

The Impact of Transportation Infrastructure on the Minerals Exploitation in Saudi Arabia

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Introduction

National economic diversification is considered a strategic goal for the Saudi Arabian government. The minerals sector in Saudi Arabia is one of the economic activities which has already started to achieve this strategic goal of diversification away from oil-related activities as the main source of national income. Although non-oil mineral activities are far less significant than oil activities, their development has the potential to contribute to the economic diversification of the Saudi economy. Exploration and development of non-hydrocarbon mineral resources has, therefore, been a consistent objective of the government throughout successive Development Plans. The territory of the Kingdom contains abundant strategic minerals such as phosphate and bauxite, as well as industrial raw materials that can be used in the domestic, regional and overseas markets after processing. The diversified geological terrain, strong economy and strategic location of Saudi Arabia in the GCC countries are among the most fundamental features attracting investment in the mineral industry. Furthermore, it is hoped that this sector will become a major source of revenue generation for the Kingdom during the next decade. New mines and associated investments will also create employment opportunities in the Kingdom.

The development of a minerals sector has led to a high demand for transportation infrastructure, the provision of which has become a necessity. The number of roads and ports has increased to satisfy this demand and the railway network has expanded. The development of transportation infrastructure plays an important role in the economic development of a country, and therefore a critical issue for most mining projects in remote areas is the extent to which the costs of the required infrastructure facilities, including transportation, are shared

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or allocated to the mining project alone. This affects the profitability of mining projects considerably. Therefore, the main aim of this paper is to identify and evaluate the relationship between the transportation infrastructure and minerals development in the Kingdom of Saudi Arabia.

The economic importance of transportation

Transport is the means by which people and commodities are moved from one place to another by a number of physical modes including roads, water, railways, airlines and pipelines. So transport in one form or another is a basic and essential part of the daily rhythm of life throughout the inhabited world (Hoyle, 1988). Based on Mieczkowski (1978: 1), "the transport system may be likened to the blood circulation system in a living organism. Without it the organism dies". Transport is considered an essential feature of all modern economies. In general terms, as an economy grows and develops, it becomes more dependent upon its transport sector (Robinson and Bamford, 1978). Transportation was considered for a long time as the main factor of economic development; however this view has changed in the past few decades. According to Aldcroft and Freeman (1983), until the 1960s the prevailing view of the role of transport in economic growth was a very positive one, where transport was seen as a leading economic sector in itself, engendering growth. However, after 1960 it emerged that this traditional interpretation of the positive view of transport's role was shaky; at the least; and there was a case not only for seeing transport as playing a permissive role but also for regarding it as a lagging sector.

Relying on Yeser (1990), the permissive view is usually associated with the reciprocal relationship between transport and economic activities, but this relationship is not always a direct one. The provision of adequate transport facilities permits economic and social development, which would not otherwise be possible, but the provision does not determine that development, which depends on an often complex combination, of favourable factors taking place. For example, the extensive iron ore deposits of the Hammersley Ranges (Western Australia) depend on the building of railways to the coast

for their exploitation. But exploitation also depended on the demand for ore from the expanding Japanese steel industry. Therefore, transportation may be a necessary but not a sufficient factor for economic development. The 'lagging' view is usually associated with government investment in transport infrastructure such as roads and airports, which require heavy investment and thus the larger and poorer parts of the country gain few benefits from these investments. However, arguments of this kind are perhaps controversial. "What seems to be emerging is that there can be no universal rules concerning the relationship between transport and economic growth. It is necessary to recognise that there is scope for positive, permissive and even 'negative' (i.e. transport investment being misdirected investment) viewpoints" (Aldcroft and Freeman, 1983). Above all, it must be accepted that "the nature of the relationship may vary over space and through time - from one region and from one country to another, and over the historical continuum. Variability through time is to some extent inevitable, given the 'lumpy' nature of so much transport investment, capacity often being added in fits and starts rather than evenly over the years" (Langton, 1979).

Generally the transport sector affects most aspects of regional economic development because most economic activities either depend on or use transportation to some extent. Moreover, transportation means affect regional productivity by connecting different regions to each other and allowing the exchange of goods and services to occur among them. Additionally, they are considered key components in business efficiency for the level and ease of access they provide to customers, markets, materials and workers. Thus, it seems indisputable that the transport sector is a telling indicator of a country's economic development, which will be clear through Saudi Arabia case.

The Minerals Projects

The phosphate and bauxite deposits exploration programmes will lead to the establishment of phosphate and bauxite industries and a number of downstream industries with encouraging economic indicators in the Kingdom. The two important deposits economically,

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Al Jalamid phosphates and Az Zubirah bauxite will be nuclei around which a number of industrial projects can be established. Furthermore, these projects will create a new pillar of the Saudi economy after hydrocarbons and petrochemicals and will make the Kingdom an important global player in the phosphate and aluminium industries.

Al Jalamid Phosphates: This project lies in the northern part of the Kingdom, about 120 kilometres east-southeast of Turayf city. The feasibility study for this project, which was prepared by the Ma'aden-Saudi Oger consortium and S.N.C. Lavalin of Canada and Jacobs of the U.S., indicates that the Al Jalamid phosphate is estimated to contain 313 million tons of phosphates able to provide sustained production for at least 27 years. Also, the feasibility study indicates that 11 million tons of Al Jalamid phosphate will be mined annually, upgrading the concentration of ore to 32 % to produce 4.5 million tons of phosphate concentrates.

The initial plan for this project is to mine and beneficiate phosphate rock. The phosphate rock will then be transported via the North-South Railway (NSR) to the industrial city of Ras Az Zawr for conversion into di-ammonium phosphate (DAP) fertilizer for export. The DAP export is expected to be phased into the market by 2009 to reach about 3 million tons per year. The Ras Az Zawr site is about 60 kilometres north of Jubail Industrial City on the Arabian Gulf.

The estimated cost of the phosphate projects at Ras Az Zawr is around \$1.9 billion, plus additionally about \$400 million to develop the mines at the Al Jalamid site. The availability of molten sulphur and natural gas from within the Kingdom as a feedstock alongside the local phosphate rock will make it a highly competitive integrated production facility within easy reach of growing Asian markets. Ma'aden intends to use the phosphate rock in the production of a number of value added products, such as fertilizers, chemicals, animal feed, and detergents. After the di-ammonium phosphate plant reaches peak production in five years time, Saudi Arabia will be in direct competition with producer countries such as Morocco, Jordan and the USA, as it will produce a quarter of the world's DAP

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production. Furthermore, Al-Naimi (2004) said in that the phosphate fertilizer project will boost the Kingdom's non-oil exports and make the Kingdom the third largest producer of phosphate fertilizer in the world.

Az Zubirah Bauxite: This deposit lies in three main zones: the north zone, the central zone and the south zone, which together span a distance of 105 kilometres between Al-Qassim and Hail. The initial mining is earmarked for the south zone which is near Qibah town about 470 kilometres northwest of Riyadh. The Bechtel Group carried out an extensive feasibility and marketing study on the deposit. Also, Ma'aden has signed a financial consultancy contract with Riyadh Bank and the Australian/New Zealand banking group to provide financial services for the feasibility study of the Alumina and Aluminum project. The final feasibility study indicates that Az Zubirah bauxite is estimated to contain 126 million tons with an average grade of 57.3 % alumina and 8.2 % of silicon dioxide. Furthermore, the reserves of bauxite are sufficient for over thirty years with an annual rated capacity of 3.5 million tons of crushed bauxite ore.

Based on Smith (2003) the feasibility study indicated that the project should not be limited to the construction of an aluminum refinery, but must aim to develop an integrated industry, because of the availability of bauxite, natural gas, petroleum coke and caustic soda, etc. in the Kingdom. Therefore, both the alumina refinery and the aluminum smelter will be part of Ma'aden's giant industrial mineral complex in Ras Az Zawr and the total cost of these projects is estimated at \$3.8 billion including mine development and construction. The project's annual production is estimated at 1.4 million tons per year alumina from processing of the bauxite ore, and 623,000 tons per year aluminum from processing of the alumina, as an initial output, which will then increase by about 200,000 tons per year because the smelter's design will allow for output to be more than doubled. Infrastructure facilities for the bauxite project at Ras Az Zawr will be shared with the phosphate project.

The production of the Saudi alumina refinery and smelter is expected to increase the Gulf region's participation in the world production of aluminum from 6 per cent to 10 per cent of global production. The fully-integrated aluminum production facility will make Saudi Arabia one of the largest producers of aluminum by 2020, because the mined bauxite and the availability of cheap gas supplies mean its production costs will be lower than any other aluminum producer. In addition, the global demand for aluminum is rising fast and an eight million tons per year deficit in aluminum supplies is forecast by 2010 if recent levels of world economic growth continue.

Transport Infrastructure for Minerals Projects

The transport infrastructure in the minerals areas, especially around the locations of phosphate and bauxite deposits are quite poor and almost nonexistent. Thus, in order to enhance the potential of the minerals projects and their exploitation, the improved transport infrastructure must be in place. In the past few years, two feasibility studies have been undertaken with a view to exploiting and transporting the Al Jalamid phosphate and Az Zabirah bauxite. The first option is to build a slurry transport pipeline and the second option is to build a railroad. This section compares these studies in terms of the benefits and problems of transport infrastructure and the methods for reducing mineral development costs.

The Slurry Pipeline: It is proposed that the phosphate concentrates will be transported as slurry through a 15-inch-diameter pipeline from the Al Jalamid area to the area of manufacture of DAP fertilizer. The design capacity of overall system throughput is about 4.5 million tons per year which will be reached after the initial two years of anticipated production. According to Deputy Ministry for Mineral Resources (DMMR) (1995) this option proposed two directions to transport the concentrates:

The first direction is about 1150 kilometres from Al Jalamid to the industrial Jubail city on the Arabian Gulf. This choice mainly depends on the availability of locally produced ammonia, sulphur and natural gas, and additionally the proximity of Saudi Arabia to major

consuming markets. The capital cost for this project is estimated to be \$346 million with operating costs estimated to be \$2.02 million for a total of 6 pump station facilities. The second direction is about 703 kilometres from Al Jalamid to Haql city on the Red Sea i.e. the west part of the Kingdom. The capital cost for this project is estimated to be \$282 million with operating costs estimated to be \$2.07 million for a total of 4 pump station facilities and a valve station. This route to Haql appears to be shorter than the first route to Jubail but is conservatively defined to have a high point of 1600 metres above sea level. Therefore, it would be necessary to investigate the ability to bypass or tunnel this point and evaluate the cost impact of these choices that require significant wastage of energy in order to overcome this (Turney, 1999).

There are several problems involved in these two slurry pipelines e.g. the overall system throughput is about 4.5 million tons per year which necessitates the use of 15 outside diameter pipeline steel. This restricts the availability of suitable material from within the Kingdom as this diameter is considered to be non standard. Also, the pipeline steel is the highest cost component within the project. Any change which affects the pipeline steel tonnage will impact the final price significantly. The cost of batching with water in these projects is considerable. Furthermore, to optimize these slurry pipelines would require field investigation to study constructability, geotechnical and physical conditions. Consequently, this option for transport infrastructure has about the downside of committing funds in an out of charter business which is economically less attractive than railroad, which will act as a stimulus for economic development of the whole region (MAADEN, 1999).

The Railroad: This railroad is called the North-South Railway (NSR), and its primary objective will be to connect the phosphate and bauxite mines at Al Jalamid and Az Zubairah to processing facilities located at the Arabian Gulf port of Ras Az Zawr. About 5.2 million tons a year of phosphates and about 3.3 million tons a year of bauxite would be transported to the smelters and refineries. In addition to mineral transportation, the North-South railway project would serve passengers and freight traffic from Riyadh to Al-Hudaitha. Relying

on Ministry of Finance-Public Investment Fund to carry out the North-South Railway project, in May 2006 the Council of Ministers approved the licensing of a new firm named Saudi Arabian Railways (SAR) with a capital of \$267 million and gave the company's general assembly the authority to float either full or part of its shares for public subscription.

The company is licensed to operate and manage the North-South Railway project, and additionally its related services and associated utilities, either directly or through firms with the required efficiency according to regulations. Moreover, the company is authorized to transport minerals, raw materials, fuels, goods and passengers. The licensing of this company comes after the Minister of Finance Dr. Ibrahim Al-Assaf signed a \$136.8 million contract with a consortium of multinational companies led by the Louis Berger Group of the United States in November 2005, for the complete design and construction of a 2,400 kilometre freight and mineral transportation project. Besides the leading Louis Berger Group, other members of the consortium include Systra Engineering Consultancy Co. of France, Canarail of Canada and Saudi Consolidated Engineering Co. Khatib and Alami of Saudi Arabia.

This project is divided into four major parts for construction. The first part is about 650 kilometres which will transport bauxite from the starting point at the Az Zabirah bauxite mine, with the line connecting through a direct link to the processing facilities at Ras Az Zawr. The second part is about 782 kilometres which will transport phosphate from the starting point at the Al Jalamid phosphate mine, and will pass through Al Jawf, Hail, and Az Zabirah. From Az Zabirah it will connect through a direct link to the processing facilities at Ras Az Zawr. These two parts are the minerals railway. The third part is about 530 kilometres, which will start from King Khalid airport in Riyadh to Az Zabira junction, through Banban, Majma'h and Buraidah. The fourth part is about 438 kilometres which will start from Al Jalamid junction to Qurayyat on the Jordanian border as well as a short link which will go to Al Basayta. The latter two parts are the passenger and general freight routes.

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This undertaking will require that more than 450 million cubic metres of sand and stone will have to be moved. In addition, the construction process covers the roadbed for 83 million m³ of earthworks, concrete bridges for 254 sites and concrete culverts for 1059 sites. The main problem of this project is the costs associated with land acquisition and actual purchase price of land, especially in Riyadh and some agricultural areas. Another issue is the location of this railroad through the desert, where the height of the dunes poses an enormous challenge for the contractors.

With regard to the benefits of this project, Dr. Dabbagh (2004) has said that "the construction of the proposed railroad from north towards south will contribute in the establishment of new mining projects with investments in excess of SR 22 billion. It will give a development boost to the national industrial sector and will be a new source of revenue for the country". Also, he said that "the railroad will not only link various regions of the Kingdom, but also be a powerful incentive for investment in mineral industries and other industrial enterprises, in addition to expanding the transport of oil and other petroleum products". In interview with 'Ahlan Wasahlan Magazine' (2005), Dr. Jubaira Al Suraisry, the Minister of Transport stressed his vision which considers "transport not only as a service to Saudi citizens but also as a major component in Saudi efforts to develop the national economy and to assume a significant and growing role in regional and international economics affairs". Furthermore, the railway line would also lead to the establishment of many other mineral projects worth SR5.5 billion to exploit the Kingdom's vast manganese, iron, nickel, titanium, silica and calcium carbonate.

Summary of findings

The main findings are as follows:

- Lack of infrastructure and non-availability of public services in the most promising mining areas (Al Jalamid Phosphates and Az Zubirah Bauxite) have been major constraints to the exploitation of mineral resources. However, the North-South

Railway, which links these minerals projects with their industries at Ras Az Zawr, will make the minerals sector a key economic sector that has promising potential to diversify the country's economic base.

- The North-South Railway is considered an economic lifeline for minerals development in the Kingdom, as it will facilitate the transport of raw materials and provide mobility for workers to reach the work place and market place. Moreover, it should facilitate the diversification of the national economy and has the potential to be a powerful instrument in promoting long-term growth and employment.
- The North-South Railway will have impacts on firms not only through transport cost reductions but also through the scope for cost reductions throughout the logistics chain. Also, it will have a positive impact on the labour market through lowering wage levels and increasing the availability of labour because of the reduction in travel time.
- The railway will link key centres in the Kingdom such as Al Jawf, Hail, Al-Qassim, Majma'h and Riyadh thus making the area competitive for growth. Furthermore, it would also lead to the establishment of many other mineral projects to exploit the Kingdom's vast manganese, iron, nickel, titanium, silica and calcium carbonate.
- The impact of accessibility on the social, economic and physical aspects of life will be very apparent following the creation of the new transportation infrastructure in the Kingdom. There is no doubt that the new railway will increase the level of economic activities. Indeed transport infrastructure appears so important to some enterprises that it is almost worth thinking of it as another factor of production. For example, the "economic cities" in Tabuk and Hail that will be a big boost to development in the region, mainly depend on the North-South Railway. Another aspect

of better accessibility is the establishment of small markets in the small cities that the railway passes through, such as Majma'h.

- The strategic location of new industries relative to domestic and export markets is systematically influenced by the provision of effective transport infrastructure as analysis has shown that the North-South Railway has a major role to play in the choice of the minerals industry location at Ras Az Zawr.
- The transport infrastructure investment to ensure access to the east-coast of the Kingdom will be an important contributor to regional development, because of the export orientation of much of minerals industry. At Ras Az Zawr there will be huge potential for downstream industries as well, as there is potential to process minerals such as silica, magnesite, dolomite and calcium carbonates.

Conclusion

In a developing country like Saudi Arabia, with lack of necessary infrastructure improvements, introduction of new transport infrastructure leads to large effects on economic performance. The main findings above have shown that the transportation infrastructure provides a vital service to the local economy through its effects on minerals development. Therefore, the transport infrastructure should be accounted for as an important economic resource, the lack of which prevents normal economic development. Hence, government's role is to foresee future needs of an economy in transport infrastructure and fulfill them in the best way.

Regarding the significance of the minerals industry, the mining sector has great potential to play a leading role in the diversifying Saudi economy due to the Kingdom's enormous and relatively untapped mineral occurrences, large area (more than 2,000,000 square kilometres) and the increasing demand for raw materials both in domestic as well as international markets. Moreover, the improved

transport infrastructure which will lead to the exploitation of minerals. The minerals industry in Saudi Arabia, which includes phosphate and bauxite, will become one of the main activities attracting foreign investment, and during the next decade it is hoped will be one of the causes of considerable economic growth in the region and the country. The mineral industry will also have several positive effects on the national economy, such as constituting a source of additional revenue for the government, increasing exports and contributing to export diversification, creating new opportunities for the creation of industrial activities in the Kingdom, and contributing to harmonious regional development and an improvement in the regional balance.

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