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Developing a Multimodal Transportation Model for China to Minimize Travel Time and Cost under Belt and Road Initiative

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Abstract — China exports several goods to other countries or cities and to shift these goods has to use different ways such as road, air, and water for their shipment irrespective of air pollution. Recently China invests in Pakistan Gwadar port to transport goods in a multimodal transport system under Belt and Road Initiatives (BRI). As a partner of BRI, Bangladesh offers port facilities for China to transport its goods to reach destinations in the multimodal transportation system. This study offers three alternatives way Kashgar-Gwadar, Kunming- Chittagong, and Shanghai as sources to shift goods from China and other countries as a destination. This research measures the effective travel time in the roadway as well as seaway and then finds the total travel time from each source to each destination. We develop a transportation model using travel time that helps china to make decisions to shift goods from each source to each country to minimize travel time that helps to minimize transportation cost. This model also is effective to take transportation costs instead of travel time and then it will provide direct minimum transportation cost.

Keywords — Multimodal Transport system, BRI, Transportation model, Dummy variable.

I. INTRODUCTION

Belt and Road Initiative (BRI) is a highly ambitious project to monetarily associate to the member countries. There are two monetary goals in obtaining the scheme: firstly, to use the local currency Renminbi for international transactions; and secondly, to increase the foreign exchange reserves for funding on infrastructural progress in Asian countries to reduce the dependency on the USD [1]. The main functions of the BRI project are policy synchronization, unrestricted trade, amenities connectivity, monetary incorporation, and human contacts [2]. Bangladesh has joined the BRI project in the year of 2016 and to recognize the viable growth and mutual success for the both countries [3]. Under BRI, China has suggested for two main corridors: the first one attach the Western China to the Pakistani port city of Gwadar, named as China-Pakistan Economic Corridor (CPEC); and second one is to establish Bangladesh, China, India, and Myanmar Economic Corridor (BCIM-EC) for increase the financial and regional connectivity [4].

The transportation system for distributing commodities to the countries within minimum time and cost is essential for international trade. Every country invests huge to develop

their transport infrastructures to reduce transport costs and travel time. China has one of the biggest economies which is the highest energy consumer over the world and ensure the security of the natural oil supply chain [5]. The global maritime trade of China is 60% while in total global maritime trade from sea is 22% [6]. Here are several unforeseen issues like China's local arguments, pirate occurrences, and the geopolitics which has influence on china's economic development. For overcoming these issues, China needs to acquire the access of deep water seaports in neighboring countries [7]. Under the CPEC Corridor, China investing in Pakistan to attach the Gwadar port of Pakistan to the Western China i.e Kashgar by enhancing a transportation route involving highway and rail [8].

Under the BCIM-EC, a 2800 km long road has been proposed that starts from Kunming in China connecting through Mandalay in Myanmar to Sylhet, Dhaka in Bangladesh [9]. The main seaport in Bangladesh is the Chittagong Port which is added to the BRI project and it has a great prospect as an international seaport in South Asia [10]. The sea port Chittagong port is located in the north of Bangladesh that would be a crucial for the China to connect with the broad regional economic zone in South and Southeast Asia. Gwadar port is one of the most preferable port for the China to solve business issues through the seaway and link Western China to the rest of the countries to establish local and monetary networks [11]. Furthermore, China can choose Chittagong port as an alternative way to connect to the world.

The aim the study to do the proper analysis and to propose a transportation model that reduces the transport cost and time and would be profitable for international trade in China. China wants to establish an alternative transportation network into the Middle East and the Europe which is small in distance, money-saving, and harmless. Chittagong Port would be one of the shortest transitions which connects the China through the Middle East and the Europe. Chittagong Port is one of the crucial seaports which has great influence on the world trade. Since different port has different ability to shift goods, this study considers a transportation model that suggests these two sea port (Gwadar, and Chittagong) as

two different delivery point to ship goods to destination countries. The solution of the transport model will suggest the minimum transportation cost and time for the 40-foot vessel through the current available routes and the estimated proposed routes.

A multimodal transportation system is efficient for transporting goods for international trade. It also can be tracked by the help of IOT applications [12-13]. The growth of this model happened in developed countries such as the USA [14]. Nozik and Moriok [15] discussed the developmental aspect of the integrated sources to make this model time, cost, and quality effective. Islam [16] studied to use of cheaper resources, multimodal transportation is very effective. An effective transportation model can reduce 37.5% transportation cost compare to the existing transportation system [17]. Data mining approach or WSN applications are also significant in this scenario[18-19].

Thus, from the above discussion, it is observed that a few research are conducted on the multimodal transport system for transporting goods from China to other countries under BRI project. In particular, none of the research discussed multimodal transportation modal to shift goods from china to other countries through efficient cost.



Figure 1: Map of BCIM-EC in South and Southeast Asia. Source: The Daily Star

Fig. 1. Map of BCIM-EC in South and Southeast Asia [18]

II. METHODOLOGY

This research identified how many numbers of units of goods have to be transported from which sources to which countries to optimize total transportation cost. We develop two multi-model transportation systems and one existing system that can use in China for transportation. These are considered sources of transportation for China.

Kashgar-Gwadar Source: China can save about \$71 billion in transportation costs and about 11000 t 14000 km distance to transport under CPEC route [8]. On this route, China shifts goods from Kashgar, China to Gwadar, Pakistan in the roadway. Again, shifts from Gwadar port to Middle Eastern and European countries through the waterway.

Kunming- Chittagong Source: Another way is proposed and that is from Kunming, China to Chittagong, Bangladesh roadway. This route is proposed under Bangladesh-China-India-Myanmar Economic Corridor, a 2,800-kilometer-long road that starts from Kunming in China connecting through Mandalay in Myanmar to Sylhet, Dhaka in Bangladesh

(Karim 2018). Again goods can shift from Chittagong port to another destination.

Shanghai Port: The main seaport in China which is performed to shift goods from china to others countries. Most of the seaway shipments are done in China in this way.

Destination: Using these above three sources, China can trade with Oman, Saudi Arabia, Kuwait, Netherlands, Germany, France, Srilanka, Indonesia, Malaysia, Singapore, Kenya Greece, and Italy. These countries are considered our destinations. The countries and their corresponding seaport are given below;

TABLE I. COUNTRIES AND THEIR CORRESPONDING PORT

Country	Seaport
Oman	Port of Salalah
Saudi Arabia	Jeddha
Kuwait	Shuwaikh Port
Netherlands	Rotterdam
Germany	Hamburg
France	Le Havre
Srilanka	Colombo
Indonesian	Tanjunguban
Malaysia	Klang
Singapore	Singapore

If C_{ij} is the travel time or cost, D_j demand of each destination, S_i is the availability of each source, then the transportation model is given below:

TABLE II. TRANSPORTATION PROBLEM MODEL

	Kashgar-Gwadar	Kunming Chittagong	Shanghai Port	Demand
Port of Salalah	C11	C21	C31	D1
Jeddha	C12	C22	C32	D2
Shuwaikh Port	C13	C23	C33	D3
Rotterdam	C14	C24	C34	D4
Hamburg	C15	C25	C35	D5
Le Havre	C16	C26	C36	D6
Colombo	C17	C27	C37	D7
Tanjunguban	C18	C28	C38	D8
Klang	C19	C29	C39	D9
Singapore	C110	C210	C310	D10
Supply	S1	S2	S3	

III. RESULTS AND DISCUSSION

The road travel time calculation from Kashgar, China to Gwadar, Pakistan and from Kunming, China to Chittagong is given below:

TABLE III. ROAD TRAVEL TIME CALCULATION

	Kashgar to Gwadar	Kunming to Chittagong
Distance	2800	1700
Required Day (40km/h)	2.91 days	1.77 days
Delay Time (per day 10 hours)	1.21 days	0.77 days
Total Travel	4.12 days	2.5 days

The travel time for sea transport from each port to every destination are given below:

TABLE IV. SEA TRAVEL TIME CALCULATION

Destination Port	Country	Speed(knots)	Days in Sea from Gwadar, Pakistan	Days in Sea from Chittagong, Bangladesh	Shanghai, China (Days)
Port of Salalah	Oman	12	3	11	21.8
Jeddah	Saudi Arabia	12	8	15.3	25.5
Shuwaikh Port	Kuwait	12	4	14.3	24.6
Rotterdam	Netherlands	12	24	31.5	41.7
Hamburg	Germany	12	25	31.6	42.6
Le Havre	France	12	23	30.6	40.8
Colombo	Srilanka	12	6.3	5.3	15.1
Tanjunguban	Indonesia	12	12.3	6.6	9.3
Klang	Malaysia	12	11.4	5.7	10
Singapore	Singapore	12	12.2	6.5	9.3

Total travel times from China to different countries through different ports are given below:

TABLE V. TOTAL TRAVEL TIME CALCULATION

Destination Port	Country	Kashgar-Gwadar (Days)	Kunming-Chittagong (Days)	Shanghai, China (Days)
Port of Salalah	Oman	7	13.5	21.8

Jeddah	Saudi Arabia	12	17.8	25.5
Shuwaikh Port	Kuwait	8	16.8	24.6
Rotterdam	Netherlands	28	34	41.7
Hamburg	Germany	29	35	42.6
Le Havre	France	27	33	40.8
Colombo	Srilanka	10.3	7.8	15.1
Tanjunguban	Indonesia	16.3	9	9.3
Klang	Malaysia	15.4	8.2	10
Singapore	Singapore	16.2	9	9.3

From the above discussion we got the required travel time in multimodal transportation system from each source to each destination. Now we put these travel times in the transportation model.

TABLE VI. TRANSPORTATION MODEL

	Kashgar-Gwadar	Kunming-Chittagong	Shanghai Port	Demand
Port of Salalah	7	13.5	21.8	D1
Jeddah	12	17.8	25.5	D2
Shuwaikh Port	8	16.8	24.6	D3
Rotterdam	28	34	41.7	D4
Hamburg	29	35	42.6	D5
Le Havre	27	33	40.8	D6
Colombo	10.3	7.8	15.1	D7
Tanjunguban	16.3	9	9.3	D8
Klang	15.4	8.2	10	D9
Singapore	16.2	9	9.3	D10
Supply	S1	S2	S3	

If we solve the above transportation problem then this model suggests how many a number of units have to shift from which source to which destination with a minimum travel time that helps the decision-maker to make an effective decision. Similarly, if we put here transportation cost then it will also find the minimum transportation cost to shift goods from sources to destinations.

IV. CONCLUSION

The aim the study to do the proper analysis and to propose a model to transport of goods from China to other countries through a multimodal transportation system that provides minimum travel time. If travel time can be minimized then transportation costs automatically would be minimized. On the other hand, if we consider the transportation cost for each source to each destination, then directly the model minimizes the total transportation cost of china to shift goods to these countries.

A. Limitation of study:

Bangladesh-China-India-Myanmar Economic Corridor (BCIMEC) is not in operation. BCIMEC is just now in proposed. From this research we try to show if China and Bangladesh implement BCIMEC then how much it would be impact on their transportation. One the other hand CPEC project is not fully completed but very soon it going to operation.

B. Data availability:

The data of this research are taken from different local transporters, Google map, oec.world, and port.com [20-24].

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