in the Khulna Division. Furthermore, it will assist in the development of the trans-Asian rail network (Padma Multi-purpose Bridge, Bangladesh, 2019).

As a result of the operations of the PMB, the distance between Dhaka and other locations in the southwest region was reduced by at least one hundred kilometers. This resulted in a reduction in the amount of time it took to travel as well as the cost of doing so, and it also improved the country's commodity movement systems (Hafsa *et al*., 2022). In addition to this, the PMB will improve links between the various districts. In the scientific literature, the question of how far the PMB would reroute traffic geographically and regionally, all the way to Dhaka and beyond, has not yet been explored.

This paper aims to investigate how the construction of the PMB will re-route traffic between the southwestern region and Dhaka. The research, therefore, tries to identify the change in connectivity and travel patterns due to PMB. The objective of the research is to identify the inter-district and inter-region new transport networks as a result of the PMB. In doing so, the study tries to map the primary and secondary spheres of traffic re-routing due to the PMB. Secondly, the study tries to find out the shortest path based on time and distance to and from different parts of the southwestern regions to Dhaka due to the construction of the PMB.

Construction of the PMB has impetus for alternative route development. For example, the Kalna Bridge has re-routed traffic from Khulna. Thus, the construction of bridges has incentives for alternative route development or even the development of secondary and tertiary routes. To our knowledge, this is the first study that investigates the re-routing of traffic from the southwestern district to Dhaka. Subsequently, bridges have social, economic, and political consequences. Additionally, the PMB has the impetus for land use conversion in the Munshiganj district. Therefore, this study can assist future studies on the PMB and other bridge construction projects in Bangladesh and beyond. The rest of the paper is organized in the following manner. The second section is materials and methods. The third section is results and discussion, followed by conclusion in the fourth section.

2. MATERIALS AND METHOD

2.1 Study Area

The Padma Bridge is a multifunctional railroad bridge that is built in Bangladesh across the Padma River. The bridge joins Mawa and Janjira, connecting the country's southwest to its northern and eastern areas. It is a two-deck composite steel truss building. A four-lane highway can be found on the upper deck, and the lower deck will eventually hold a rail line, a gas transmission pipeline, an optical fiber cable, and electricity transmission lines. The bridge is 22 m wide and 6.15 km long. The bridge is made up of 41 spans, each measuring 150.12 m. It is the longest bridge in Bangladesh and is the longest bridge over the Ganges by both span and overall length.

We have chosen 21 districts as the destinations that are cut off from the rest of the country by the river Padma: Satkhira, Khulna, Bagerhat, Pirojpur, Jhalokhati, Barguna, Patuakhali, Bhola, Barishal, Gopalganj, Narail, Jessore, Madaripur, Shariatpur, Faridpur, Magura, Jhenaidah, Chuadanga, Meherpur, Kustia and Rajbari. We have selected two locations in Dhaka as the starting points for this study (Figure 1).

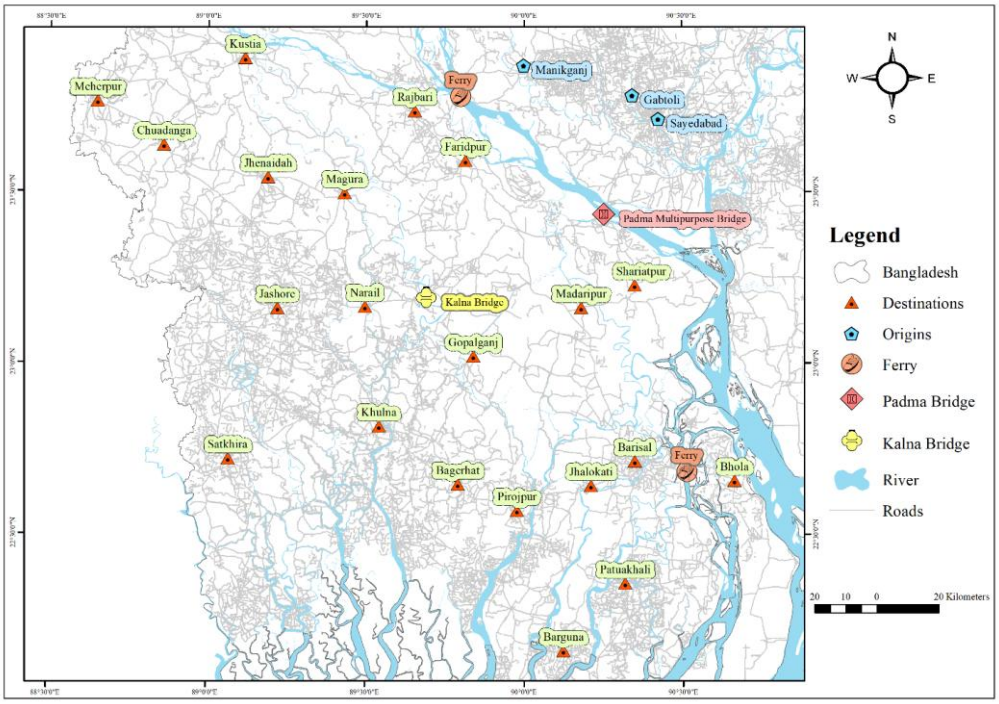
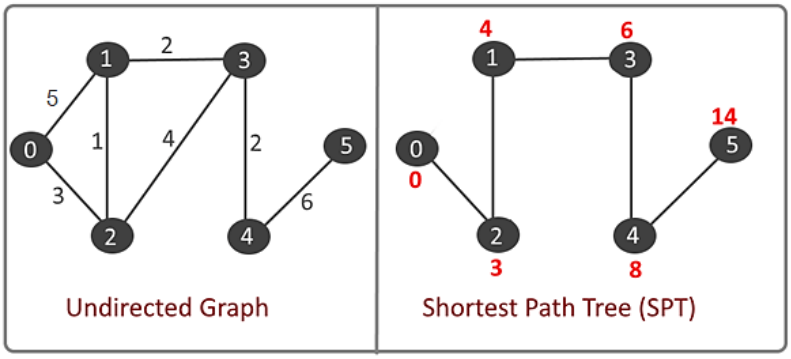


Figure 1: Study area

2.2 Research Framework

A total of 21 districts are considered for the shortest time and distance analysis. The primary objective is to see how the PMB has re-routed traffic to and from Dhaka and the 21 districts. Secondly, Google Application Programming Interface **(**API) data is used for identifying the shortest time and distance between the two origins, 21 district headquarters and Dhaka. APIs can also offer estimated travel durations that factor in real-time traffic. This information is gathered from diverse inputs, such as GPS data from Google Maps users, signals from government sensors, and contributions from other data providers. We identified the shortest time and distance before and after the construction of the PMB. Thirdly, travel time and distance are calculated between the two-time frames. Finally, the re-routed traffic is mapped in GIS.

The shortest path is the best route or the route with the least impedance between two or more points (*GIS Dictionary*, 2014). Dijkstra's algorithm (Figure 2; self-explanatory) determines the shortest pathways between two nodes in a weighted graph, which can symbolize a road network. Figure 2(a) shows multiple options from the 0-starting node to the 5-finish point. Figure 2(b) shows the shortest distance through the connecting node. We can determine the shortest route between any two graph vertices using Dijkstra's approach. The shortest distance between two vertices may not include all of the graph's vertices, which makes it different from the minimal spanning tree (Khan, 2020).



(a) Undirected traffic flow (b) Shortest path traffic

Figure 2: Shortest path based on Dijkstra's Algorithm

Dijkstra applied this principle in the reverse direction, meaning that we overestimate the distances between each vertex and the origin. To determine the shortest sub-path to each node's neighbors, we then visit each node and those neighbors. The method takes a greedy approach in that we look for the next best solution in the hopes that the final result will be the best answer to the entire problem (Khan, 2020).

2.3 Data Collection

The shapefile of Bangladesh's road system was compiled from (Bangladesh Road Network, 2020). The dataset included seven different categories of roadways: highways, primary, secondary, tertiary, residential, track/trail, and pathway. The road network considered in the analysis included highways, primary, secondary and tertiary roads that support vehicular movement, while residential roads, tracks, trails, and pathways were excluded to maintain focus on vehicle accessibility. Travel times and distances between districts were collected using Google Maps routing service for two distinct times to assess the impact of Padma Bridge construction (Table 1).

Table 1: Travel route, time and distance before and after construction of the PMB

District	Before Padma Bridge (September, 2021)			After Padma Bridge (September, 2022)		
	Travel Route	**Travel Time**	**Travel Distance**	**Travel Route**	**Travel Time**	**Travel Distance**
Khulna	Khulna city Bypass(N709)- Dhaka-Aricha Hwy/N5 (ferry)	7 hr 20 min	271 km	Gopalganj-Padma Brg Rd-Dhaka	4 hr 30 min	221 km
	Khulna - Shariatpur to Mawa-Kaorakandi Ferry	7 hr	245 km			
Bagerhat	Bagerhat-Khulna Rd-Dhaka-Aricha Hwy/N5 (ferry)	7 hr 12 min	270 km	Khulna-Bagerhat-Padma Brg Rd-Dhaka	4 hr 49 min	215 min
	Bagerhat- Khulna Hwy-Shariatpur to Mawa-Kaorakandi (ferry)	6 hr 47 min	218 km			
Jessore	AH1 and N1 to terminal Rd to Paturia- Daulatdia-Dhaka-Aricha (ferry)	6 hr 33 min	206 km	Naldanga Rd-Vatiyapara-Padma Brg Rd-Dhaka	5 hr 12 min	182 km
Kushtia	Dhaka-Kushtia-Dhaka-Aricha (ferry)	5 hr 34 min	170 km	Faridpur-Faridpur-Bhanga-Padma Brg Rd-Dhaka	5 hr 7 min	208 km
Magura	N7 to Paturia- Daulatdia Ferry (ferry)	5 hr 45 min	167 km	Faridpur-Bhanga-Padma Brg-Dhaka	4 hr 23 min	174 km
Satkhira	Satkhira- Paturia-Daulatdia (ferry) (best)	9 hr 46 min	327 km	Satkhira-Khulna-Padma Brg Rd-Dhaka	7 hr 25 min	325 km
Gopalganj	Tekerhat-Gopalganj-Bhanga-Paturia- Daulatdia (ferry)	6 hr 48 min	192 min	Gopalganj-Padma Brg Rd-Dhaka	3 hr 54 min	169 min
	Tekerhat-Gopalganj – Bhanga- Mawa (ferry)	6 hr 10 min	140 km			
Faridpur	Faridpur-Magura-Paturia-Daulatida (ferry)	4 hr 37 min	136km	Faridpur-Magura-Bhanga-Padma Brg-Dhaka	3 hr 31 min	141 km
Barisal	Dhaka - Barisal - Bhanga - Mawa-Kaorakandi (ferry)	6 hr 42 min	202 km	Barisal-Padma Brg Rd-Dhaka	4 hr 39 min	185 km
Pirojpur	Gopalgonj-Tungipara-Shibchar-Mawa-Kaorakandi (ferry)	6 hr 33 min	233 km	Gopalgon j- Padma Brg Rd-Dhaka	4 hr 44 min	216 km
Barguna	Barisal-Bhanga - Mawa-Kaorakandi (ferry)	8 hr 7 min	283 km	Bakergonj, Bhanga-Padma Brg Rd-Dhaka	7 hr 22 min	269 km
Jhenaidah	Paturia-Daulatdia-Dhaka-Aricha (ferry)	6 hr 43 min	195 km	Faridpur-Bhanga-Padma Brg Rd-Dhaka	4 hr 46 min	195 km
	Faridpur – Bhanga-Mawa-Kaorakandi (ferry)	6 hr 18 min	195 km			

Pre-bridge data was collected in September, 2021 and post-bridge data was obtained on September, 2022. We conducted all searches using driving mode as the primary transportation method. The routing algorithm utilized Google Maps' default fastest route optimization, which automatically selects the most efficient path based on current road network conditions. Importantly, the travel time and distance calculations incorporated all real-world travel conditions, including ferry crossings and toll roads to provide accurate representations of actual journey requirements. Even though the study considers 21 districts, only 12 of those are highlighted to give an overview of the impacts.

3. RESULTS AND DISCUSSION

3.1 Shortest Path

The shortest paths based on travel distance are estimated for two major entry points to Dhaka from the southwestern coastal regions: Gabtoli and Sayedabad (Figures 3-4, Tables 2-3).

3.1.1 From Gabtoli

In the case of the connectivity from Gabtoli to other districts taken into account for this study, it is found that Meherpur, Chuadanga, Jhenaidah, Magura, Jashore, Rajbari, Faridpur, Kushtia take the ferry route. On the contrary, Barguna, Patuakhali, Jhalokathi, Barisal, Madaripur, Shariatpur, Khulna, Gopalganj, Bagerhat, and Pirojpur –these ten districts directly take the route over the Padma Multi-purpose Bridge, because it proves to be the shortest path for these districts. Meanwhile, Satkhira and Narail take Kalna Bridge first and then take the route of the Padma Multi-purpose Bridge to get their connectivity to Gabtoli.

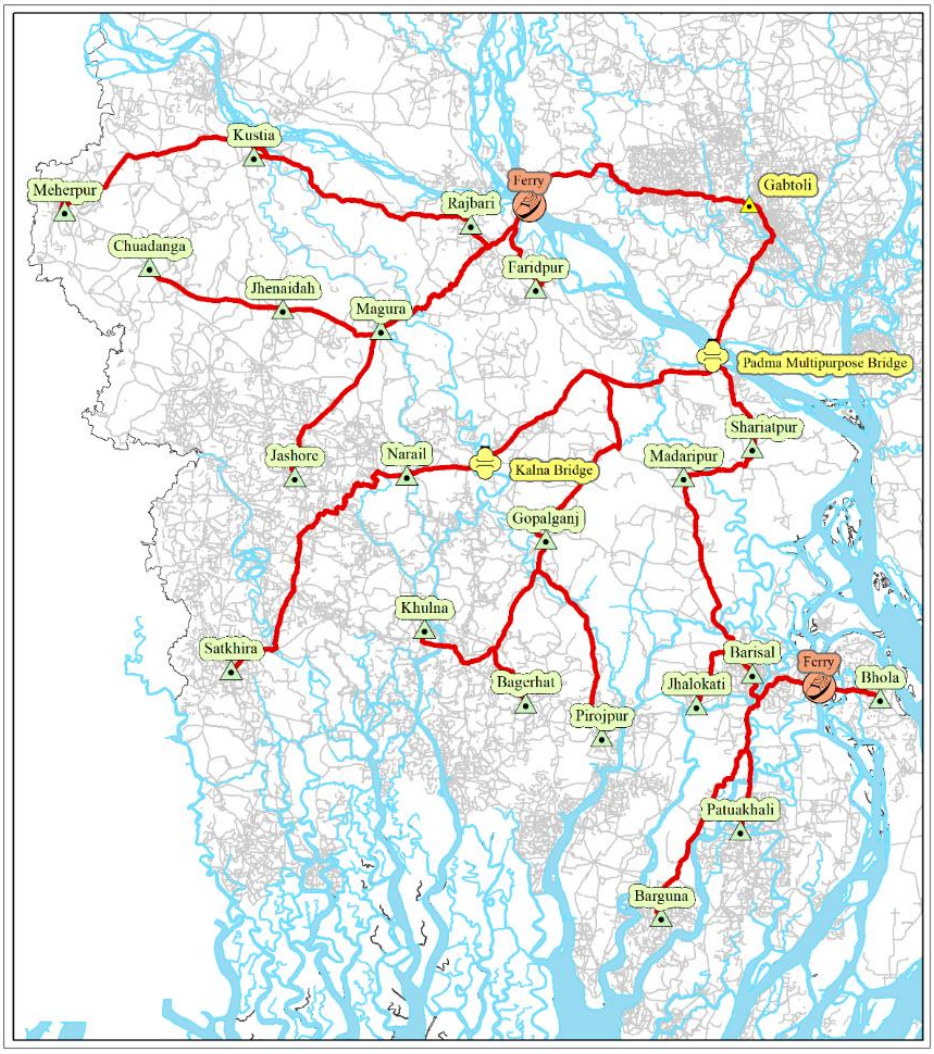


Figure 3: Shortest path from Gabtoli

Table 2: Route length from Gabtoli

Route	Distance (km)	Via
Bagerhat - Gabtoli	187.76962	Padma Bridge
Barguna - Gabtoli	234.119816	Padma Bridge
Barisal - Gabtoli	176.04679	Padma Bridge
Bhola - Gabtoli	199.259665	Padma Bridge
Chuadanga - Gabtoli	192.027009	Aricha Ferry
Faridpur - Gabtoli	99.412936	Aricha Ferry
Gopalganj - Gabtoli	136.472083	Padma Bridge
Jashore - Gabtoli	173.898072	Aricha Ferry
Jhalokathi - Gabtoli	174.141109	Padma Bridge
Jhenaidah - Gabtoli	154.594229	Aricha Ferry
Khulna - Gabtoli	194.416632	Padma Bridge
Kushtia - Gabtoli	157.201505	Aricha Ferry
Madaripur - Gabtoli	99.707092	Padma Bridge
Magura - Gabtoli	126.946041	Aricha Ferry
Meherpur - Gabtoli	217.260734	Aricha Ferry
Narail - Gabtoli	144.049904	Padma Bridge
Patuakhali - Gabtoli	199.599379	Padma Bridge
Pirojpur - Gabtoli	195.468935	Padma Bridge
Rajbari - Gabtoli	93.107327	Aricha Ferry
Satkhira - Gabtoli	232.415877	Padma Bridge
Shariatpur - Gabtoli	77.442172	Padma Bridge

3.1.2 From Sayedabad

From Sayedabad to Rajbari, Kushtia, Meherpur, Chuadanga, Jhenaidah, and Magura taking the ferry route is adopted as it is the shortest path here. On the other hand, Faridpur, Shariatpur, Barguna, Patuakhali, Jhalokathi, Barisal, and Madaripur along with Khulna, Gopalganj, Bagerhat, and Pirojpur –these districts directly take the route through the Padma Multi-purpose bridge. At the same time, Satkhira, Jashore, and Narail first pass through the Kalna Bridge and then use the Padma Multi-purpose bridge to get connected with Sayedabad.

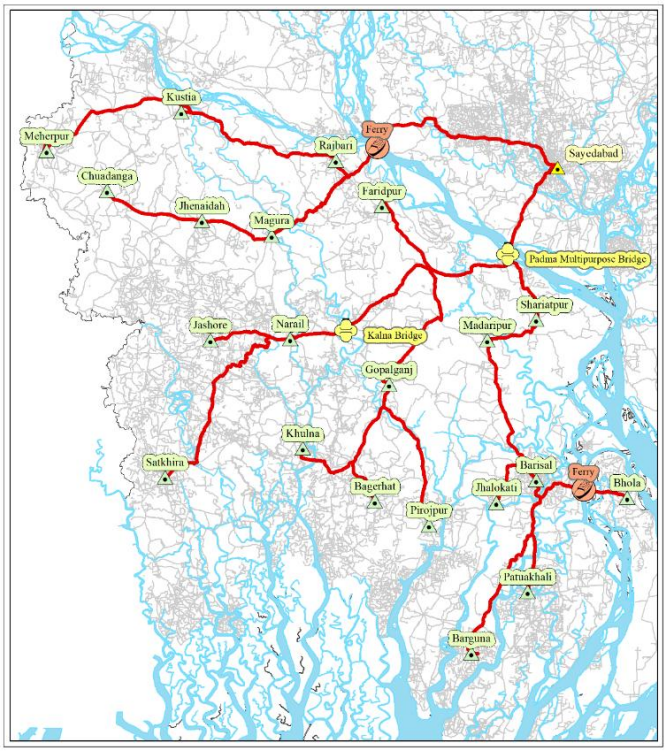


Figure 4: Shortest path from Sayedabad

Table 3: Route length from Sayedabad

Route	Distance (km)	Via
Bagerhat - Sayedabad	179.510015	Padma Bridge
Barguna - Sayedabad	228.106469	Padma Bridge
Barisal - Sayedabad	167.787184	Padma Bridge
Bhola - Sayedabad	191.000059	Padma Bridge
Chuadanga - Sayedabad	204.728783	Aricha Ferry
Faridpur - Sayedabad	104.147919	Padma Bridge
Gopalganj - Sayedabad	128.212477	Padma Bridge
Jashore - Sayedabad	165.831567	Padma Bridge
Jhalokathi - Sayedabad	165.881503	Padma Bridge
Jhenaidah - Sayedabad	167.296003	Aricha Ferry
Khulna - Sayedabad	186.157026	Padma Bridge
Kushtia - Sayedabad	169.90328	Aricha Ferry
Madaripur - Sayedabad	91.447486	Padma Bridge
Magura - Sayedabad	139.647815	Aricha Ferry
Meherpur - Sayedabad	229.962508	Aricha Ferry
Narail - Sayedabad	135.790298	Padma Bridge
Patuakhali - Sayedabad	191.339773	Padma Bridge
Pirojpur - Sayedabad	187.209329	Padma Bridge
Rajbari - Sayedabad	105.809101	Aricha Ferry
Satkhira - Sayedabad	224.156272	Padma Bridge
Shariatpur - Sayedabad	69.182567	Padma Bridge

3.2 Quickest Path

The quickest path analysis was conducted using travel time data obtained from Google Maps to identify the quickest routes between origin-destination pairs across the study region. Google Maps provided real-time and historical travel conditions, accounting for road accessibility, traffic patterns and infrastructure limitations. For each origin-destination pair, the fastest available route was extracted directly from Google Maps.

3.2.1 Before Padma Bridge

Before the construction of the Padma Bridge, the primary route from Dhaka to the southern region was the Dhaka-Aricha highway through Daulatdia-Paturia ferry (Figure 5). The figure shows that many primary and secondary roads from the southwestern coastal region connect to the Dawlatdia-Paturia ferry, resulting in not only long distance to Dhaka but also long queue and waiting time at the ferry ghat.

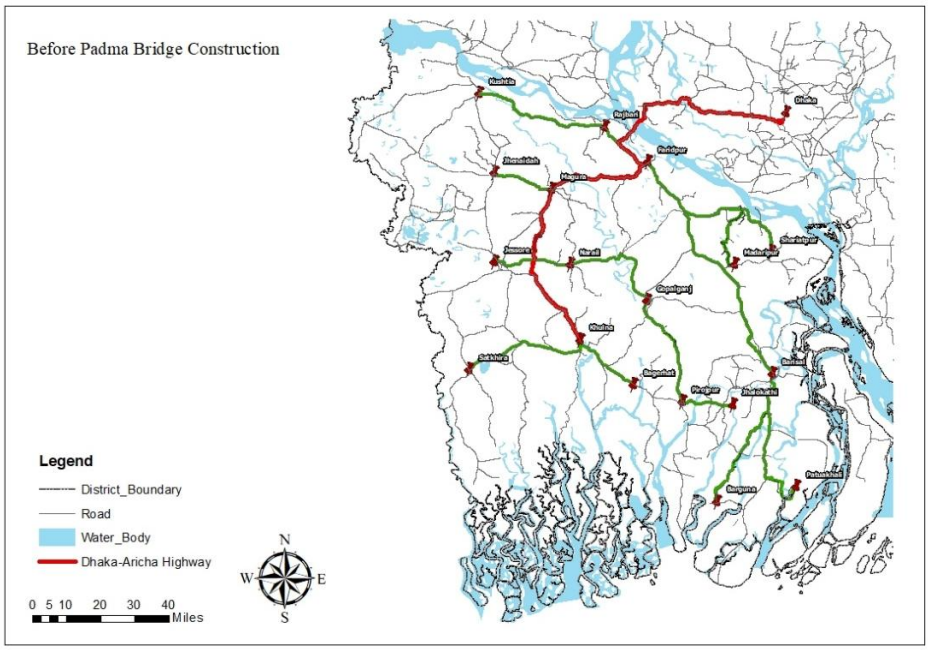


Figure 5: The quickest paths before construction of the PMB

3.2.2 After Padma Bridge

There is a significant change in the connectivity to Dhaka from the southwestern region. This is mainly due to the PMB, which resulted in traffic re-routing (Figure 6).

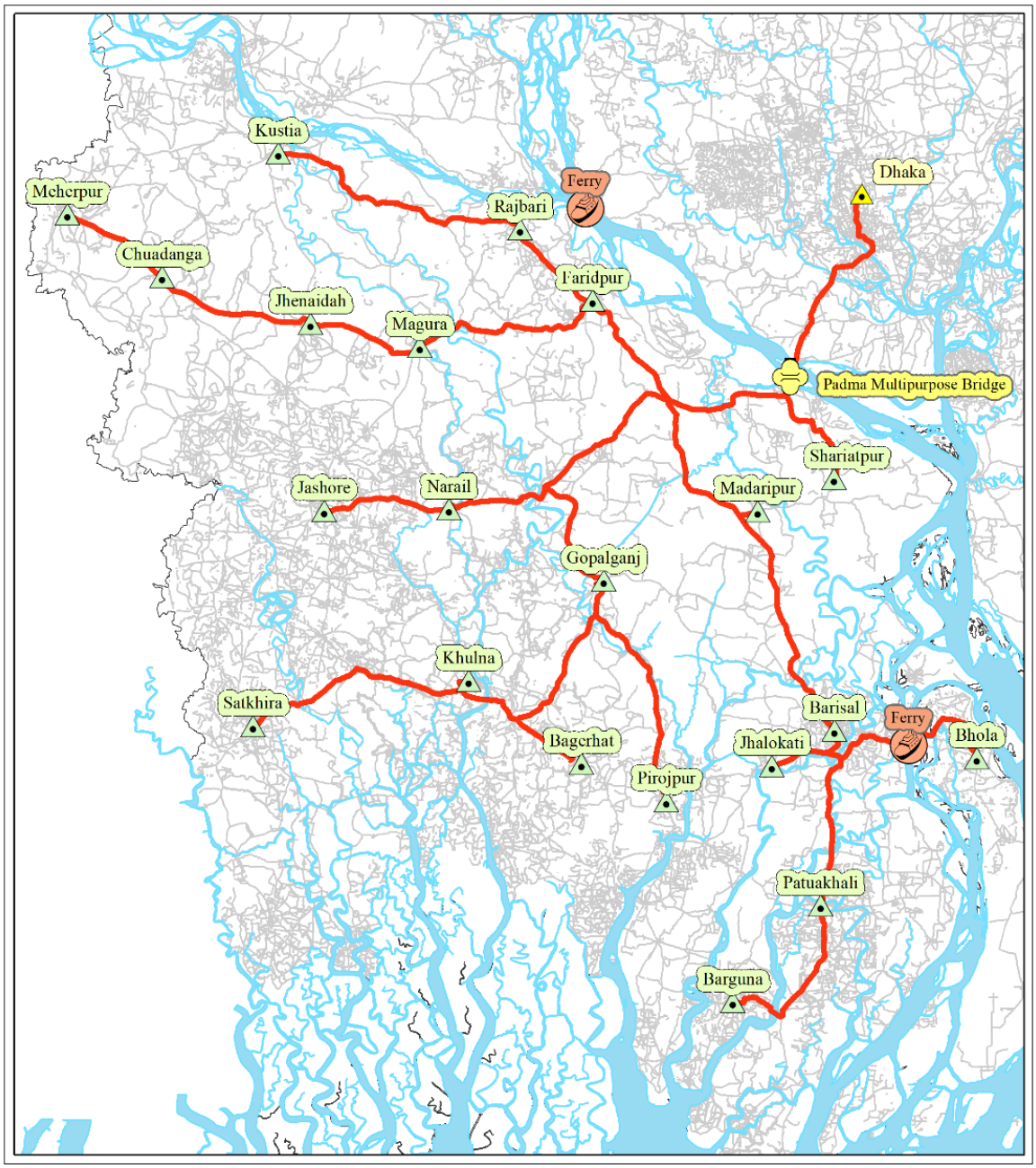


Figure 6: The quickest path after construction of the PMB

We can see that (Figure 6) after the construction of the Padma Bridge, the primary route from Dhaka to the southern region is through Mawa (PMB). Also, the shortest path and the quickest path are different. The reason is the Aricha ferry. For Rajbari, Faridpur, Kushtia, Meherpur, Magura, Jhenaidah, Chuadanga, and Meherpur, the shortest path is by ferry, but the quickest path is through Padma Bridge. Table 4 shows the time difference between before and after construction of the PMB. Post-bridge travel time was obtained on September, 2022 using Google Maps routing service.

Table 4: Time Variations (min) between before and after construction of the PMB

District	Dhaka				Time Difference (Minutes)
	Before		After		
	Time (Minutes)	Route	Time (Minutes)	Route	
Bagerhat	407	Mawa	289	Mawa (PMB)	118
Barguna	487	Mawa	442	Mawa (PMB)	45
Barisal	402	Mawa	279	Mawa (PMB)	123
Bhola	648	Mawa	537	Mawa (PMB)	111
Chuadanga	508	Aricha	312	Mawa (PMB)	196
Faridpur	277	Aricha	211	Mawa (PMB)	66
Gopalganj	370	Mawa	234	Mawa (PMB)	136
Jessore	393	Aricha	312	Mawa (PMB)	81
Jhalokathi	467	Aricha	359	Mawa (PMB)	108
Jhenaidah	378	Mawa	286	Mawa (PMB)	92
Khulna	420	Mawa	277	Mawa (PMB)	143
Kushtia	334	Aricha	307	Aricha	27
Madaripur	297	Mawa	191	Mawa (PMB)	106
Magura	345	Aricha	263	Mawa (PMB)	82
Meherpur	509	Aricha	352	Mawa (PMB)	157
Narail	389	Aricha	260	Mawa (PMB)	129
Patuakhali	546	Aricha	350	Mawa (PMB)	196
Pirojpur	393	Mawa	284	Mawa (PMB)	109
Rajbari	276	Aricha	229	Mawa (PMB)	47
Satkhira	586	Aricha	445	Mawa (PMB)	141
Shariatpur	317	Mawa	188	Mawa (PMB)	129

Table 5 show the distance variation between the shortest and quickest path. It is evident from the table that for some districts, distance has increased significantly when traveling through the PMB.

Table 5: Distance variation (Km) between the shortest and quickest path

District	Dhaka		Distance Difference (km)
	Through Aricha Distance (km)	Through Padma Bridge Distance (km)	
Bagerhat	293	212	81
Barguna	320	261	59
Barisal	243	182	61
Bhola	326	269	57
Chuadanga	222	232	**-10**
Faridpur	115	123	**-8**
Gopalganj	221	158	63
Jessore	208	191	17
Jhalokathi	264	203	61
Jhenaidah	184	193	**-9**
Khulna	254	220	34
Kushtia	178	208	-30
Madaripur	191	103	88
Magura	157	167	**-10**
Meherpur	238	258	**-20**
Narail	213	152	61
Patuakhali	288	227	61
Pirojpur	277	216	61
Rajbari	113	145	**-32**
Satkhira	263	268	**-5**
Shariatpur	207	87.7	119.3

3.2.3 Preference between shortest path and quickest path

Figure 7 shows that even though traveling through the PMB may require traveling more distance, however, it is preferred due to the low travel time. For some districts, the quickest path and the shortest path are different. The red-marked district's shortest paths are through Aricha, but the quickest path is through the Padma Bridge.

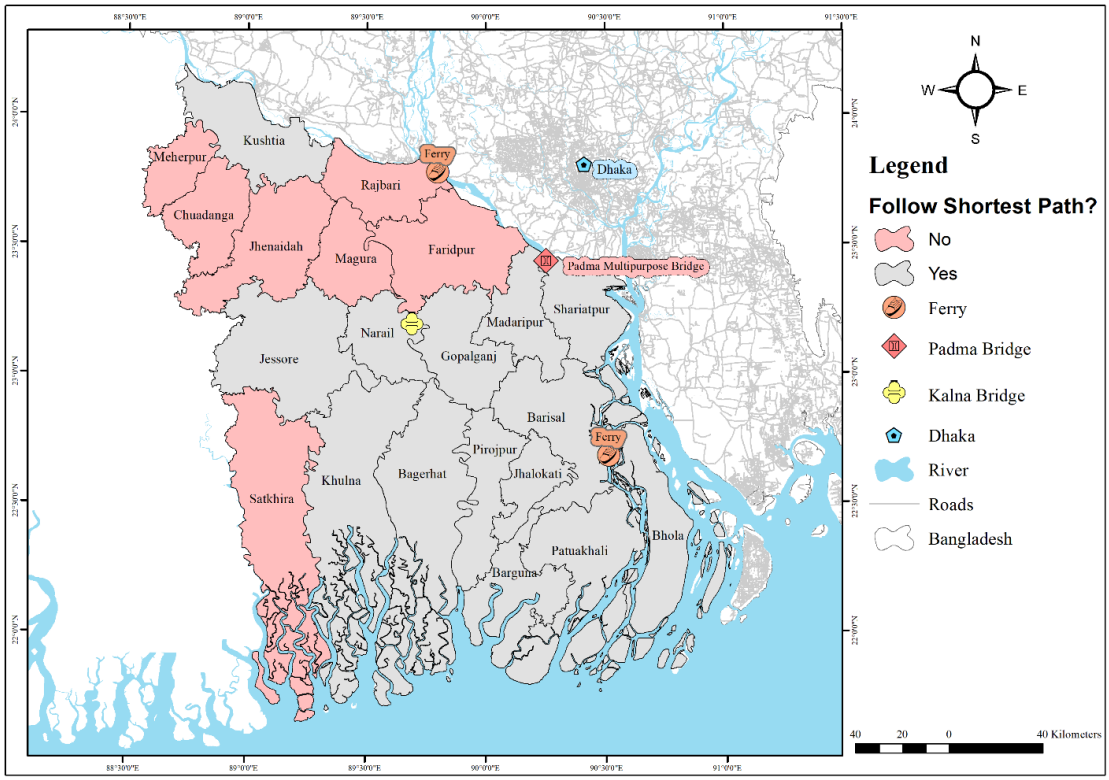


Figure 7: Districts that prefer the quickest path over shortest path

Among the 21 districts of Bangladesh's southern region, only Kushtia shows that the quickest path to Dhaka is not through the Padma Bridge. The remaining 20 districts quickest path is through the Padma Bridge.

3.3 Discussion

In a riverine country like Bangladesh, bridges are critical infrastructure for decreasing physical barriers (Jalil & Mia, 2021). The Padma River acts as a physical barrier between the rest of Bangladesh and the country's southwest (Hafsa *et al*., 2022). The Padma Bridge is crucial infrastructure because it connects the rest of Bangladesh to the country's southwest area (*Padma Multi-purpose Bridge, Bangladesh*, 2019). The purpose of this research is to identify new inter-district and inter-regional transportation networks as a result of the PMB. The shortest path has been measured using Dijkstra's Algorithm in ArcGIS. We calculated the difference in travel time before and after the construction of the Padma Multi-purpose Bridge using data from the Google Maps API. We have used the 'closest facility' function from ArcMap to find the shortest path.

We have found that the travel time has reduced drastically after the construction of the Padma Bridge. The travel pattern has also changed. After the Padma Bridge, the preferred route of most of the southern district is through the Padma Bridge because it is time-saving. For seven among the southwestern 21, their shortest path is not the quickest path. They travel more distance for a shorter travel time. Apart from Kushtia, every district's quickest path to Dhaka is through the Padma Bridge.

Route choice and route-switching are established sciences in transport studies (see, for example, Vacca and Meloni, 2013; Bukvić *et al*., 2021). Understanding the static traffic behavior over the years, commutes from home to work, wherein experience equips users with a comprehensive understanding of the road network, and regarding geographical characterization. Unlike other travel options (such as modal choice), the number of possibilities might be extensive, resulting in potential overlaps that lead to intercorrelation (Bovy, 2009). On the contrary, bus routes for regional transport, which follow a predefined path, have limited route choice options on the run; rather, this is reflected by the re-routing of the bus network. The study emphasizes the significance of re-routing traffic from the southwestern districts to Dhaka as a result of the Padma Bridge. In doing so, the implications of

infrastructure projects on regional transport, which can be a guideline for future infrastructure projects in Bangladesh, are highlighted.

So far, there has been no study that quantitatively analyzes the change in route choice behavior due to the PMB construction. Therefore, this study lacks a reference for comparison. Among the limited studies available, Sourav *et al*. (2023) examined the impact of the PMB on the transportation system in the Barishal division. Their findings suggest that a profound transformation has occurred in the transportation business. People are reaching their destinations faster, establishing new bus routes, expanding daily bus services, and moving commodities more rapidly. This paper is the first such study that explores the shortest and quickest route from the southwestern region to the capital, Dhaka.

4. CONCLUSIONS

The Padma Multi-purpose Bridge is a long-awaited mega-infrastructure project in Bangladesh. The main purpose of this research is to explore the implications of the bridge for rerouting traffic from 21 southwestern districts of Bangladesh. The study utilized Dijkstra's Algorithm to determine the shortest path for rerouting traffic flow from the 21 districts to Dhaka. Google API data is used to estimate the shortest and quickest path. The results are mostly presented in maps using ArcGIS. The major finding is that the bridge has significantly altered the route to Dhaka, as 20 out of the 21 districts are using the PMB. Even though the shortest distance has not significantly reduced due to the construction of the bridge, 14 districts prefer the bridge route due to the quickest time. Additionally, the shortest path and the quickest path are often different due to the Aricha ferry. For example, the shortest path for Rajbari, Faridpur, Kushtia, Meherpur, Magura, Jhenaidah, and Chuadanga is through the Aricha ferry; however, the quickest path for these districts is through Padma Bridge. One of the key findings is that districts like Satkhira prefer the shortest time over distance, a new phenomenon due to the bridge construction. The conclusion is that the bridge has significantly re-routed traffic in the southwestern regions of Bangladesh.

Traffic flow is dynamic. The opening of the Kalna Bridge recently has re-routed traffic again for districts like Narail, Jessore, and Satkhira. Therefore, the rerouting is not a fixed consequence of the bridge. Secondly, the research relies heavily on Google API data, which requires active internet users. However, a comprehensive primary data collection may point to a different conclusion. Thirdly, the research is based on bus traffic; thus, alternative travel modes, i.e., speedboat or launch, are not included. Finally, the PMB is a long-awaited project. The initial traffic generation and re-routing are often influenced by the hype surrounding the PMB. People's route choice may change due to the congestion created by the re-routing. Therefore, the study is a subsequent study with panel data to identify the actual traffic re-routing due to the PMB. The study does, however, highlight how significant bridge construction projects affect traffic flow in a riverine nation like Bangladesh.

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