Transport Infrastructure and Foreign Economic Cooperation of Mongolia

BATNASAN Namsrai*

Abstract

Transport infrastructure is one of the key issues of Mongolian foreign economic cooperation. This paper explores the nexus between transport infrastructure and country's trade performance, which will help contribute to our understanding of how the quality of internal transportation infrastructure affects regional access to international markets.

Keywords: freight demand, large mining projects, transport infrastructure and railway

1. Introduction

Transportation and logistics sector in our country is on the verge of major changes. In the recent few years, this sector encountered a number of challenging factor that affected its development and caused major changes in the economic structure, regional development, movement and settlement of the population. On the one hand, global economic crisis, the slowdown of Mongolia's economic growth and its major trading partners, the drop-in export prices, increasing foreign debt and financial difficulties are decreasing passenger and transport demand and deteriorating transport and logistics conditions. On a positive note, changes like expansion of economic cooperation between China and Russia and the development of major mining projects are boosting economic growth of the country, stimulating freight and passenger demand.

Correspondingly, it is necessary to update the transportation and logistics structure in harmony with the country's development focus. Before making large investments in the transportation and logistics sector, it is crucially important to develop and put in place an integrated sectoral development strategy that is in sync with the strategies of other sectors of the economy, as well as the development plans of large mining and industrial projects. Consequently, it is necessary to carryout well-found and comprehensive study in order to develop this sector.

Transportation and logistics sector of Mongolia, which consists of the railroad working at its full capacity, underdeveloped domestic road transport and air transport, which is offering scheduled passenger service only, obviously cannot meet the increasing demand of freight and passenger transportation.

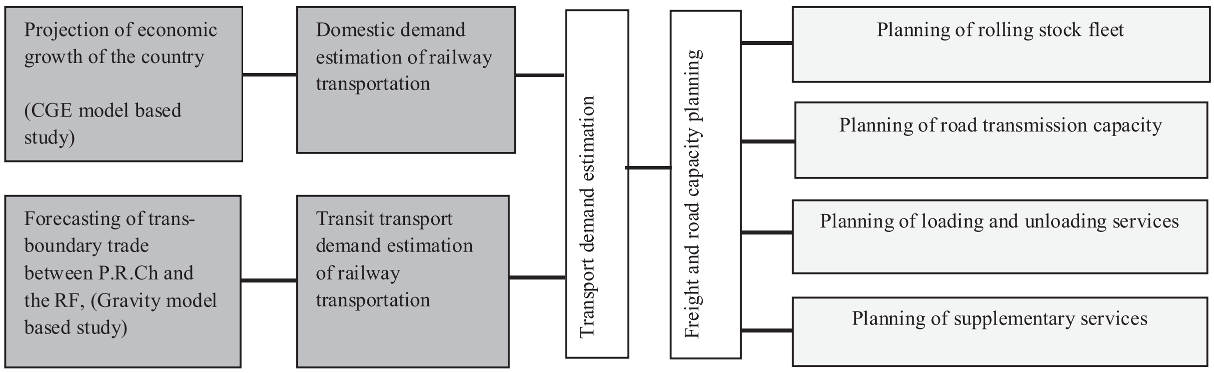
The outcome of any decision regarding economic policy could be measured by the socio-economic consequences after the implementation of the policy. The prerequisite for any successful implementation are fundamental research and study. Various studies have been done in regard to promoting the development of the transport and logistics infrastructure in Mongolia, including Pre-feasibility Study of New Railway Project, Mongolia (Ministry of Roads and Transportation of Mongolia, 2011), Strategic Plan of State-owned "Mongolian Railway" Company - 2020 (N. Batnasan, D. Narandalai, 2010), and Strategic Plan to Develop Air Transport Sector (N. Batnasan, 2008).

The study on the establishment of transport and logistics network needs to consider not only direct impacts from the development of large mining and industrial projects, but also the indirect impacts of those projects, including impact on freight turnover, population and work force movement and settlement, impacts from different sectors of the economy. On the other hand, resulting from the rapid changes in transportation and logistics environment, previous studies are now outdated and have become ambiguous in terms of factuality, hence the critical need to update some of the results of previous studies in conformity with the existing situation.

Within the framework of this study (Figure 1), we will take into consideration recent phenomenon of rapidly changing economic situation and confounding changes in economic structure that could affect to the transport demand. It also will consider the need for upgrading the supply side factors of the current transport and logistics infrastructure in meeting such demands. Furthermore, the study will cover main focus areas of the development of transport and logistics infrastructure in our country, the possibilities to integrate transportation and logistics policies with the foreign and macroeconomic policies of the country.

For those purposes of estimating the effect of factors affecting to the transport demand, such as country's GDP growth, trade expansion, intercorrelation and development of economic sectors, in the present study, author has used GDP growth forecast from the Dynamic General Equilibrium Model based study, which is being implemented in 2018[1]. And results of recent gravity model-based study implemented by researchers from Far Eastern Federal University of the Russian Federation was also used.

Figure 1. General Algorithm of Transport Demand Estimation, Freight and Road Capacity Planning



The following interrelated issues of transport and logistics infrastructure development have been researched within the framework of this study. They include:

- Transport demand for passenger and freight are dependent on economic situation and its changes. The assessment of direct and indirect impacts of mining sector on economy is based on the Dynamic Computable General Equilibrium Model (DCGE).
- Impact assessment of economic growth on transport demand is also based on the afore-mentioned DCGE model[2]. Furthermore, feasibility studies and investment estimations of large mining and industrial projects are reflected in the impact assessment.
- For the planning and calculation of railway rolling stock needed for railway transportation, we've used universal methodologies adopted from the Organization for Cooperation of Railways[3].

2. Analysis of current situation

Mongolia is a landlocked country, situated far from the world's major transport channels and sea ports, which mainly exports agricultural and mining products to world markets and provides its domestic consumption with import goods. For a country with high transportation cost alike Mongolia, railway transport has a significant role in the transport system of the country because of its advantages in terms of low transportation costs and contribution to trade and economic cooperation. Mongolia's railroad network, of which the north-to-south main line links with Naushki station on the Trans-Siberian railroad of the Russian Federation in the north and Erlian railway station in the PRC in the south, and it is approximately 1,908 kilometers in total length and accounts for over 80% of total freight ton-kilometers in the transport market. There is no east-west railway line crossing the country. This railway also serves as one of the important means of passenger transportation. The importance of the railway is magnified by the sparsely settled population, underdeveloped transport infrastructure, geography, the harsh continental climate, and great distance, which all make road connections inefficient.

The main line of the Mongolian railway is approaching to its full capacity; therefore, it is clear that the increase in transit transportation and exploitation of large mining projects would require additional capacity and investment. According to 2018 statistics, utilization rate of the main railway line capacity had reached to its full capacity and the railway transported a total of 25.6 million tons of freight[4]. Therefore, even a slight increase of freight transportation along the main railway line could surpass it's full operating capacity.

The main railway line is 1,110 kilometers long, which connects two border points of Sukhbaatar in the north and Zamyn-Uud in the south. The construction of 1 kilometers railroad costs about 2 million USD in the Mongolian context, hence the expansion of the main line capacity by constructing double railway track would still require at least 2.2 billion USD in investment[5].

In recent years, Ulaanbaatar railway has been trying to improve its capacity to carry freight from the current 25-27 million tons to 30 million tons a year[6] by constructing new railroad intersections, by increasing locomotive power and average speed of transportation, and by using railroad automatic switching systems. The increase of locomotive power would require that thickness of the layer of track ballast is increased from the current 20 centimeters to 35 centimeters.

The mandatory life span of locomotives and rolling stocks used at the Mongolian railway are 20-25 years old. According to guidelines, the percentage share of locomotives and wagons that have been used for more than 20 years should not exceed 20 % of the total locomotives and wagons and they have to undergo regular refurbishment. However, two thirds of the 2,792 freight wagons, more than one half of 340 passenger wagons, and three fourths of the 164 locomotives of the Ulaanbaatar Railway have been in service for over 20 years[7]. Moreover, there were several serious accidents in the last decades. Unfortunately, renovation overhauling of locomotives and increasing of the thickness of track ballast layer require large investment.

According to the strategic policies approved by the Mongolian Parliament, the Government of Mongolia is aiming to establish road and railway networks critically important for the country's economic development. The purpose of those policies is to increase the carrying capacities of the road and railway transportation, to build integrated and efficient transport network directed at meeting the rapidly growing transport demand, and further, utilize large mineral deposits, accelerate national economic development by way of exporting value added products, and to ensure long-term sustainable economic and social development.

The Government is planning to add an additional 5,600 kilometers, therefore, an unprecedented five-fold increase in Mongolia's railway system is underway. The addition of two more rail transit corridors – one for transit between Russia and China and the other enabling internal cargo to move to the two neighbors – will result in a total of three Mongolian transit rail corridors. The Government is planning to expand its railway network with the aim of using the mineral and oil resources in Mongolia's eastern and Gobi regions, and to improve the use of Dornod's dead-end railway, and furthermore ensure connection with to the transport routes of Northeast Asia. The strategic positioning of Mongolia's railway in relation to the Tavan Tolgoi and Oyu Tolgoi mines will increase its economic benefit and may change the country's economic and industrial landscape dramatically.

With the exploitation of the large mining projects, total railway freight transportation turnover is expected to increase dramatically. On the other hand, Mongolia's two neighbor with large economies are planning to expand their mutual economic cooperation, which means there could be a substantial increase in the transit freight transportation demand between them.

4. The impact of large mining projects on the economy

Rich reserves of coal, copper and other minerals are key revenue earners for Mongolia, however the fluctuation of the global commodities prices has a destabilising effect on the national economy. Due to falling prices for mineral products and raw materials on the global market, foreign direct investment in Mongolia becomes doubtful as can be illustrated by the fact that the double-digit economic growth between 2011 and 2013 shrank to as low as 2.3% in 2015, and even further to 1.2% in 2016. However, Mongolia's economy grew by 5.1% in 2017 and 6.9% in 2018, recovering strongly from the lowest level of the growth rate observed in the last two decades, that has been recorded in 2016.

In October 2009, the Government of Mongolia signed an investment agreement for the development of the Oyu Tolgoi copper mine and since has been searching for ways for an efficient development of coal production at the Tavan Tolgoi mine. It is clear that the exploitation of the giant Oyu Tolgoi copper mine with a reserve of 35.8 million tons of copper, 1.4 thousand tons of gold, and the 6.5 billion ton capacity Tavan Tolgoi coal mine would definitely make a weighty contribution to the economic growth of the country[8].

Those two mega projects of Oyu Tolgoi and Tavan Tolgoi are closely interrelated to each other. The exploitation of the Oyu Tolgoi mine would create the demand for the construction of a power plant using coal from Tavan Tolgoi, and finally surplus power could be exported. The construction of the thermal power plant would enable the country to set up an industrial complex producing end metallurgical products, including refined copper and steel.

Proceeding from this premise, it can be said that dependent on these two major projects are policies that are designed at cutting down on high transportation costs of export, exporting goods and products on the competitive markets, improving the efficiency of foreign trade, reducing dependency on external markets, expanding ties with industrialized countries, speeding up technological progress, promoting the development of industrial cluster based on relative advantage of the country, and accelerating the pace of the country's economic growth. Therefore, successful implementation of these projects will boost an economic capacity of not only the southern regions of the country, but also the overall national economy.

Accordingly, in order to determine the economic development prospects for Mongolia for the forthcoming years, this paper analyzes the development issues of transport and logistics system of the country, including the mining sector's direct and indirect impact by employing a dynamic Computable General Equilibrium (CGE) model[9]. This CGE based-study covers the impacts of two large investment projects, Oyu Tolgoi (OT) and Tavan Tolgoi (TT), to be expanded in the coming years. The Government of Mongolia is offering two different options of coal extraction at Tavan Tolgoi: 20 million tons (TT1) or 40 million tons (TT2) in a year. And Oyu Tolgoi company is aiming to expand its production capacity by more than doubling its current 850 thousand tons' copper concentration production in a year to 1,800 thousand tons.

Although Mongolia is a country with abundant natural resources, it has not reached such a level of industrialization that could otherwise transform raw materials from the mining sector into final products of metallurgical industry. Hence, the Government of Mongolia recently resolved to build a one-million ton capacity copper smelter (CR) at Oyu Tolgoi mine. According to preliminary feasibility study of this project, a total of 1.5-2.1 billion USD is required. The government is hoping that with the implementation of this project there will be a significant growth in GDP, budgetary and export revenues, job creation and establishment of different types of related factories.

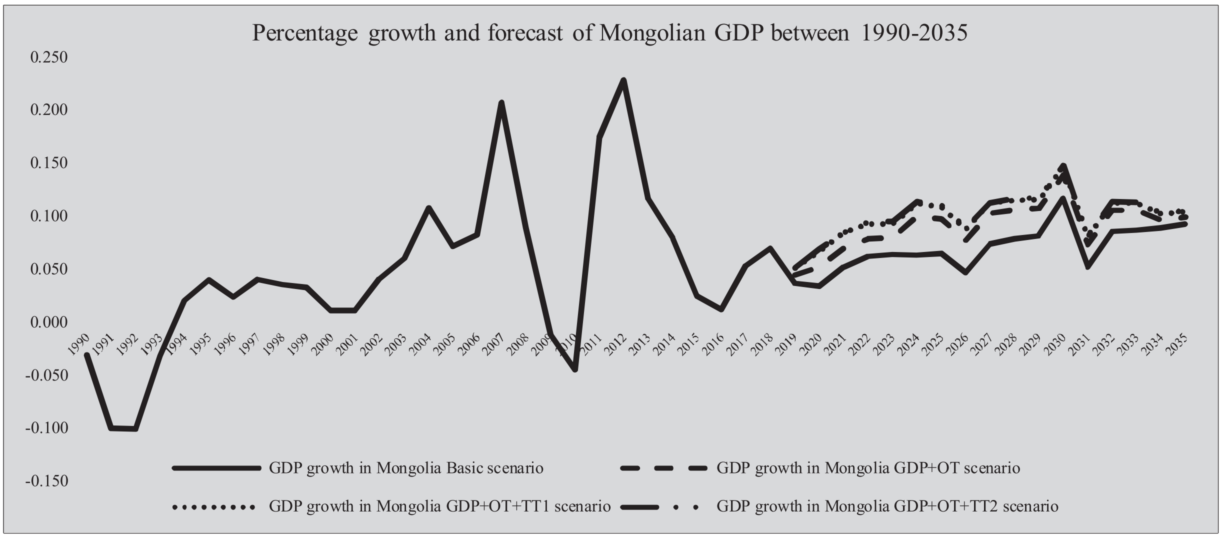
While considering the aforementioned situation of the economic development of Mongolia, four different scenarios in addition to the baseline scenario have been investigated in this study. They include the following:

1. Baseline scenario (BL)
2. Projection including OT expansion (BS+OT)
3. Projection including OT and TT1 expansion (BL+OT+TT1)
4. Projection including OT and TT2 expansion (BL+OT+TT2)

In all scenarios, we assumed that long term prices of metals would be at the level of current metal prices of 2.90 USD/pound for copper, 1,300.0 USD/oz for gold and 15.0 USD/oz for silver. We estimate that cumulative total investment in Oyu Tolgoi mine will 19.1 billion USD and initial investment before the start of the exploration would require an additional 5.1 billion USD as stipulated in the investment agreement signed with the government.

Furthermore, in the OT+TT1 scenario, we assumed that Tavan Tolgoi mine would extract and export 20 million tons of coal annually and the coal price will be 87 USD per ton as was the case in 2018[10]. The development of the coal mine will require 741.0 million USD in operating cost and tax rate estimated at 25.0% for income tax, 10.0% for VAT and royalty for natural resources at 5.0% respectively. In OT+TT2 scenario, we assumed that the annual extraction of coal from Tavan Tolgoi would be 40 million tons and the annual operating cost would be 983 million USD. Other conditions are similar to OT+TT1 scenario. These calculations were based on the "Integrated Development and Operations Plan" of Oyu Tolgoi project produced by the "AMC Consultants" Pty Ltd in 2012 and the balance sheet indicators of Tavan Tolgoi mine for the year 2016.

Figure 2. Percentage Growth and Forecast of Mongolian GDP between 1990-2035 under Different Scenarios



Source: BATNASAN Namsrai "Impact assessment of Mongolia – Korea EPA" MoFA, 2018

The economy will be affected directly and indirectly by the exploitation of the large mining projects. The GDP and trade volume will increase directly from the impact of such mining projects. According to 2018 statistics, average annual exchange rate was 2,472.4 tugriks for one USD and the GDP stood at 32.16 trillion tugriks. The GDP were divided by the total population, per capita GDP was 13,010.0 thousand tugrigks or 4,017.3 USD. Those are baseline indicators to be used for the further comparison of outcomes of our study.

The result of our study shows that if the large mining projects were not implemented and the current economic growth trend is maintained, the country's GDP will increase by 43.4% in 2025, 110.2% in 2030, and by 210.0% in 2035. GDP per capita is estimated as 5,280.8 USD in 2025, 7,233.5 USD in 2030 and 9,998.0 USD in 2035, with a 1.3% increase in a year, similar to the average population growth rate in the last decade.

If the Oyu Tolgoi mine development and production are maintained according to its planned schedule and if the Tavan Tolgoi annual coal output is brought up to 20 million tons, then the GDP can increase by 49.8% in 2025, by 115.9% in 2030, and 211.9% in 2030 from the current level and GDP per capita is estimated to be 5,498.8 USD in 2025, 7,429.8 USD in 2030 and 10,115.9 USD in 2035 respectively. If Tavan Tolgoi's annual coal production reached 40 million tons then it is estimated that GDP per capita would be 5,507.7 USD in 2025, 7,437.8 USD in 2030 and 10,115.9 USD in 2035 at the current price level. Simulation results indicate that the development of the giant mining projects will significantly increase growth and size of Mongolia's economy (Figure 2).

Our calculation shows that exploitation of large mining projects would lead to an increase in mining and business services sector's share in GDP, while there would be a decline in the rest of the sectors of the economy. The mining industry accounted for 23.6% of Mongolian GDP value in 2018, considering the effects of global commodity prices and the implementation rates of the projects, the ratio is estimated to be 16.7-17.0% by 2035.

Table 1 shows the future freight demand of the main railway line. The first column in the table shows the condition where large mining projects are inactive. The third and fourth columns show the increase in the demand for railway, including freights generated by Oyu Tolgoi and Tavan Tolgoi, when coal production would be 20 and 40 million tons respectively.

Table 1. Forecast of Freight Demand for the Main Railway Line

Year	Freight demand / mln.ton				
	Domestic	Export	Import	Transit	Sum
Forecast of freight demand under BL scenario					
2018	10,326.8	9,272.4	2,798.4	3,365.7	25,763.3
2025	13,052.8	18,541.3	4,030.3	1,739.0	37,363.5
2030	16,363.1	27,430.5	5,827.0	3,667.6	53,288.3
2035	21,759.6	41,823.7	8,593.2	5,395.3	77,571.8
Freight demand under BL+OT scenario					
2025	13,245.6	18,647.8	4,149.9	1,739.0	37,782.3
2030	16,624.9	27,998.6	5,949.2	3,667.6	54,240.3
2035	21,961.8	42,806.2	8,654.3	5,395.3	78,817.6
Freight demand under BL+OT+TT1 scenario					
2025	13,329.6	18,770.9	4,192.2	1,739.0	38,031.7
2030	16,718.1	28,259.9	5,990.2	3,667.6	54,635.8
2035	22,060.3	43,175.5	8,697.4	5,395.3	79,328.5
Freight demand under BL+OT+TT2 scenario					
2025	13,342.2	18,785.5	4,198.9	1,739.0	38,065.6
2030	16,731.5	28,292.4	5,996.7	3,667.6	54,688.2
2035	22,076.1	43,227.4	8,704.5	5,395.3	79,403.3

Source: author's estimate

Under the indirect impact of the large mining projects, the GDP and total consumption tend to increase which make it imperative to increase freight demand. Using the feasibility studies of large mining projects and GDP calculation from our previous study, based on DCGE model, we have estimated the freight demand of forthcoming years by using the error correction model (Table 2).

Table 2. Error Correction Model

Freight demand is taken as Y and GDP as X. If they have linear correlation $y=\beta_0+\beta_1 x$, difference between actual and estimated values then they would have an error margin of $ut= y - \beta 1x$.
Error correction model's main equation has the following features: $\Delta y_t = \alpha_1+\alpha_2 u_{t-1}+\alpha_3\Delta x_t+\alpha_4 x_{t-1}+\alpha_5 y_{t-1}+\nu_t$ $\Delta x_t = x_t - x_{t-1}$ $\Delta y_t = y_t - y_{t-1}$
x_t – GDP of t-the year y_t – domestic freight demand for the year - t

After testing the impact of factors that could influence the freight demand, we have investigated that the most influential factor is GDP growth. By using above mentioned estimation of GDP, we were able to forecast the freight demand up to the year 2035.

However, it is possible to estimate domestic freight demand based on our dynamic CGE model study, demand estimation of transit freight requires the forecasting of trans-boundary trade between China and the Russian Federation, using gravity model. For this purpose, I've used the result of recent study implemented by researchers from Far Eastern Federal University of the Russian Federation[11]. The result of this study is reflected in Table 3.

Table 3: Bilateral Trade between China and Russia

Model	Variable	Value (t-statistics)	Equation of dependence	Coefficient of determination R^2 / (F-value)
Export flow	α_0 α_1 α_2	3.444 (2.74) ** 0.289 (2.60) ** 0.763 (7.81) ***	$E = \alpha_0 Y_1^{\alpha 1} Y_2^{\alpha 2}$ (1) $E=3.444Y_1^{0.289}Y_2^{0.763}$	0.96 (237.77)*
E: total export, Y_1: per capita GDP in Russia, Y_2: per capita GDP in China, α_0: regression parameter, α_1: elasticity of export (the exporter-country's GDP), α_2: elasticity of export (the importer-country's GDP)				
Import flow	α_0 α_1 α_2	0.018 (6.28) *** 0.908 (5.75) *** 0.715 (5.155) ***	$I= \alpha_0 Y_1^{\alpha 1} Y_2^{\alpha 2}$ (2) $I=0.018Y_1^{0.908}Y_2^{0.715}$	0.96 (256.70)**
I: total import, Y_1: per capita GDP in Russia, Y_2: per capita GDP in China, α_0: regression parameter, α_1: elasticity of import (the importer-country's GDP), α_2: elasticity of export (the exporter-country's GDP)				
With dummy variable included	α_0 α_1 α_2 γ_1 γ_2	2.706 (2.45) ** 0.546 (6.87) *** 0.537 (6.44) *** Inclusion of variable is statistically irrelevant 0.447 (4.82) ***	$T=\alpha_0 Y_1^{\alpha 1} Y_2^{\alpha 2} e^{\gamma 1 D1}\, e^{\gamma 2 D2}$ (3) $T=2.706Y_1^{0.546}Y_2^{0.537}e^{0.447D2}$	0.99 (449.45)**
T: total trade turnover, Y_1: per capita GDP in Russia, Y_2: per capita GDP in China, α_0: regression parameter, α_1, α_2: elasticities of trade turnover of Russia and China, respectively Dummy variables D_1 for Russia and D_2 for China, which equal to 1 if a country is a member of WTO, and γ_1 and γ_2 are respective coefficients of variables				

**Significant at 5%, ***Significant at 1%.
Source: Evgenie P. Zharikov, Alla A. Kravchenko, Olesya O. Sergeeva, Victor V. Stetsyuk (2016)

The final result of Gravity model-based estimation of bilateral trade between China and the Russian Federation has given us an opportunity to forecast transit freight demand of the main railway line. We assumed here that, particular share of export and import goods to be traded between China and Russia should transported through Mongolian territory. For this purpose we've calculated weighted average of percentage share. Table 3 shows domestic, export, import and transit freight demand forecasting.

Transportation of freight as stated requires the expansion of the existing capacity of the main railway line and emphasizes the need for a double parallel railway line. Besides this, increasing freight demand will require additional number of locomotives and wagons. Table 4 shows the number of locomotives and wagons required for the above stated freight transport after the exploitation of large mining projects. This would require an estimated investment of 0.8-1.4 billion USD.

Table 4. Number of Locomotives and Wagons Needed for Transportation in Main Line

	2025				2030				2035			
	BL	BL+OT	BL+OT+TT1	BL+OT+TT2	BL	BL+OT	BL+OT+TT1	BL+OT+TT2	BL	BL+OT	BL+OT+TT1	BL+OT+TT2
Locomotive	229	230	230	231	313	314	318	318	455	457	462	463
Wagon	16,649	16,735	16,783	16,836	22,209	22,209	22,318	22,555	32,330	32,414	32,824	32,849

Source: author's estimate

Even though it is important to increase the quantity and speed of freight transportation by expanding the main line, this kind of expansion will not be able to connect products of mining sector to its main markets. Moreover, these mining deposits could not be connected to major cities and industrial centers such as Erdenet, Darkhan, and Sainshand, where the government has been planning to build large industrial complexes. In other words, there won't be any change in the status of current unprocessed raw material export, and what's more, the plan to build industrial complexes could fall apart simply because of the non-availability of any raw material supplies to these centers.

Currently, the government has given the right to build the railway lines in the southern region to a state-owned company "Mongolian Railway" LLC and has granted the right to a private sector enterprise to build railroads from Tavan Tolgoi through Oyu Tolgoi to the state border.

There are four main alternatives to connect OyuTolgoi and Tavan Tolgoi to international market. First, building 126 kilometers long railway line from Tavan Tolgoi to Oyu Tolgoi and another 80 kilometers railroad from Oyu Tolgoi to state border, which would facilitate the export of copper concentrates and coals from these mines directly to the Chinese market. Second, connecting these mine deposits to the main railway line by building 126 kilometers long railroad from Oyu Tolgoi to Tavan Tolgoi and another 496 kilometers long railway line from Tavan Tolgoi to Zuunbayan. Third, building 725 kilometers railway line connecting Zuunbayan to Tavan Tolgoi including Oyu Tolgoi and Gashuun Sukhait. Fourth, extending the third alternative by connecting it to the Sainshand-Choibalsan line. These alternatives, which are designed at facilitating transportation of raw materials from large mining deposits, have their own advantages, as well as disadvantages.

For instance, the first option would make it possible to market raw materials at the lowest possible investment cost. If the railway line would be of narrow gauge, then the products will be supplied to the market without trans-shipment that would lower the cost altogether. This alternative gives the opportunity to connect large deposits to Chinese market at a low investment cost, however, without linking these deposits to the main railway line, it will be unrealistic to process these minerals domestically, what's more, other foreign markets will remain closed.

In case of the second alternative, this would require a heavy investment, and products will be supplied to the market after longer transportation routes featuring trans-shipment. Moreover, there will be loading and unloading at the main railway line which would make it important for building a double railway line for the Sainshand-Zamyn Uud line in order to increase the existing transport capacity. It is extremely important to build new railway lines that connects Oyu Tolgoi and Tavan Tolgoi mines to the main railway line in order to connect these strategically-important deposits to the planned domestic manufacturing factories and to export minerals from these deposits to markets in Russia, Europe, Japan and Korea at a competitive price.

If the third alternative is chosen, it will present the opportunity to implement both first and second options separately or both of them combined together at the same time. If the new railway lines would be exploited exactly as outlined in the first and second alternatives, there will be some deficiencies that would arise. The main weakness of this alternative from an economic standpoint would be the low efficiency of the route connecting the deposits to the main railway line.

For the fourth alternative, even though it requires higher investment, this route has some advantages such as exporting extracted minerals to Southeast Asian markets through Russia, linking the eastern region of the country with the rest of Mongolia. Strategic eastward expansion into the ports of Vladivostok, Vostochny and Vanino in the Far East of the Russian Federation will introduce new points of access into the key potential markets such as Japan, Korea and Southeast Asia. What's more, route could facilitate in developing domestic oil refinery relying on the oil deposits of Dornod aimag in the extreme west of the country. Here transportation costs could be higher considering the distance between Sainshand, Ereentsav and Vladivostok, when going around the northern frontier of China through the Russian territory. However, transportation cost could be reduced significantly thanks to the preferential condition granted by the Russian Federation. Thus, the second, third and fourth alternatives, which connect Oyu Tolgoi and Tavan Tolgoi deposits to the main railway line look promising.

Many different ideas are floating on the matter whether state or private owned entities should build and operate the new railway lines or not. Once the government begins the construction of the new railway lines, private companies in the mining industry will join the railway-building network and it will increase the chance to build a new additional line. Mongolia's Ministry of Road and Transportation is prepared to support private investment and it has to date received a number of unofficial proposals. The ministry has also given the license to build the railway lines connecting Tavan Tolgoi, OyuTolgoi and Gashuun Sukhait.

4. Conclusion and recommendations

In the present conditions of high transportation costs, Mongolia does not have the possibility of supplying, at a relatively higher price, such commodities as thermal and coking coal, copper concentrate and iron ore, to markets that can offer comparatively higher prices. For Mongolia, it has become inevitable to use minerals deposits as economic leverage, increase the economic benefit by developing mining-based manufactures, expand foreign economic cooperation with its major trading partners, and start successful beginnings to suit the long-term development of the country.

Mongolia is inherited railway infrastructure from the past, that is not ideally suited to country's future economic development needs. The development of mining-based cluster will make it incumbent to focus attention on developing production and transport infrastructures. The volume of goods transported by railway is likely to grow drastically with the development of the major extractive industries. However, today it has become obvious that the existing railway capacity would be unable to meet the challenges of such a growing demand, and therefore, there would be an imperative need to lay new railway lines. To attain these goals, it is truly important to develop mining-based infrastructure and to choose the most optimal alternative.

According to our study, firstly, the third alternative, which allows mineral deposits to be connected to the both the neighboring markets and the main railway line, must be opted for; secondly, go for the government proposal, submitted to the Parliament, in which export costs can be reduced by not requiring trans-shipment; and thirdly, we recommend that the steps to shift from the third to the fourth alternative should be taken early in the near future.

And there are considerable expenditure needs to invest required construction of new railway lines and to upgrade existing route. The construction of 1 kilometer railroad costs about 2 million USD in the Mongolian context, hence the construction of the different alternatives of new railway lines would require between 0.5 to 3.8 billion USD in investment.

The combination of country's economic growth, growth resulting from the investment in large mining projects will require a major change in the size and composition of the rolling stock fleet over the next two decades. With the assumptions and scenarios modelled in this article, the total number of wagon is forecast to grow by between 11.6 and 11.8 times by 2035, while the number of locomotives would rise from 2.78 today to more than 2.82 times over the same period. Rolling stock fleet innovation under different scenarios would require extra 3.4-3.5 billion USD investment at the current level of price wagons and locomotives.

Economic development and the transport infrastructure are closely related, and in fact it is impossible to industrialize and boost economic growth in Mongolia without the construction of new railway lines.

* Professor, Business School, National University of Mongolia, Email: batnasan@num.edu.mn

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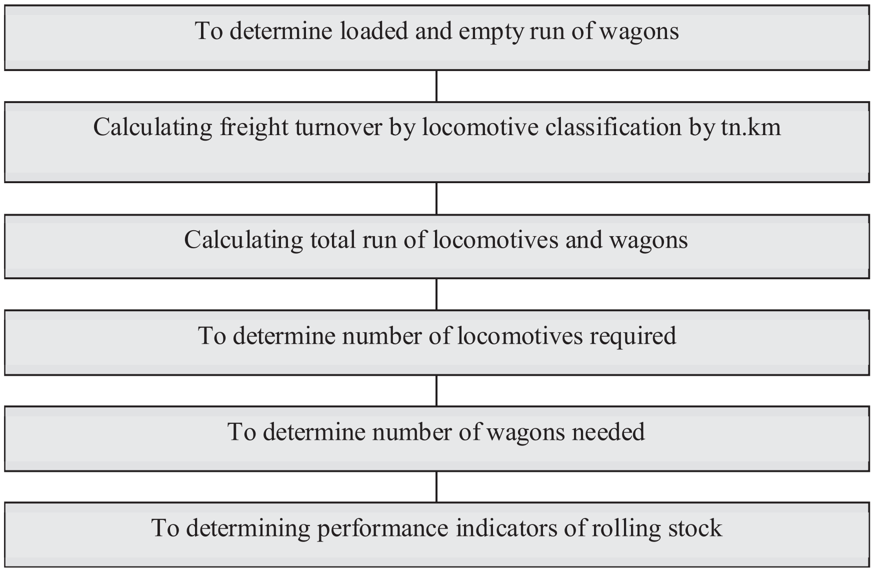
APPENDIX

Calculation methodology

The calculation of number of locomotives and wagons has been made in accordance with universal methodologies adopted from The Agreement on International Goods Transport by Rail (SMGS). General algorithm of calculation is shown below.



Calculating number of locomotives required per day:

$$N_{loc} = \frac{\Gamma_t \text{ x } K_{un}}{365 \text{ x } Q_{br} \text{ x } \varphi}$$

Nloc – number of locomotives required per day
Γt – total weight of freight at t-th year, tns
Kun – unbalance degree coefficient of freight transportation
Qbr – gross weight of the locomotive
φ - ratio of net and gross weights of the locomotive

Calculating number of wagons in a train:

$$N_{wag} = \frac{Q_{net} \text{ x } \varphi}{Q_{st}}$$

Nwag –Number of wagons in a train
Qbr – Gross weight of the locomotive
Qst – static tonnage of the wagon
φ - ratio of net and gross weights of the locomotive

Calculating the total number of wagons in operation:

$$n_{\text{p}} = \frac{1}{24}\left[\frac{\Sigma ns}{v_r} + \Sigma n_k t_k + \Sigma n_t t_t\right]$$

np – Number of operating wagons
Σns – Distance run by the wagon, wagon.km
νr – Average speed of locomotiveon the route, km/hour
Σnktk – Wagon hours for loading and unloading
Σnttt – Wagon hours for maintenance

Calculating total wagon number:

$$n_{инв} = n_p \times (1 + \beta)$$

пинв – Total number of wagon
np – Number of wagons in operation
β - a coefficient to determine the number of wagons out of operation