Red Sea and Mediterranean Sea land bridge via Eilat

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Abstract: Many successful land-bridge projects have been constructed around the world. This fact has led the Israeli government to design a land bridge from Eilat port on the Red Sea coast to the Ashdod Port on the Mediterranean Sea coast. The planned project is expected to realise many benefits and profits. These are grouped into two groups. The first group comprises considerations associated with freight shipment: consolidation, specialisation, and the economic analysis and viability with respect to freight shipment and transshipment. The second group is the social and economic benefits of this project to Israel with respect to connecting the southern periphery with the centre of Israel.

Keywords: land-bridge; intermodal transportation; railways.

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1 Introduction

Los Angeles was a small port town of about 1,600 residents when the USA took control of it at the Mexican-American War in 1847. The local port was a major source of livelihood for the city's residents, but the upheaval was to happen only 20 years later. In 1867, the port was connected to the railway network by Southern Pacific Railroad and Los Angeles began to grow at an incredible speed until nowadays when Los Angeles and its suburbs are a home to about 13 million people. Los Angeles currently has two sea ports – Port of Los Angeles and Port of Long Beach. These two ports are the largest ports in the USA (Frazier, 2014; Sullivan, 2009; Klein, 1997).

Recently, the Israeli government approved the construction of a railway to Eilat (Israel Ministry of Transportation, 2012a). This project will bring many benefits and advantages to the Negev area (i.e., the southern part of Israel). Currently, the railway system of Israel is connected to the Mediterranean Sea, but there is no train connecting the Red Sea. A new railway from the Mediterranean Sea to the Red Sea as is suggested by the Israeli government and shown in Figure 1, will be able to compete against the Suez Canal just as the US trains are a competition for the marine transport going through the Panama Canal. Consequently, as we show in this paper, the new railway will create many new jobs for numerous Israelis and will generate immense revenues to Israel economy.

Figure 1 The planned route for Eilat-Ashdod Mediterranean Sea to the Red Sea railway (see online version for colours)

This new transportation project's vision is analogous to the vision of the prominent Interstate Highway system constructed by the 34th President of the USA, Dwight David Eisenhower (Cox and Love, 1996; Murphy, 2009). Similar to the Interstate Highway System, the Mediterranean Sea to the Red Sea railway has these benefits:

- positive impact on the Israel economy by expanding access to freight and reducing freight costs and subsequently improving the economic efficiency and productivity
- increased access to the less expensive land of the vast Negev region and the development of the Negev area
- increases competition resulting in a larger variety and lower consumer prices
- promotes business expansion as well as new businesses that will draw new investments and will create new jobs
- reduces traffic congestion, traffic accidents, saves lives, lowers number of injuries and decreases the economic loss due to traffic accidents
- saves travel time and expands the geographical area in which the citizens of Israel can operate
- improves air quality by substituting numerous private cars and trucks with rail cars
- supports national security by enabling moving large numbers of military personnel and massive quantities of military equipment and supplies to Israel south if a defence action is needed.

Indeed, many other countries have adopted the concept of developing transportation infrastructure with the aim of boosting up periphery regions. E.g., Spain for its sparsely populated provinces (Garmendia et al., 2011) or China for the region of its capital city, Beijing (Zhao, 2010).

Lately, because of political disputes in Israel, the Mediterranean Sea to the Red Sea railway has been deferred (Bar-Eli, 2014). Unfortunately, all the aforementioned benefits may be eliminated, if this deferring persists.

2 Review of land-bridges over the globe

Land-bridges are an emerging practice for bypassing shipping routes. Inter-modal delivery service is required to balance various factors like fuel costs, freight type, time, distance, etc., in shaping an optimal route for freight. The different options of inter-modal transportation are usually aimed at circumstances when time is critical and takes precedence over other considerations. The many new land-bridges around the globe are evidence to the necessity of this niche.

The USA serves as a land-bridge with the purpose of bypassing Panama Canal (Cope et al., 2014). Talley (2000) describes the effects on the transportation of goods when delivery services started using trains to cross the USA instead of using the Panama Canal. A standard ship travels usually at a speed of no more than 20 to 25 knots in normal conditions, that is, it usually travels no more than 20 mph. Train travel speed is considerable much faster, so typical travel time has been reduced by five to six days. Sullivan (2009) also notes that the cost is only 10% higher. USA eastern ports and mainly

the Port of New York were in control of 22% of the trade with China and the East before the use of trains to bypass Panama Canal. After rail shipping, USA eastern ports share of the trade dropped to only 15% of the trade since now a large volume of freight uses the rail system in lieu of the marine ports.

In the other side of the globe, Saudi Arabia is constructing a 590-mile of double-track railroad connecting Jeddah on the Red Sea to Dammam on the Gulf coast. Currently, shipping time between these ports require approximately three days. The port-to-port rail will reduce connection time to about only 10 hours (Cooper, 2013).

Israel's potential land-bridge already has a competitor. Russia is contemplating the construction of a rail route from the Korea region to Europe that will facilitate the transfer of cargo from East Asia to Europe via railways instead of passing through Suez Canal (Shatalova and Brautlecht, 2013).

Apparently not only manmade canals are being bypassed. The 1.7 mile wide Strait of Malacca is an example to this. The government of Thailand is constructing a rail land-bridge from Andaman Sea to Gulf of Thailand (Uabharadorn, 2011). The Thai land-bridge will bypass the Strait of Malacca and will shorten the freight transport time.

But the longest prospective land-bridge is The Great Equatorial Land Bridge running from Douala in Cameroon through Central African Republic and South Sudan to Lamu in Kenya – a total of 2,625 miles of railways connecting the South Atlantic Ocean with the Indian Ocean. The route capacity will be 20 millions TUEs per year (Njiru, 2011) and will have high speed freight trains that will travel at an average speed of 75 mph (Muli, 2012).

There are a number of considerations that support the creation of this Eilat-Ashdod land bridge (EALB) project. These considerations are grouped into two groups. The first group comprises private and commercial considerations associated with freight shipment: consolidation, specialisation, and the economic analysis and viability with respect to freight shipment and transshipment. The second group is the social and economic benefits of this project to Israel with respect to connecting the southern periphery with the center of Israel. It is beyond the scope of this paper to estimate precisely whether the private and commercial benefits are enough to incentivise private parties to fund the project. Notwithstanding, the magnitude and impact of such a project necessitates the entire country to be committed to it. The indirect benefits are therefore crucial to the success of the project and when added to the commercial benefits serve to bring to advantages of the project to above the tipping point. We detail these considerations in the following sections.

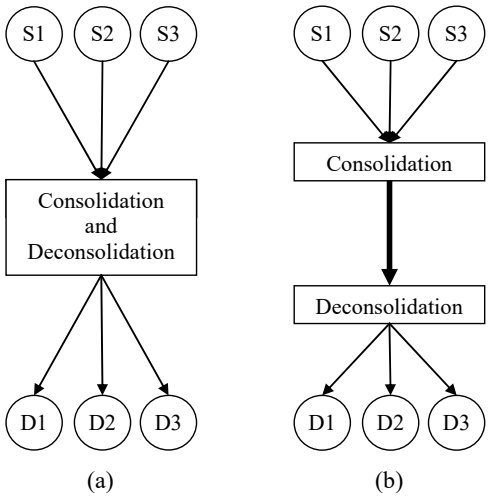
3 Freight consolidation

Freight consolidation (Wang and Cullinane, 2014) is a used extensively in logistics and freight ships. Consider N different source ports with freight that needs to be delivered to M different port destinations. Without consolidation, N*M different ships would have to transfer goods from each source to each destination. Shipping times will be relatively slow, because filling a ship would require longer waiting time as no single source needs to take considerable freight to any single destination. To shorten shipping time the frequency of ships leaving each source to each destination would have to increase but then either we have that ships will leave with partial cargo or smaller ships will be used. Either choice results with significantly higher shipping price per TEU.

To solve this problem a port is used as a hub in which freight from many sources sharing the same destination is consolidated and carried by a ship dedicated to that destination. There are two model approaches to consolidation (see Figure 2).

In Figure 2(a), there is a single hub located between the sources and the destinations. Each ship will travel half the distance and N+M ships are needed. In Figure 2(b), there are two hubs. The first hub is located very near the sources and the second is located very near the destinations. Now, more than N+M ships are needed. However, the N+M ships have to travel very short distances and only the additional ships that connect between the hubs will have to travel the long distance.

Figure 2 Two models for container consolidation



Each of these models has its advantages, which depend on the amount of freight that needs to be shipped from each source and to each destination.

In the type-a model Eilat-Ashdod hub can serve as a consolidation port for traffic shipped between the European market and the Indian Ocean and Western Indian markets. Israel is geographically located almost exactly in the middle of these shipping routes.

In the type-b model Eilat-Ashdod hub can serve as one of the two hubs connecting between East Asian ports and the European market. Freight from East Asian ports can be consolidated in hubs like Singapore or Shanghai transported in larger vessels to Eilat and in Ashdod they will be deconsolidated to local Mediterranean ships dedicated to each European port.

It is beyond the scope of this paper to research each and every one of the advantages of Eilat-Ashdod hub to the shipping industry for either model. In what follows, however, we provide a motivational case in point to demonstrate the economical possibilities of using an EALB in international shipping routes. In our case, the EALB functions according to first model (i.e. model a of Figure 2), which is then compared to the two models (a and b) using the Suez Canal. We consider only the one-way, east to west, shipping problem.

Our case demonstrates the advantages of the EALB on a shipping route between India and Europe. India is the second most populated country in the world and as a developing country has potential for tremendous growth. We consider the biggest container ports in

India, JNPT (Mumbai), Chennai and Kolkata. These ports shipped during the 2013–2014 year, 4,161, 1,468 and 449 thousands of TEU, respectively (Indian Ports Association, 2014). We now consider a very basic scenario in which each of the Indian ports needs to ship a thousand containers to each of major European ports, Piraeus (Greece), Barcelona (Spain) and Rotterdam (Netherlands). These European ports were chosen because of their large size and the fact that they form a triangle surrounding most of Western Europe, one of the largest consumer markets in the world. See Figure 3 for the location of the ports.

Figure 3 The major ports of the case in point (see online version for colours)

We consider three ways to ship these containers:

- *Suez 1:* An empty 9,000 container ship loads 3,000 containers from Kolkata, continues to Chennai port in which it loads another 3,000 containers and then continues to JNPT to load the final 3,000 TEUs. Now that it has reached capacity it sails to Piraeus via the Suez Canal. In Piraeus it unloads the 3,000 containers destined to Piraeus, then continues to Barcelona to unload the 3,000 containers destined to Barcelona and finally completes its route in Rotterdam.
- *Suez 2:* The containers from Kolkata and Chennai are shipped to JNPT using two 3,000 TEU container ships. In JNPT all the containers destined to Europe are consolidated to a 9,000 TEU ship that sails through the Suez Canal to Piraeus. In Piraeus the containers are deconsolidated with two 3,000 TEU ships used to ship the 6,000 containers destined to Barcelona and Rotterdam.
- *EALB:* Three 3,000 TEU boats ship the freight from each of the Indian ports to Eilat. The containers are carried by train to Ashdod where three 3,000 TEU boats take the containers to each of their European port destinations.

The distances between the ports in nautical miles are described in Table 1. These distances were calculated using Sea Route & Distance (2014).

Table 1 Nautical mile distances between ports

	Ashdod	*Eilat*	*Rotterdam*	*Barcelona*	*Piraeus*	*Kolkata*	*JNPT*	*Chennai*
Chennai, India		3,862	7,949	5,993	4,900	890	1,206	
JNPT-Mumbai, India		3,086	7,173	5,217	4,124	2,096		1,206
Kolkata, India		4,752	8,840	6,883	5,790		2,096	890
Piraeus, Greece	865		3,299	1,342		5,790	4,124	4,900
Barcelona, Spain	1,973		2,237		1,342	6,883	5,217	5,993
Rotterdam, Holland	3,930			2,237	3,299	8,840	7,173	7,949
Eilat, Israel						4,752	3,086	3,862
Ashdod, Israel			3,930	1,973	865			

Travel costs depend on a number of factors. We separate fuel costs from other ship operation costs. These operations costs are computed according to the number of days the route takes and the vessel size. Daily operational costs used for this example are given in Rodrigue (2015a). Indeed, a smaller container ship costs considerably less to operate and fuel in absolute values. Of course, per TCU it is considerably more expensive. Our argument for the EALB does not hold if shipping 9,000 TEU port to port is needed. These cases are not common. In contrast, we argue that when the port to port shipping requirements do not exceed 3,000 TEU and therefore either multiple stops are needed (i.e. Suez 1) or some form of consolidation is needed (i.e. Suez 2) then using the EALB as a consolidation port and as an alternative to the Suez Canal crossing is advantageous.

We assume that each leg in a route requires a day for loading and unloading freight. The Suez Canal crossing can take on average 14–16 hours. In addition, a vessel must arrive at least three hours prior to the flotilla departure and flotillas depart every 12 hours (http://www.elsharkawygroup.com/scanal.html). Considering the strict flotilla timing requirements, we assume the entire Suez Canal crossing requires two days. Results do not change considerably if we relax this assumption to a single day.

Slow steaming was considered by researchers as early as 1982 in Ronen (1982). Approximately 25 years later, the industry began to extensively apply it and today slow steaming is a well-known practice in the shipping industry and is extensively researched to be optimally applied (e.g. Bonney, 2010; Ronen, 2011; Kiiski, 2013). Lee et al. (2015) explain that the drastic fuel savings gained by steaming easily offsets the additional operational costs of the stay at sea. Indeed, there are additional considerations such as the strain to the supply chain. However, especially when demand is low slow steaming is practiced throughout the industry.

We therefore consider slow steaming in our example and examine how the costs for each route changes with the shipping speed in knots. Obviously, these costs are very sensitive to fuel costs, which are approximately (when crude oil price was in the range of 100$ per barrel) half the total operating cost (see http://www.people.hofstra.edu/geotrans/eng/ch3en/conc3en/containeroperatingcosts.html). For our numerical example, we use Rodrigue (2015b) to compute the fuel consumption given the ship's speed and size.

In Figure 4, we present the price of each route when oil prices are 100$ per barrel and in Figure 5 we present the cost of each route when oil prices are down to 50$ per barrel. It can be clearly seen that even for lower fuel costs, the EALB is still more attractive than the alternative routes. Indeed, it appears that fuel cost has little effect on to which route is optimal.

Figure 4 Total shipping cost when fuel price is 100 USD per barrel

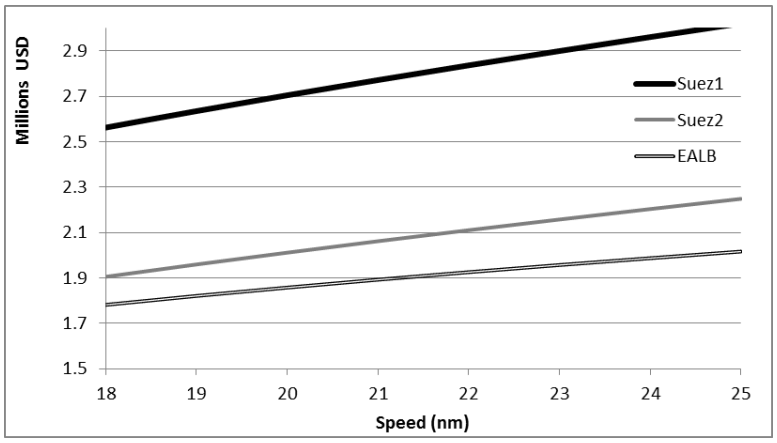
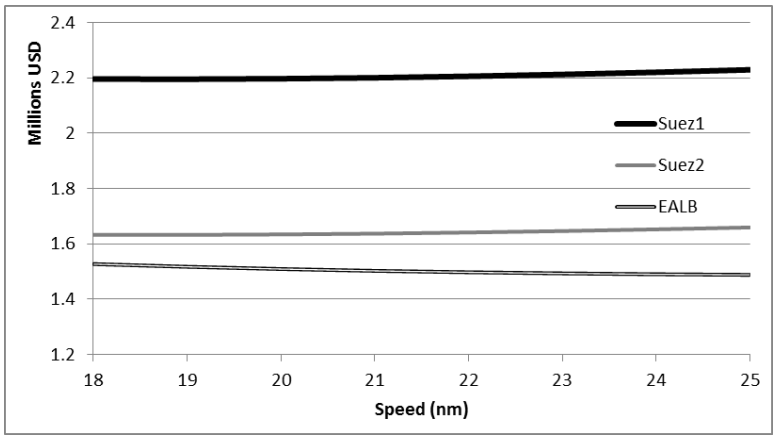


Figure 5 Total shipping cost when fuel price is 50 USD per barrel



There are four major routes that travel through the Suez Canal.

- westbound routes:
  1 Asia to Eastern North America
  2 Asia to Europe
- eastbound routs:
  3 The American east coast to Asia
  4 The European ports to Asia.

Our case numerically demonstrates the advantage of the Ashdod-Eilat land bridge to the second route. In fact, the fourth route can enjoy even greater benefits from the existence of Ashdod-Eilat land bridge. Many of these Europe to Asia routes use a consolidation port that is in the proximity of Ashdod, such as Port Said (178 nm), Piraeus (865 nm) or Malta (1,176 nm). Instead of consolidating in such hubs and then crossing the Suez Canal, consolidation can take place in less time using the Ashdod-Eilat land bridge. Since prices and timetables across ports are more or less similar, we can reasonably assume that the Ashdod-Eilat hub cost is not considerably more time consuming or expensive than the Piraeus option. This implies that using Ashdod-Eilat land bridge will save shipping lines the entire cost of the Suez Canal fees and more importantly, the two days that the crossing takes on average.

Nevertheless, it should be noted that there are a number of limits to the capacity of such a land bride, which is constrained by the maximal capacities of the Asdhod Port, Eilat Port and the proposed rail track.

There is a disagreement about Ashdod port maximum capacity, which ranges from 1.5 million containers to 5 million containers (Royal Haskoning, 2005). A new port that will be constructed in the coming years near Ashdod Port and will have a capacity of 1.5 million containers will further expand the capacity of the Ashdod terminal of the land bridge (Israel Lays Cornerstone of New Chinese-built Seaport, 2014).

Eilat port is currently too small and can handle a relatively small number of containers per year. Therefore, Israel's ministry of transportation invited relevant parties worldwide to submit proposals to its published request for information (RFI) with the aim of examining the feasibility of establishing a canal port at the North East Eilat Bay (Israel Ministry of Transportation, 2012b). The goal of this RFI is to increase the capacity of the Eilat terminal of the proposed land bridge. Of course, expansion need not be upfront, but made gradually using optimisation models such as in Giat (2013).

The trains also pose a significant constraint. The longest trains are a few miles long and consist of at most several hundreds of wagons (Connell, 2010; Long Bnsf Trains, 2009) even when double-stack wagons are used (Thoung, 1989). This implies that if, on average, ten full trains travel daily, the railway capacity is about 2 million containers annually. This is much more than the current traffic at Ashdod Port that is only 0.77 million containers per year (Israel Ministry of Transportation – Administration of Shipping and Ports, 2014), but much less than Suez Canal traffic that was 42 million containers at 2014 (Suez Canal Traffic Statistics, 2014). This leads to the understanding that the new Ashdod-Eilat land-bridge will be only a minor route for moving freight from the Red Sea to the Mediterranean Sea; whereas the Suez Canal will not lose its role as the major route for shipping freight from the Red Sea to the Mediterranean Sea.

4 Connecting the southern periphery to the centre

4.1 Passenger trains

The railway to Eilat will serve passenger trains as well. The passenger service will have significant additional advantages. These advantages, by themselves, may justify the execution of the project.

4.2 Land availability and price

Israel is experiencing a serious housing problem (Weiner and Fuerst, 2014). Home prices have consistently risen in real prices and this problem has turned into a serious political concern. To demonstrate the desperation this problem has caused among politicians, Israel's Minister of Finance has proposed at 2014 eliminating the 18% VAT in Israel for young couples purchasing their first house. The estimated annual cost of this program is well over the 2 billion NIS (500 million USD) and was advanced despite a consensus among economists that it will only further hike house prices (Hudi, 2014).

Experts on the matter agree that the biggest challenge to reducing prices is the scarcity of land in the main areas of demand (the centre of Israel, Jerusalem area and Haifa area). Abundant area exists in the Negev, but since the Negev is economically remote, few are willing to build their homes there. The train's proposed route will allow shortening the distance between these vast areas of land and thus increasing their appeal to many families. Further, the jobs created by this line will create economical hubs in the South that will increase the area's pull.

The cost of an acre in the urban areas of Israel can reach more than 20 million USD dollars. Even if we consider prices outside of Tel Aviv, a lot of that size zoned for private homes has been recently sold at more than 4 million dollars just south of Rishon Lezion (Pauzner, 2011). In the Negev, there are more than a million acres available for development.

4.3 Prevention of felonies and land grabbing

Israel is experiencing security problems in its southern border (Wiseman and Giat, 2016). The existence of civilian population will bolster human presence and reduce smuggling and human trafficking.

More to the point, Israel currently has a problem with Bedouins illegally trespassing lands and over time claiming it as their own. This no-man-land approach is possible only because there is little human presence and no one to report this land grabbing. As a result, Israel experiences losses estimated in billions. These losses are due to legal costs associated with eviction, which in Israel can take many years and require many resources.

Even worse, many times the government is unable to evict the illegal settlers from those lands, whose estimated cost can be many billions. In areas where there is a higher concentration of civilians these problems do not occur. Once officials are aware early enough of a trespassing event, the legal process to evict the trespasser is quite simple and straightforward. In fact, the presence of civilians itself is an excellent deterrent to prevent trespassing and the problem rarely arises.

4.4 Greener environment

In the centre of Israel – specifically the greater Tel Aviv urban area – there is an increasing pollution problem (Cohen et al., 2014). Relieving the constant pressure for more population in that area and shifting demand to the south should help mitigate the increase in pollution in the centre of Israel.

Furthermore, instead of many private cars travelling to the south, a single train can replace many of these cars with considerably less gas emissions.

The land bridge may serve to reduce noise pollution as well. Approximately 19,000 airplanes have travelled to and from Eilat airport at 2014 (Israel Airport Authority, 2015). The noise of the airplanes departure and arrival at the centre of Israel instigated protests against the nuisance (Giladi, 2014) and authorities are seeking how to alleviate this problem (Wiseman, 2014a, 2014b). The traffic from and to Eilat is certainly only a fraction of the entire traffic to the centre of Israel; however even moving some of this traffic to trains can be advantageous.

4.5 Accident prevention and safety

Train travel is the safest for of travel in Israel and even in the world. In 2014, there were only 172 recorded deaths worldwide in train accidents. The majority came from the Santiago de Compostable crash in Spain, which claimed a total of 78 lives (Gayle, 2015). In the same period nearly 1.3 million people died in road crashes. Road crashes are the leading cause of death among young people ages 15–29 and cost USD $518 billion globally, costing individual countries from 1–2% of their annual GDP (Association for Safe International Road Travel, 2015). Train are not susceptible to the different types of accidents that are prone to happen when driving by car or truck (Wiseman, 2010, 2013a, 2013b). Accordingly, many lives can be saved by shifting some of the traffic to a train.

5 Miscellaneous

5.1 Pirating

All the ships travelling in the West Indian Ocean are exposed to serious pirating risks (Gilpin, 2009). These risks sometime cost the lives of crew members and also cost the shipping industry and countries great sums of money. The monetary costs include loss of cargo, loss of ships, ransom money (hundreds of millions annually), insurance premiums, and cost of defence.

It is therefore economically profitable for ships, if possible, to avoid the travel in that region, or at least transfer freight to ships that specialise in travelling these waters.

Using the Ashdod-Eilat land-bridge as a hub allows ships to operate *either* in the Mediterranean-Atlantic waters or the Indian-Pacific oceans. Therefore, all the Mediterranean-Atlantic ships will not incur the additional costs associated with piracy, which can be somewhat excessive (King, 2008). More specialisation is therefore achieved as the Indian-Pacific ships focus on that region only and will specialise in anti-piracy tactics.

5.2 Specialisation

The aforementioned regional specialisation has additional advantages. Crew members that work in a smaller territory will have better knowledge of the terrain. Weather changes are smaller; for example, consider the climate change between the subequatorial Indian Ocean and the Mediterranean (Menendez et al., 2014). Replacement crews can be accessed more easily and crewmembers, assuming they live in the region can enjoy better access to their families.

5.3 Travel time

The driving force behind the use of the Suez and Panama canal is shortening the distance and thus gaining lower fuel costs, and more importantly, shorter travel times. The cost of each day for a medium sized container ship is approximately $30,000 (Qu and Meng, 2012). Suez crossing takes an average of two days. In contrast, a container ship arriving at Eilat can be unloaded in 8 hours and reloaded at Ashdod in 8 hours (Iseya and Takadama, 2010). The distance between Eilat and Ashdod is about 190 miles and can be travelled by train in about 4 hours; therefore the entire process is about only 20 hours. This forecast time shortening is similar to contemporary shorting time of other existing land-bridges as was surveyed at Section 2.

5.4 Closure of the Suez Canal

During its 150 years of operation, the Suez Canal was not always fully functional and in particular, was not accessible to Israeli ships. There are several notable stories of interest about confiscation of ships and freight because of political reasons. These incidents happened despite the Convention of Constantinople (Leslie, 1935) that guarantees a free use of the Suez Canal. The saga of the Israeli Bat-Galim ship (Gross, 1957) took place during 1954 when the Egyptian security forces illegitimately confiscated the ship and its freight. Three years later, an Israeli sailor who worked at the Danish Brigitte Toft ship was kidnapped by the Egyptian authorities when the ship passed through the Suez Canal (The Global Jewish News Source, 1957). In 1959, two more incidents occurred. The Danish Inge Toft ship freight and the Greek Astypatea ship freight were unlawfully confiscated by the Egyptian security forces (Katz, 1973). More recently, in 2014 an Egyptian court sentenced 26 people to death for establishing a terror group that tried to attack ships at the Suez Canal with the aim of closing the vital route (Times of Israel, 2014). These examples demonstrate the volatility of the political situation surrounding the Suez Canal making a case for the creation of a viable and economical alternative.

6 Conclusions

The concept of a railway land-bridge that circumvents a canal of a sea strait is an emerging model that has been adopted by many countries. The Israeli government has made its first steps towards the major project of railway land-bridge between the Red sea and the Mediterranean Sea. Unfortunately, there are many obstacles and difficulties in the way to accomplish this task. The questions, therefore, is whether the potential benefits of such a project outweigh the obstacles and problems it may create.

We demonstrate the potential benefits of the land bridge and categorise these benefits into two groups. The first group comprises considerations associated with freight shipment: consolidation, specialisation, and the economic analysis and viability with respect to freight shipment and transshipment. The second group is the social and economic benefits of this project to Israel with respect to connecting the southern periphery with the centre of Israel.

Considering the many advantages and promise of the EALB we believe that it has the potential of successfully joining other active and planned land bridges around the world, such as the US land bridge and future land bridges crossing Saudi Arabia, Equatorial

Africa and the Kras Isthmus of Thailand. We conclude, therefore, that it is imperative to accomplish the task of constructing the EALB despite the political resistance to the project and the project's financial cost.

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