Freight Movement Sustainability A Need for Rail Based Transportation System

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Abstract— Sultanate of Oman with its large physical and geographical setting is spread along a costal length of 2100 Km length. Even though the country is well developed in its transportation infrastructure, absence of rail network is a major hindrance for its economic development. The country with dwindling oil energy resources is focusing on economic diversification to non-oil based industries and service sector. In Oman, where the country is largely depending on road transport for its logistic movement, need to shift to rail mode which is highly economical and also environment friendly for the sustainability of the country. In this technical paper an attempt is made to understand the geographical setup of production and consumption centers and logistic arrangements for the freight movement and economic sustainability. For the study, the data is derived from secondary sources and established reports. Qualitative and quantitative observations are drawn and the need for rail based transportation system is highlighted.

Keywords— freight movement by Rail, bulk solid transport, break even distance for goods movement.

I. INTRODUCTION

The Sultanate of Oman is a politically stable country with vibrant economy, situated at the world cross roads is a gate way for large economic opportunities. The Sultanate of Oman is located in the south of the Arabian Peninsula, spread over a geographical area of 309,500 Sq km. Total estimated boundary length of the country is 3,466 km, of which 2,092 km is coastline. The country is well developed with good highway infrastructure, ports and airports catering to the domestic as well as international trade. At the moment the country for its internal passenger and goods movement is largely depending on highway transportation as there is complete absence of rail network. Economic development of any Nation depends on its transportation infrastructure development, as larger portions of the petroleum products are consumed in the transportation sector. In Oman also highway transportation sector is the major (more than 70%) energy consumption segment [1]. Movement of goods, containers and bulk solids from production centers to the consumption centers is measured by million ton-Km(MT-Km) or Billion Ton Km by commodity wise and is used as proxy for measurement of Transportation Energy.

Since 1970, petroleum industry is the main force driving Oman's economy and is consistently supporting country's infrastructure in the areas of transport, electrical, telecom health and other public infrastructure services for promoting high standard of living. To reduce the true dependence on oil sector the government is encouraging private sector to invest in various industries. With the initiatives taken by the government of Sultanate of Oman, non-oil sector contribution to the GDP has been consistently increased from 33% during 1975 to 59% during the last year. Also rapid urbanization coupled with migration, people from rural to urban area brought structural changes in demography and currently about 90% of country's population is living in Cities[2] which are being the consumption centers for the consumer goods, food products and building materials. Oman's economy being largely driven by oil-refinery based industry and other heavy industries, currently dependent on only roadway sector for its exports and imports. Hence there is a need to explore other modes of transport for energy savings and economic sustainability of freight movement.

II. PROBLEM STATEMENT

The research paper aims at examining firstly, the driving forces of the ongoing economic and spatial development and urbanization trends, and secondly at developing strategies towards resource-saving in freight movement. In this paper the issues pertaining to the freight logistics such as geographical spatial distribution of the population, transportation infrastructure (Ports, airports, highways), mineral resources, industrial productions centers and consumption centers are analyzed qualitatively and inferences are drawn for its economic sustainability. For this most of the information is derived from secondary sources and data available from the ministry. Each of the parameter which is having a bearing on transportation energy consumption is discussed briefly to draw conclusions in the following lines.

III. GEOGRAPHICAL - SPATIAL SETUP A RECONNAISSANCE

A. Geographical and spatial distribution of population:

Oil revolution in the country changed the demographic structure of Oman. And continuous increasing trends in urban migration[1], making the capital city the Muscat to hold one third of country's population. Critical review of spatial and temporal developments in the country revealed that urbanization pattern in the country is characterized by dispersed and patchy settlement structures and high vehicle dependent community. Also due to the geophysical and climatic setting in the country 75% of the country's total surface of 212,460 Km^2 is covered by desert and mountains leaving very limited land resources for public and societal development. New patchy scattered developments in Oman is characterized by large separation of settlements and high vehicle dependency need to focus on depleting oil resources of the country and on energy savings for its sustainability.

Region wise distribution of population is shown in the following table-1 and Exhibit-1. From the table it can be seen that more than 55% the country's population is concentrated in Muscat and Al Batinah where these are the large consumption centers of food grains, consumer goods and building materials, depending on ports for their logistics. Average distance among the settlements with respect to the capital city Muscat being is estimated as about 200Km. Also all the settlements depending on highway sector for the logistics are the large consumption of transportation energy.

Table 1. Region wise distribution of population in OMAN

Region	Population	%	Population Density Pop/sq Km
Muscat	695432	28%	178.3
Dhofar	234709	9%	2.4
Ad Dakhliyah	280687	11%	8.8
North Ash Sharqiyah	146655	6%	8.8
South Ash Sharqiyah	184205	7%	9.4
North Al Batinah	430996	17%	54.4
South Al Batinah	257176	10%	56.4
Adh Dhahirah	223573	9%	5
Musandam	30637	1%	17
Al Wusta	24867	1%	0.3
Total	2508937	100%	8.11
Source: Annual Health Report, Ministry of Health, Oman (2005)			

B. Freight Transport Overview

Global freight movement involves multi modal transportation systems which includes and includes ocean and coastal routes, inland waterways, railways, roads, and airways, and consists of both mono-modal and multi- modal networks. In a mono-modal scenario, freight is moved from one location to another using a single mode of transport (e.g., truck) and which is currently in practice within Oman. In a multimodal scenario, freight is moved using combinations of transport modes (e.g., truck to barge to ocean-going vessel). International freight transportation commonly incorporates multiple transport modes via an "intermodal network," providing efficient transfers—often in the form of containerized cargo. The choice of transport mode involves balancing tradeoffs to facilitate trade among global corporations and nations. The factors governing the choice of mode for freight movement factors like on time, cost, and type of material and delivery reliability. Low cost transport modes are less preferred over the faster modes for time sensitive cargo. Now a day's cargo is mostly delivered by containers for its advantages of handling at the transit locations.

C. Spatial distribution of mineral resources in OMAN:

Oman is rich in large mineral deposits which are yet to be unearthed and were essential part of Oman's economy. Oman's mountains host large intact and exposed ophiolites, (Exhibit-2) which contain metal deposits such as chromite, cobalt, copper, gold, lead, magnesium, manganese, nickel, palladium, platinum, silver, vanadium, and zinc. Gypsum resources and reserves were estimated to exceed one billion metric tons (Gt) of gypsum in the southern region of Oman, including 165 million metric tons (Mt) of minable gypsum in the Shuwaymiyah area (Industrial Minerals, 2010; Oman Daily Observer, 2010). Mining and quarrying activity was an integral part of the Government's economic diversification policy (Royal Decree No. 27/2003), Oman was the seventh ranked crude oil producer and the fifth ranked producer of natural gas in the Middle East region and accounted for about 1.1% and 0.8% of total world production[3][4], respectively. Oman exported mineral-based commodities as aluminum building materials, chromite, gold, gypsum, laterite (low-grade iron ore used for cement), limestone, marble, silver, and urea in addition to crude oil, natural gas, and refined petroleum products. The country also produced cement, clay, iron and steel, quartz, salt, and silica sand mainly for domestic use. Most of the industrial estates are located in Sohar, Slalaah, and Wusta Regions.

D. Spatial distribution of sea ports:

There are 8 major sea ports situated over a distance of distance of 2100 km of sea coast [exhibit-3]. The ports are:

- Port Sultan Qaboos - Port of Shinas
- Port of Duqm - Port of Salalah
- Port of Mina Al Fahal - Port of Sohar
- Port Qalhat LNG - Port of Khasab

The capacity of the ports varies from a maximum draft of 18m (Sohar and Sultan Qaboos) to a minimum of 3m (Shinam) [5]. Among the ports Sultan Qaboos and Sohar are the major ports having a handling capacity of 5M TEU.

E. Break even distance for Freight Commodities

The competing distance for each commodity is normally measured by the Break Even Distance (BED) or Break-Even Point (BEP). BED or BEP represents the cutoff point between comparative distance based modal transport costs (total of operator & user costs) of the selected modes in movement of a commodity. Break-Even point defines the limit up to which movement of a commodity by a mode is cost effective and beyond which cost advantage shifts to the other mode. Break-Even point thus defines optimal area of operation for the movement of a commodity by a particular mode. Commodity specific Break-Even Distances thus provide the basis for optimal allocation of traffic amongst modes. Mode choice for commodity movement depends on multiple components like distance of travel, transportation cost, perishability of the commodity, time value of money, packaging cost, operator and user costs, transit facilities for handling the goods, fixed costs variable costs and the process adopted for estimation. Break-Even Distance depends on the relative ratios of fixed and variable costs of two different choices. The case is illustrated with two modes; mode 1 (say road) has a high variable cost but low fixed cost and mode 2 (say rail or coastal shipping) has low variable cost but high fixed costs. For obvious reasons for short distances mode 1 would be preferred and preference would shift to mode 2 in the case of long distance. Mathematically it can be illustrated as follows.

$$FC_1 + FVC_1 \times D = FC_2 + VC_2 \times D$$

Where FC is the fixed cost and VC is the variable cost of a mode. BED or BEP cost vary as they depend on input costs of the parameters under consideration and vary from country to country. In GCC countries like Oman, as the fuel costs are low comparative to other countries, but other costs like labor handling, transit charges may be relatively high. Using the concept of variable costs and fixed costs commodity wise BED range has been arrived at for Oman and presented in the Table-2.

Table 2. Commodity wise BED range for selected commodities

Sl.No	Commodity	BED in KM
1	Food Grains	200-250
2	Fruits and Vegetables	300-350
3	Coal and Other Minerals	175-200
4	Fertilizers	175-200
5	Sugar	350-400
6	POL Products	100-150
7	Cement	150-200
8	Live stock	150-200
9	Iron and Steel	150-200
10	Containers	300-350
11	Others	300-350

From the above table it shows that the highest Break-Even Distance is in the case of sugar followed by fruits & vegetables, containers, etc. Similarly the lowest Break-Even Distance is observed in the case of POL products. Railway sidings and overall terminal costs are the critical factors for deciding BED in case of food grains and it is depends of quantity of goods to be transported. In Sultanate of Oman Logistics are totally depending on highway transport due to the absence of rail facility. Even though fuel is available at cheaper prices in Oman, there is a great need for modal shift from road to rail for the economic sustainability of country protecting the environment and reducing the greenhouse emissions. Estimated BED's are inclusive and specific Break-Even Distance for each commodity need to be estimated in case of Oman.

F. Airports

The major air ports in the country are Muscat International Airport and Salalah airport which are under completion stage with state of art infrastructure facilities. Also there are regional airports in Sohar, Adam, Ras Al Hadd and Ad Duqum under completion stage [exhibit-4].

IV. OMAN VISION 2020

Oman's oil resources are relatively limited and increasingly difficult and costly to extract. It is estimated that the oil resources will be exhausted in less than 20 years [1]. Currently the oil sector contribution to its GDP is 48.44%. For this reason, the Government has embarked on a development strategy focusing on economic diversification. The Sultanate of Oman has been consistently pursuing a development plan focusing on diversification, industrialization and privatization, with the objective of reducing its dependence oil sector contribution to GDP.

In spite of the country's positive macroeconomic outlook, Oman's main economic and social challenge is to provide

more employment opportunities for its citizens [6]. Unemployment is a growing concern as Oman has a young population, with over 52 per cent of citizens under the age of 20 and 82 per cent under 35. There are more than 30,000 young Omanis entering the market each year [8], many of them unable to find a job. About 60 per cent of the labor force of almost one million is made up of non-nationals (mostly South Asians). At the instruction of His Majesty Sultan Qaboos bin Said a plan for Oman's economic future up to the year 2020 is set out lining the country's economic and social goals which include:

- Economic and Financial stability
- Reshaping the role of Government in the economy and broadening private sector,
- Diversifying the economic base sources of national income
- Globalization of Omanis economy
- Upgrading the skills of work force and developing human resources.

a. *Need for Rail transportation system:*

The geographical spatial development in Oman is linear as the major sea ports, airport and major urban centers being developed along the sea coast line of 2100km. currently in land freight and passenger movement is depending on road transport only. Looking at the large dispersal of economic activity, spatial distribution of the mining locations, industrial estates and urban centers there is need to connect all the prime locations with an efficient safe-faster economical and pollution free surface communication, for which railway connectivity is the only option for the sustainability of country's economy.

The Supreme Committee for Town Planning (SCTP) has been entrusted with the task of developing Oman's first railway system. Steps are initiated for inviting detailed project report preparations, design engineering, and project management proposals from global MNC's and a special purpose vehicle under Oman Railway Company is also constituted. It is expected that the railway project [exhibit 5, 6] is scheduled to be fully operational by 2017. Benefits of the rail project would be [7]:

- The full rail network in Oman will ultimately span 2,135 km and connect Oman's major ports, industrial areas, mineral deposits and population centers both with each other and with the wider GCC region.
- Cheaper access into and out of the GCC markets (up to USD 250,000 savings on fuel charges per vessel only)
- Trade facilitation – Oman will be developed as logistic centre –hub in the gulf region and facilitates faster movement of cargo and acceleration of doing business [8].
- Human capital – In this area, the Oman Logistics Centre aims at enabling an adequate supply of labor and the development of the local workforce capabilities employment creation for its citizens[9][10].
- Use of transport infrastructure to the fullest extent. Developed expressways, seaports, air ports and industrial estates are in place; rail connectivity enhances the productivity and improves GDP significantly.
- Technology – Finally, the Oman Logistics Centre aims at developing a state-of-the-art work environment in order to increase the attractiveness and productivity of Oman's logistics infrastructure.

V. CONCLUSION

Oman's transport infrastructure is well developed, but absence of rail connectivity is a major obstacle for its economic development, to emerge as a global logistics centre. Oman being located at strategic location at the world cross roads, could not fully explore its major mineral resources due to lack of accessibility and cost effective surface transportation system. At present road way is the only means of transport for the movement its logistics. Current set up of large spatial distribution of population centers, industries, mining centers and ports in Oman indicate the need for immediate shift of mode from road to rail system based for its freight movement. Development of rail infrastructure and transit facility in Oman facilitates for equal distribution of resources and to achieve balanced spatial development. Critical examination the statistical data of different sectors is strongly recommending the need for rail based transportation system.

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