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The logistics potential of the Aqaba Special Economic Zone as a regional gateway

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THE LOGISTICS POTENTIAL OF THE AQABA SPECIAL ECONOMIC ZONE AS A REGIONAL GATEWAY

By

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To :

My Mother, My Wife & My Children

23.08.20004

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: **The Logistics Potentials of the Aqaba Special Economic Zone (ASEZ) as a Regional Gateway**

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The dissertation is a study of the potential hinterland markets of the Aqaba Port and ultimately the logistics potential of the Aqaba Special Economic Zone (ASEZ) in view of the ongoing trade liberalisation and the expected economic cooperation in the Mashrek region.

A look is taken at the logistics tendencies in the Mashrek region and the currently available levels of major logistics and transport physical infrastructure. Similarly, the efficiency of the transport logistics system in the region is examined.

The present logistics environment in the ASEZ is described and the major logistics shortages and deficiencies in the ASEZ's contribution to the national and regional multimodal transport network are identified.

The total transport logistics cost concept is employed as a formal method, for the first time, to identify the true potential hinterland markets of Aqaba Port. Accordingly, an econometric model and cost analysis approaches are developed to investigate which maritime trade route could use Aqaba Port as the least cost route for shipments to the main economic centers in Mashrek countries.

The concluding chapters analyse the location advantage of the ASEZ and examines several national and regional multimodal transport solutions such as a land bridge between the Red Sea and the Mediterranean based on the total cost concept.

KEYWORDS: ASEZ, Total Cost, Logistics, Multimodal, Transport, Efficiency, Location, Aqaba Port.

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LIST OF ABBREVIATIONS

AEA	Association of European Airlines
ASEZ	Aqaba Special Economic Zone
ASEZA	Aqaba Special Economic Zone Authority
ASYCUDA	Automated System for Customs Data
DPA	Dubai Port Authority
EFTA	European Free Trade Association
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCWA	Economic and Social Commission for Western Asia
EU	European Union
FTA	Free-Trade-Area
GDP	Gross Domestic Product
IATA	International Air Transport Association
JICA	Japan International Cooperation Agency
L/C	Letter of Credit
MENA	Middle East and North Africa
NCB	Negev Continental Bridge
OECD	Organisation for Economic Co-operation and Development
Red-Med	Red Sea - Mediterranean
TC	Total Cost
TEU	Twenty Equivalent Unit
THC	Terminal Handling Charges
UNCTAD	United Nations Conference on Trade and Development
WTO	World Trade Organization

"In the past few years, Jordan has made great strides toward becoming a full player in all that the global economy has to offer."(Amman, 11-Dec-2002)

" Thus, we have to keep the pace of opening up on the world around us, reutilise the experiences of others, and the scientific, technological and cultural inputs of this age." (Amman, 25-May-2003)

" Great opportunities lie ahead. A world where all people share in the promise of human knowledge; participate in global prosperity and growth; and fulfill their human potential. This is our goal in Jordan, and this is Jordan's goal for the Middle East." (Chicago, 11-Jun-2004)

" In Jordan, an extensive reform program is well underway. We are determined to help our people achieve their potential, in every sphere. In the economy, we have encouraged innovation, enterprise, and partnership with the private sector." (London, 02-Jul-2004)

His Majesty King Abdullah II

CHAPTER 1

1. INTRODUCTION

Increasingly, it is becoming evident that international economic and political pressure is building up to bring stability to the Middle East and to modernise the economic and social structures of this region's economies. Unless these efforts succeed, the region risks becoming marginalised from the global economic system. In fact countries of the region are gradually accepting to shift responsibility to markets and to encourage greater integration with the world economy. Several countries are negotiating or have signed major market opening agreements with foreign partners. Furthermore, globalisation and regionalism will soon lead to the opening of the transport market in this region, particularly the Mashrek region. Subsequently trade barriers giving preferences to national ports will be removed and shippers and carriers will have several chances to select the best route for shipments, which will increase competition between intermodal nodes in the region.

Accordingly, in its efforts to integrate the country into the global trading system and enhance its competitiveness, in mid February 2001, the Government of Jordan decided to declare the whole city of Aqaba, where country's only port (Aqaba Port), as a duty free Special Economic Zone. Many writers and experts suggest that Aqaba Port chances in the upcoming competition are low for many reasons; specifically for being situated away from international maritime trade routes and because other ports in the region are closer to hinterland markets than Aqaba Port (Wilbur, 2001; Muller, 2002; Bar-El, 2003). On the other hand, a few other studies suggested that the progress in the peace process might generate additional freight flows via Aqaba Port (GOPA, 1996; JICA, 1996). However, all the work that has been done so far used

informal methods, which do not allow for tests of hypotheses. Evidently, there is a need for more studies to be conducted to formally identify the true potential markets of Aqaba Port. Therefore, this research aims at identifying the competitive maritime trade routes and the potential hinterlands markets of Aqaba Port and ultimately highlighting the logistics importance of the Aqaba Special Economic Zone (ASEZ). A second goal is to examine the logistics viability of a land bridge between Aqaba Port on the Red Sea and ports of the region on the Mediterranean.

In order to achieve the research objectives it was necessary to define the potential region from political, social and economic perspectives before narrowing the scope of the research to the ASEZ logistics infrastructure, particularly Aqaba Port. Accordingly, chapter two defines the Mashrek region and explains the trade liberalisation trends in this region. It also describes the present logistics environment in each country of the region.

Chapter three highlights Jordan's economic policy and its effect on transport and logistics industries locally and regionally. Furthermore, it describes the available logistics infrastructure in the ASEZ, Jordan's main logistics center, and the demand on its logistics platforms and facilities.

Chapter four uses the total transport logistics cost concept to develop an econometric and cost analysis for shipping to the Mashrek region via Aqaba Port. It identifies the different routes available between main economic centers in the region and Asian markets and examines whether transporting via ASEZ could be the least cost route.

Chapter five provides an analytical assessment of the results in previous chapters. Further, it pinpoints the major shortages in ASEZ's logistics chain and examines several intermodal solutions for Jordan and the region.

Finally, the conclusion in the last chapter summarizes the findings of this research.

CHAPTER 2
2. LOGISTICS TENDICIES IN THE "MASHREK" SUB-REGION

2.1 Background

The movement toward globalization and trade liberalization paralleled by the revolution in information and communications technologies is continually advancing and significantly altering existing markets and triggering a race for the future. Apparently a new economic era is materializing and driving more countries toward global economic integration. While partnering and forming alliances are companies' best response (Doz, 1998), regionalism is emerging as countries' powerful option in face of these ongoing global trends (Ezrahi, 2003). National borders are increasingly disappearing and trade barriers are dismantled. The last decade witnessed the creation of various regional trade blocks as well as the expansion of existing blocks to encourage regional trade and economic integration and prosperity.

Europe - Mediterranean Partnership initiative between member states of the European Union (EU) and their twelve Mediterranean partners was launched at the 1995 Barcelona Euro - Mediterranean Conference and referred to as the "Barcelona Declaration". The main objective of this partnership is the creation of a multilateral Free-Trade-Area (FTA) around year 2010 (Muller-Jentsch, 2002). Similarly, following the Oslo peace accord many economic initiatives were proposed, including a "Free Trade Area" to connect the economies of Jordan, Palestine and Israel (Lawrence, 1995). A study by the Organisation for Economic Co-operation and Development-OECD (1997) concludes that most of the Middle East economies have similar comparative advantage with limited scale. Further, it calls for implementing

the international concept “growth triangles”, which facilitates sub-regional economic co-operation, in the Middle East between Arab countries and Israel. Evidently, the base for regional integration exists but lacks the momentum and the political will. Although slow, the underway national, regional and international political and economic efforts seem to be leading to successful growth triangles in the region.

2.2 Mashrek Sub-Region

The Europe - Mediterranean Partnership initiative has been internationally accepted as a mechanism for speeding the economic and trade reforms in the region.

The Mediterranean partners include Maghreb countries (Morocco, Algeria and Tunisia), Mashrek countries (Jordan, Lebanon, Syria, Egypt, Israel and the West Bank and Gaza), Turkey, Malta and Cyprus. Both Maghreb and Mashrek form natural sub-regions within the Middle East and North Africa (MENA) region, which covers the economies of the Arab League (Algeria, Bahrain, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, the UAE, and Yemen), Iran and Israel.

This part of the research focuses on the Mashrek sub-region which includes Jordan, where the ASEZ is located, being the subject of this research. Although, politically it includes Egypt, for logistical and geographical reasons, the Mashrek sub-region under discussion has been redefined within the context of this research to cover only Jordan, Lebanon, Syria, Israel and the West Bank and Gaza. While, all these countries are located in Asia, Egypt is located in Africa. Similarly, several ports within this sub-region, except for Egypt, share potentially overlapping hinterland markets. Muller-Jentsch (2002) identifies that economic centers in Jordan and Syria are closer to foreign rather than domestic ports. Amman and Damascus are closer to the ports of Gaza, Ashdod and Beirut on the Mediterranean than the ports of Aqaba on the Red Sea and Latakia on the Mediterranean.

Figure 2.1 Highlight of the defined Mashrek countries
Source: http://www.lib.utexas.edu/maps/middle_east_and_asia/middleeast_ref01.pdf

2.2.1 Economic & Political Background

Economic cooperation within the Mashrek region has been very limited due to political reasons and different economic policies in the countries of the region. While the Arab-Israeli conflict prevented any cooperation with Israel, the various levels of economic protectionism policies limited cooperation among Mashrek Arab countries.

Although the Mashrek sub-region has not been able to materialize the advantages of economic growth and regional integration due to political instability, currently, the region is undergoing international political efforts to end the Arab-Israeli conflict and bring stability, peace and prosperity to the region. The Copenhagen Action Plan, an important international political initiative adopted by the countries of the region in November 1993, aims at promoting regional economic development in the region and addresses the issues of infrastructure, trade, finance and tourism. Through this plan, countries of the region will work to encourage the free movement of people, goods, services, capital and information among the partners in the region; to

stimulate economic development and to reduce regional economic disparities; to promote the region's integration in global markets to fully exploit respective advantages by promoting regional trade, facilitating investment and developing infrastructure. (Ezrahi, 2003)

In principle, the peace process in the Middle East is expected to remove political constraints and therefore facilitating higher economic growth. Accordingly, the peace agreements between Jordan and the Palestinian Authority with Israel open the door for initiating a regional economic cooperation (Bar-El, 2003). Similarly, Ezrahi (2003) reports that global trends of globalization, liberalisation and regionalism coupled with the settlement of political disputes will be reflected in the Middle East and therefore leading to economic co-operation between region countries.

Accordingly, the Europe - Mediterranean Partnership initiative is widely recognised as the proper tool which will speed the integration of the region into the international economy; therefore creating a favourable environment for linkages across the region's markets and production systems, which will result in regional liberalisation and cooperation on transport infrastructure projects and facilities (Petri, 1997).

Similarly, the World Trade Organization's (WTO) efforts will continue to liberalize and facilitate cross-border trade worldwide (UNCTAD, 2002). Currently two Mashrek economies: Jordan and Israel are members in the WTO and other economies are in an ongoing negotiations process, which ensures the region's commitment to adhere to WTO standards, particularly toward trade policy reforms and liberalization along the global WTO track.

However, in order to capture the economic benefits of the Euro-Mediterranean free trade agreements on both regional and international levels, the countries of the region need to eliminate the non-tariff barriers and to improve the transport efficiency. Micco (2003) shows that reduction in artificial trade barriers has emphasized the

importance of transport costs as a remaining barrier to trade. However, the "Barcelona Declaration" acknowledges the importance of transport sector reforms, particularly the removal of all inefficiencies in the regional transport network.

2.2.2 Mashrek Economies

The Mashrek sub-region is unique in its economic and social structure. To large extent, the region consists of a culturally homogenous group of small economies with considerable differences in their levels of economic development and structure in some cases. Mashrek has a population of 36.4 million with a total Gross Domestic Product (GDP) of $ 154.5 billion. In 2002, the region exported a total of $ 51.55 billion and imported a total of $ 67.35 billion. Although each of the region's economies has its own characteristics, they are united in their need of economic improvement and technological advancement. Further, most of Mashrek countries are under-represented in manufacturing relative to economies with similar economic characteristics. Table 2.1 charts demographic, economic indicators in the region and reflects to some extent the economic disparities and how most economies in the region still operate below their potentials and therefore, not taking full advantage of the opportunities that the global economy has to offer.

Table 2.1 Economic indicators in Mashrek countries (2002)

Indicator	Jordan	Lebanon	Syria	Israel	West Bank & Gaza	TOTAL
GDP ($ billion)	9.30	17.30	20.80	103.70	3.40	154.50
Population (million)	5.20	4.40	17.00	6.60	3.20	36.40
Per capita GPD ($)	1788.00	3932.00	1224.00	15712.00	1062.00	
Imports ($ billion)	5.30	7.08	5.89	47.50	1.58	67.35
Exports ($ billion)	2.50	2.41	7.64	38.58	0.42	51.55

Source: The World Bank Group – World Development Indicators Database, April 2004.

Many of these economies remain specialized in raw material exports and labour intensive low skilled manufactures. Therefore, they risk becoming marginalized in the global economy as the globalization of goods and capital markets accelerates. Alternatively, other economies in the region are successfully advancing on the ladder

of dynamic comparative advantage toward human capital and technology-intensive goods (Muller-Jentsch, 2002).

Therefore, due to existence of significant differences in the economic structure of the region's economies, many writers argued against the idea of regional integration. They believe that opening economic borders between countries with imbalance of economic powers may lead to an "economic colonization" process (Heller, 1994) (Lawrence, 1995). While this situation may evolve only in case of full regional integration, such condition is hardly expected in the short-medium term. Yet, the same writers share with other pro-integration writers (Ezrahi, 2003) that for the immediate future, specific patterns of cooperation should be preferred to a general integration approach. Cooperation must start with transport infrastructure facilities and removal of trade barriers to improve the logistics efficiency in the region

2.2.3 Transport and Trade flows

There exists a strong relationship between economic development and trade growth. The improvement in a country's external trade is directly related to economic development, which is reflected in the growth of the GDP. According to Drewry (2000) GDP and containerised trade are directly related. Therefore, GDP can be used as an economic indicator for forecasting the cargo growth in the region. Since demand for containerisation or transport logistics in general is a derived demand from international trade of containerized cargo then ultimately it is affected by world economic and political developments.

Table 2.2 Real GDP growth in Mashrek countries between (1992-2002)

Country	GDP (US$ billion)					
	1992	2001	2002	Growth '92-'02		Growth '01-'02
				Total	Avg. Yr.	
Jordan	5.4	8.8	9.3	72%	7%	6%
Lebanon	5.5	16.7	17.3	215%	21%	4%
Syria	13.3	19.5	21.9	65%	6%	12%
Israel	65.8	112.7	103.7	58%	6%	-8%
WB & Gaza	n/a	4.0	3.4	n/a	n/a	-15%

Source: The World Bank Group – World Development Indicators Database, April 2004.

Table 2.2 which registers the growth rates of the region's GDP between 1992 and 2002 shows that during the last decade the Mashrek countries' GDP registered a remarkable growth rates, which corresponds with the growth in region's demand for trade and ultimately demand for transport services.

Similarly, during the past decade containerised transport witnessed a significant growth in all countries of the region, which have developed the required infrastructure for this type of transport. Table 2.3 compares the container traffic in the region in 1996 with 2002. It also calculates an important indicator for the penetration of containers in certain markets by calculating the number of Twenty Equivalent Unit (TEU) per million dollars of GDP (Drewry, 2000). While Jordan has the highest ratio (30) the other countries are also showing good ratios in international benchmarking standards.

Table 2.3 Container traffic growth rates in Mashrek countries between (1996-2002)

Country	1996 (TEU)	2002 (TEU)	'96-'02 Growth %	TEU/$mGDP (2002)
Jordan	139,317	277,307	99%	30
Lebanon	259,247	298,876	15%	17
Syria	150,000	257,586	72%	12
Israel	989,937	1,461,000	48%	14

Source: Containerisation International Yearbooks 1999 & 2004.

On the other hand, the vast majority of cross-border trade in the Mashrek region is seaborne, especially for economies with limited overland cross-border access due to its geopolitical location. Jordan on the other hand, which is the only country in this region without access to the Mediterranean, depends on road haulage for more than 60% of its imports by weight. Furthermore, the region's trade reflects imbalance between imports (mainly processed goods and consumer products) and exports (mostly commodities). While Jordan and Syria's exports by sea (phosphate in Jordan and oil in Syria) are higher than thier imports, Lebanon and Israel have the reverse situation. In Jordan, the share of phosphates and other minerals accounted for 54

percent of the country's total seaborne trade, while in Syria oil and oil derivatives made up to 69 percent of maritime traffic.

Table 2.4 Maritime Transport Flow in Mashrek countries (2000)

Country	Inbound (000 tons)	Out-bound (000 tons)	Inbound as % of Out-bound
Jordan	5,360	7,193	134%
Lebanon	5,195	352	7%
Syria	8,959	20,705	231%
Israel	29,196	13,866	47%

Source: Eurostat (MED-Trans Database)

Table 2.4 reflects the imbalance between the inbound and outbound maritime trade in Mashrek countries. These imbalances in the lop-sidedness of maritime transport flows, lead to considerable unused transport capacity and therefore differences in freight rates between out-bound and inbound traffic.

2.3 Logistics in the region

2.3.1 Background

With today's dynamic markets and increasingly changing technologies, companies must be flexible to respond rapidly to competition and market changes. Over the past two decades, hyper-competition led business cycles to develop various management tools and techniques to survive. Quality management, time-based competition, benchmarking, outsourcing, partnering, reengineering and change management are all examples of such instruments. The ultimate goal is to "deliver greater value to customers or create compatible value at a lower cost, or do both" (Porter, 1996, p.62). Eventually, it was realized that differences in cost derive from the large number of activities performed from creating the product or service up to delivering it to the customer, that is the supply chain. Therefore, whoever manages these activities and their flow more effectively and efficiently will gain the cost advantage and then the competitive lead. This breakdown of activities paralleled with the

introduction of containers and the revolution in the information and communication technologies resulted in the emergence of logistics and multimodal transport as a competitive strategic management tool, which enables enterprises to achieve the cost leadership. Later with the explosive expansion of international trade, global outsourcing of manufacturing and the introduction of the just in time production, transport logistics gained increased importance and became an integral part of the production process.

Although transport logistics advantages have been recognized and acquired by many countries around the world over the past two decades, it is only until recently Mashrek economies began to pay attention to this process and its requirements. In fact, Mashrek countries could not capture the full advantages derived from an efficient transport logistics system due to administrative and political barriers. Land borders between Lebanon and Israel and between Syrian and Israel are closed due to political conflicts. Similarly, Syrian law prohibits imports to the country through foreign ports (Muller-Jentsch, 2002).

Accordingly maybe the "imports freight costs macroeconomic indicator for transport sector efficiency" can be the best tool to demonstrates that most of Mashrek countries suffer from inefficient transport organization and facilities, poor utilization of assets and weak management practices. Table 2.5 provides estimates of total freight costs for imports and the percentage of total imports value of the Mashrek countries, as per United Nations Conference on Trade and Development (UNCTAD) figures (Muller-Jentsh, 2002).

Table 2.5 Estimates of freight costs for imports in Mashrek countries (2000)

Country	Value of imports (CIF) ($ billion)	Freight Costs of imports ($ million)	Freight Costs as % of imports
Jordan	4.5	574	12.8 %
Lebanon	6.2	657	10.6 %
Syria	5.3	687	13.0 %
Israel	36.8	2993	8.1 %
WB & Gaza	n/a	n/a	n/a

Source: UNCTAD

With 7-8% international best practice benchmarks, it is quite clear from the figures in Table 2.5 that (aside from Israel) Mashrek countries could save freight costs of up to 2-4% ($0.3-0.7 billion) of their total trade value if their transport logistics system were more efficient. Therefore, Mashrek countries, which are poorly integrated in the international supply chain, still have large potential gains from transport sector reforms that ultimately may lead to considerable improvement in their international competitiveness. Certainly, the fact that supply chain is increasingly managed as an integrated system underlines the importance of the efficiency and integration of the intermodal transport chain components. Therefore, the efficiency of transport logistics, which is crucial for the commercial success of individual enterprise, is a vital determinant for the Mashrek countries' international competitiveness.

Simply, the challenge facing the Mashrek region is not to expand the physical logistics infrastructure, but to upgrade and improve the logistics efficiency through policy reforms. Muller-Jentsh (2002) emphasizes that in many cases policy reforms could increase the efficiency of transport logistics and achieve the same effect as physical infrastructure expansion, but at much lower cost. For example, a study conducted by the Central American business school INCAE, on a Central American Logistics Corridor, revealed that lack of physical infrastructure was not the reason behind the bottlenecks, but the cumbersome border procedures and regulations, which restrained competition in road haulage and the development of a logistics industry (ESCAP, 2002).

As mentioned earlier demand for transport services is derived from demand for trade and therefore trade represents the demand side in this market. However, the supply side is represented by the quantity and quality of the transport infrastructure and facilities. Therefore, defining the available logistics infrastructure in the region remains necessary to understand how these two forces (demand and supply) determine the transport market in the region. Additionally, to show how intermodal

nodes and international trade corridors in each country can integrate together to form the region's multimodal transport network.

2.3.2 Logistics infrastructure

"Since a chain is only as strong as its weakest link", reliable and cost-efficient transport logistics requires efficient physical transport infrastructure. Although transport logistics are the ultimate output of the different transport means, port, rail, road and airport infrastructure and services are the essential intermediate inputs. Smooth hinterlands connection, effective cross-border procedures and professional management of the whole process are significant factors for the success of intermodal nodes, particularly ports. This importance stems from the close relationship between infrastructure quality and transport cost. Many economists have found that quality of logistics infrastructure has an inverse relationship with transport cost. Guasch and Kogan (2001) noticed in their cross-country comparison study that low quality of infrastructure is a highly possible reason for the high inventory levels in low-income countries.

Compared with many other third world nations, Mashrek countries enjoy a good physical infrastructure for trade and travel. In general the region's roads, railways, airports and ports are considered adequate and sufficient. The following parts explain briefly the available transport infrastructure and platforms in Mashrek region.

2.3.2.1 Ports

Ports are the key intermodal nodes and entry points for trade into most Mashrek countries. Hence, the region enjoys several outlets on Mediterranean and Red Sea.

Jordan: Aqaba Port is Jordan's only port on the Red Sea with facilities and berths for all kinds of cargo including a container terminal. Port installations and facilities are explained in further details later.

Lebanon: Beirut Port is Lebanon's primary commercial port and has a total of 890 meter of container quay with depths ranging from 10.5-13 meters in addition to a new container terminal with 600 meter quay and 15.5 meter water depth (Drewry, 2000). It also includes other general cargo quays with depths ranging from 8-10.5 meter (ESCWA, 2003). Currently, the port is undergoing a second privatization process after Dubai Port Authority (DPA) withdrew from a new container terminal 20 year concession contract (Daily Star, 2004, July 3). Table 2.6 lists the ports in the Mashrek region with total tons and TEUs handled in 2003.

Table 2.6 Ports in the Mashrek region

Country	Port/s	Location	2003 Total Throughput ('000Tons)	2003 Total Throughput ('000TEUs)
Jordan	Aqaba	Red Sea (north)	17,847	303
Lebanon	Beirut	Mediterranean (east)	5,219 *	299 *
	Triboli	Mediterranean (east)	n/a	0
Syria	Lattakia	Mediterranean (east)	4,867	257
	Tartous	Mediterranean (east)	5,562	0
	Banias	Mediterranean (east)	n/a	0
Israel	Haifa	Mediterranean (east)	18,805	1,014
	Ashdod	Mediterranean (east)	14,041	514
	Eilat	Red Sea (north)	2,104	22
WB & Gaza	Gaza	Mediterranean (east)	n/a	0

Source: various sources including ports' websites. * 2002 traffic.

Syria: Lattakia is Syria's primary commercial port for containers and general cargo while the southern port of Tartous is for dry bulk. Banias Port is dedicated only to the country's exports of crude oil. Some of these ports are now undergoing a massive rehabilitation and modernisation operations, particularly the container facilities. Recently the European Investment Bank has signed a 50 million Euro loan agreement to finance the development and modernization of Tartus Port.

Isreal: Haifa is Israel's main commercial port for containers and grains and the southern port of Ashdod is also for containers, general and bulk cargo. While these two ports are on the Mediterranean, Israel's third commercial port is the small Eilat Port on the Red Sea for dry and liquid bulk cargoes mainly.

The West Bank and Gaza: The port of Gaza is in planning stages and expected to play an important role in region's the trade once full peace and stability prevail.

However, ports in the Mashrek region are characterized by being close to each other and share potentially overlapping hinterlands. Syria's Tartous and Lebanon's Beirut ports are both within 100 km radius of common borders. Meanwhile, for most ports, political and administrative barriers prevent inter-port competition and cross-country optimization of logistics flows within the region. While borders between several countries in the region are closed, other countries on the other hand prohibit their imports and or exports to be processed through foreign ports.

2.3.2.2 Railways

Although railways cannot provide door-to-door service, they have a potential cost advantage for long-haul traffic. All Mashrek countries have railroad networks but with varying standards and functioning statues. Mostly the freight transported by railways in Mashrek is dry bulk cargo (raw material and grains).

Jordan: The 788 km two railway services in Jordan use a narrow gauge (1.05 meter) track. The Hijazi Railway, which connects Amman with Damascus in Syria, transports freight and passengers while the Aqaba Railway is only for freight, specifically phosphates from the mines to Aqaba Port.

Lebanon: used to have a 407 km functioning railway network, but due to destruction and obsolescence the system is no longer in use. However, the network consists of two gauge tracks in different parts and connects the north port of Tripoli with Beirut and extends to Damascus in Syria.

Syria: Two railway systems exist in Syria; the old 318 km narrow gauge track (1.05 meter) Hijaz Railway, which connects Damascus with Amman in Jordan and Beirut in Lebanon, and the 2425 km standard gauge track (1.435 meter) Syrian Railway, which connects ports of Lattakia and Tartous on west coast with industrial centers and all major cities, primarily the heavily populated and extends up to the Iraqi and Turkish borders. This network, which was completed in the

mid 1970s resulted in a considerable rise in traffic between ports and hinterlands. The rail transport in Syria is used for cargo (mostly raw materials) and passengers.

Isreal: Likewise, the 610 km railway network connects the ports of Haifa and Ashdod with major cities and industrial centers mostly in the central and west parts of the country. The railway transports passengers and containers in addition to other bulk cargoes.

The West Bank and Gaza: At the present no railway network exists in Gaza.

Clearly, cross border rail traffic between countries of the region is very limited and hampered by the diversity of track gauge. While Lebanon and Syria are unable to utilize the connection between the two countries, limited scale traffic exist between Jordan and Syria using an old narrow gauge railway system. Therefore, with such underutilization of rail transport, the region's trade is deprived of capturing the cost advantage of this transport mode. Certainly lack of modernisation and underinvestment are the main reasons for this shortage in the supply side of this important transport infrastructure. However, sooner or later the region will realise the need for a regional railway network as a viable solution for relieving road congestion, reducing road accidents and protecting the environment. Certainly, harmonised standards and technical specifications are a must in order for the region to build a regional railway network.

2.3.2.3 Roads

The roads and highways network in all Mashrek countries is a reasonably well-kept network of paved arterial roads connecting its major cities and linking neighbouring countries in most cases.

Jordan: The most important corridors in Jordan are the north-south route between the port city of Aqaba and Iraq and Syria borders besides the east-west route between Saudi Arabia and Israel and West Bank borders. These corridors provide Jordan

with connections with the region and beyond. Interestingly, Jordan is the only country in the region, which has open cross-border movements with all its bordering neighbours.

Lebanon: There are three main routes each spreading out from Beirut: a highway to Damascus, a road to Lebanon's second largest port city of Tripoli and the road to the southern part of the country. In principle the Beirut-Damascus route is the main corridor, which provides the country with linkages, through Syria to the region's network of roads and highways.

Syria: The main corridors in the country are the north-south between the Turkish and Jordanian borders and the east-west between port cities and the Iraqi border. Another important road connection is between Damascus and Beirut. These corridors provide the industrial and commercial centers and all cities with a connection to national, regional and international routes.

Isreal: Aside from the recently established west-east corridor between Jordan and Israel, most of the roads and highways in Israel are local linkages. An important highway for Israel is the north-south route between the port city Eilat and Tel-Aviv, which was used heavily during the closure of the Suez Canal.

The West Bank and Gaza: There are two main corridors; one connecting the West Bank with Jordan and the other with Israel. However, due to political unrest the infrastructure is still below the required levels.

2.3.2.4 Airports

Like ports, airport infrastructure and services are essential intermediate inputs in the air transport industry. Airports have an important impact on the air transport costs. For example, costs in and around airport charges and ground handling charges account for 24 percent of the total airline cost in Europe (AEA, 1998) and up to 10 percent on worldwide average bases (IATA, 2004). In Mashrek most countries have international, regional and local airports but with different levels of traffic

movements and services. All international airports in the region are served by wide network of airlines, which provides connections to most destinations in the world.

Jordan: Queen Alia International Airport in Amman is the main airport in Jordan and King Hussein Airport is a regional airport in the ASEZ. The other regional airport is located also in Amman.

Table 2.7 Air traffic in Mashrek countries (1999-2000)

Country	Passengers			Share of Main Airport in Total Passengers (%)	Total Air-Freight (Tons)
	Domestic	International	Total		
Jordan	73,795	2,436,292	2,510,087	92%	85,620
Lebanon	0	1,997,103	1,997,103	100%	59,243
Syria	163,296	1,713,965	1,877,261	83%	31,077
Israel	1,128,734	8,734,100	9,862,834	85%	342,799
WB & Gaza	0	88,009	88,009	100%	245

Source: Eurostat (MED-Trans Database)

Lebanon: Beirut International Airport is the major and only airport in Lebanon.

Syria: There are three international airports in Syria: Damascus, Aleppo and the port city Lattakia. Also there are two national airports in Deir Ezzor and Qamishli.

Isreal: Likewise, Israel has only one international airport and a small national airport in the port city of Eilat.

West Bank and Gaza: There is one regional airport in Gaza.

Table 2.7 shows the total air traffic for passengers and freight in the Mashrek countries in 1999-2000. Clearly, for a small region like the Mashre the available air transport infrastructure is sufficient. However, in order to integrate this important mode of transport and the other modes into a regional multimodal transport network for both passengers and freight many improvements need to take place. Therefore, the launch of the "Euro-Mediterranean Transport Forum" in 1998 is an important project, which aims at developing, through cooperation a multimodal air-sea transport system in the Mediterranean region including the Mashrek countries. Priority is given to the improvement and modernization of the ports and airports, the

elimination of restrictions and bottlenecks, the simplification of administrative procedures and the adoption of harmonized systems of management of the traffic.

2.3.2.5 Information and Communications Technologies (ICT)

Information and communication technologies are no less important infrastructure than the previous physical components in the development of an effective and efficient transport logistics industry. Today this element is changing the way in which international trade and transport are concluded (UNCTAD, 2003). Similarly, Internet is becoming a popular tool in various transport activities and trade transactions. Electronic commerce is booming and becoming a common practice; thus having a significant impact on logistics.

In the Mashrek region, most countries have made great strides in developing their communications and information technology sectors. Internet and mobile phones are now widely available in the region. In some countries like Jordan and Lebanon, the mobile phones have exceeded the landline fixed phones. However, the utilization of these technologies in transport activities is still very low in most countries of the region. While both Jordan and Lebanon implemented UNCTAD's Automated System for Customs Data (ASYCUDA), ports in both countries have not yet introduced computerisation into their operations and activities.

Evidently countries of the region possess the basic infrastructure needed for a successful logistics and multimodal transport industry. Meanwhile, political and administrative barriers prevent the region from the utilization of these resources to build a cost efficient regional multimodal transport network.

Still aware of all these political constraints but all countries are improving and modernising their infrastructure and examining the missing links and connections which can enhance competitiveness of their logistics capabilities.

2.3.3 Missing logistics links and improvements

However, creating an efficient multimodal transport network requires complete links between the different nodes and economic centers and heavily populated areas. Therefore, several transport infrastructure projects have been constructed or are under planning to improve the effectiveness of multimodal network in the region.

Within the context of the peace process in the region, several countries in the Mashrek region have explored and proposed various logistics infrastructure projects in order to improve their ports' and airports' hinterlands in the region. These projects include a 100 km highway from Latakia to Ariha (MEED, 8 December 2000) and an extension of railway connection from Haifa to major hinterlands in Syria and Jordan, particularly to Aqaba Port on the Red Sea. Furthermore, during a workshop on Regional Road Infrastructure, organised by the Commission of the European Union in October 1994 in Cairo with international participation, certain projects were selected as priority measures for improving "regional/international" road transport network in the area. These projects included a ring road in the vicinity of Aqaba/Eilat/Rass El Naqab, Sinai road corridors, road from Haifa to Irbid and eastwards and Jordan River Bridges with access roads linking the northern parts of Jordan and Israel. The last two projects have been accomplished and traffic between Jordan and Israel and the West Bank is rising as a result.

Similarly, the Integrated Transport System in Arab Mashrek by the United Nation Economic and Social Commission for Western Asia (ESCWA) demonstrates another effort toward defining a regional backbone-network of roads that will increase traffic flow efficiency.

CHAPTER 3
3. LOGISTICS FACILITIES IN AQABA SPECIAL ECONOMIC ZONE

The objective of this section is to describe the logistics environment in the ASEZ and the relevance of logistics activities in the zone to the economy from a technical and strategic point of view. Similarly, potential logistics opportunities will be highlighted and at the same time any shortages or deficiencies will be pointed out. As transport and logistics activities are mainly linked with trade, it is important to emphasize Jordan's economic policy in order to evaluate the importance of cross-border trade.

3.1 Jordan's Economic Policy

Situated at the Middle East's north-south and east-west trade routes, Jordan has a distinct geographical advantage as a trade and transport hub for the region. Considering its central location, with Saudi Arabia and Gulf States to the south and southeast and Egypt to the southwest, Syria and Lebanon to the north, the West Bank and Gaza and Israel to the west and Iraq to the east, Jordan is ideally positioned to accommodate an expanding and increasing transit market for goods destined to neighbouring countries (World Bank, 2004).

Jordan is a relatively small economy with an area of 89210 sq. km and 5.2 million inhabitants. In 2002, the country's GDP reached JD 6.6 billion (approximately US$ 9.3 billion) with JD 1238 per capita GDP (US$ 1744). Domestic exports have been growing in the past 5 years at varying percentages from JD 1.05 billion (US$ 1.5 billion) in 1998 to JD1.6 billion (US$ 2.3 billion) in 2003 (40 percent growth).

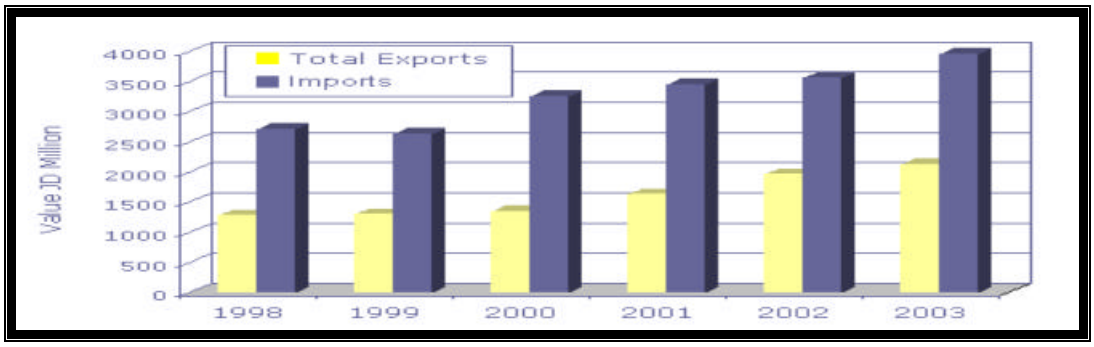

Figure 3.1 Jordan's Foreign Trade (2000 – 2003)
Source: Jordan Export Development and Commercial Centers Corporation (JEDCO).

Jordan's commitment to a more liberalized regime and to transferring the country into a regional trade and transport hub is evidenced by the country's regional and international trade agreements. With the ratification of the Jordanian Parliament on the Law of Jordan's Accession to the WTO on February 24, 2000, Jordan became officially the 136 WTO Member on April 11, 2000. Similarly, with the aim of strengthening the bonds of economic relations and cooperation between the two countries, promoting economic growth and investment opportunities and eventually raising the capacity and international competitiveness of goods and services, on October 24, 2000 Jordan and the United States of America signed an agreement to establish a FTA between the two countries. This agreement makes Jordan the fourth country in the world to have such economic partnership with the US after Canada, Mexico and Israel. Likewise, in 1998, Jordan was among the 18 members of the Arab League who initiated the creation of the Greater Arab FTA by 2008 and tariff dismantling has started. In the same way, the Association Agreement between Jordan and the European Union (EU), which entered into force on May 1, 2002 aims to establish a free trade area between Jordan and the EU countries by the year 2010. Again the free trade agreement signed on June 21, 2001, between Jordan and the European Free Trade Association (EFTA) states (Iceland, Liechtenstein, Norway and Switzerland) aims to create favourable conditions for the development of trade and to encourage economic cooperation and integration between Jordan and the EFTA states. These agreements clearly demonstrate the country's responsibility toward cross-border trade liberalization.

3.2 Aqaba Special Economic Zone (ASEZ)

Progressively, in its efforts to integrate into the global trading system and capitalize the country's geographical advantage, in mid February 2001, the Government of Jordan decided to declare the whole city of Aqaba, where country's only port, as a duty free Special Economic Zone. The ASEZ, which covers approximately 375 square kilometres, is strategically situated at the crossroads of four countries. Located on the Gulf of Aqaba on the northern end of the Red Sea, and extending to the land borders of Saudi Arabia and Israel and the territorial waters of Egypt, ASEZ enjoys a locational advantage to develop and become a logistics and distribution center for the nearby markets in these countries.

One of the main objectives of this project is to develop the zone to become an advanced multi-modal transport and logistics centre through maximizing the utilization of the four transport logistics platforms available in the zone: deep water port of Aqaba, King Hussien's international airport, network of national and regional highway linkages and the railway link with major production site in the country.

To this end, the following part of the study aims at highlighting the current logistics physical infrastructure in ASEZ, its quality and its significance to the national and other economies in the region.

3.2.1 Maritime Transport Infrastructure

It has been long established that countries with access to the sea have better chances to develop faster than those who do not. While having sea access by itself is an advantage, it is the efficiency of maritime transport infrastructure that determines the level of such advantage. Ports, which provide such physical infrastructure, are critical nodes in intermodal transport chains. In the ASEZ, the maritime infrastructure is represented mainly in the diversified port operations and activities.

3.2.1.1 The Aqaba Port:

The Aqaba port, which was established in 1952 as the first logistical platform in the city, has developed and become a center for international trade for Jordan and other countries in the region. Being the country's only deep seaport, Aqaba port gained a special strategic importance and attention, which enabled the port to expand to provide a diversified range of commodities and activities. Now Aqaba Port consists of three ports; Main, Container and Industrial ports. The logistical facilities in the port ranging from berths and various warehouse to a container terminal "can generally be classified as modern and sufficient" (GOPA, 1996, p.72).

3.2.1.2 Port's Logistical Facilities

Aqaba port activities are centred round three separate installations:

1. The Main Port, which was the first constructed facility, comprises twelve general and bulk cargo berths of draft alongside ranging from 4-15 meters. After the expansion of the city this port has become a source of environmental and social difficulties to the city.

Figure 3.2 Main Port after development-ASEZ
Source: http://www.aqabazone.com/Master/Ports.html#

Therefore, a work plan is underway to relocate the activities of this port to other ports areas outside the city and transform this location into a cruise and leisure facility for tourism purposes. This task has been one of the main goals for establishing the ASEZ. In their final report about the ASEZ Master Plan, Wilbur (2001, p.1) stated "the underlying goal for this section of the Master Plan is to provide a land utilization plan for the port of Aqaba that will serve Jordan for at least next 20 years".

2. The Container Port which is located between the Main and Industrial ports, comprises a container terminal, RO-RO berth, loading platform/dolphin arrangement for cement exports and two floating berths; one for bulk rice and the other for passengers/ferries.

Figure 3.3 Container Terminal - ASEZ
Source: http://www.aqabazone.com/Master/Ports.html#

Similarly, the container terminal has a total of 540 meters straight quay-line with water depths ranging from 15-20 meters.

3. The Industrial Port comprises three wharfs; an "L" configuration fertilizers jetty with 230 meters seaward berth (west) used for exports of potash and fertilizers and 190 meters landward berth (east) used for imports of sulphur and other bulk cargo, an oil jetty composed of jetty heads, four berthing dolphins, four mooring dolphins and an approach jetty, Timber berth located between the oil and fertilizers jetties used for the adjacent timber factory. Appendix A identifies the berthing facilities and dimensions at the three ports.

3.2.1.3 Port's Operations

The port activities grew sharply in the 1980s and peaked in 1988 at about 20 million tons. However, following the Gulf Crisis in 1990 a drastic drop in the cargo flow volumes severely affected the port activities. In 1995 the port handled about 11 million tons of cargo, which included bulk phosphates, potash, fertilizers and other bulk exports, transhipment goods and a high portion of domestic imports.

Aqaba Port, which is owned and operated by the Government, has been so far a traditional handling port whereby very minimum value added activities have developed. In fact, one of the main reasons behind the establishment of the Special Economic Zone in Aqaba is to develop the zone to become a logistics center by providing value added logistics activities in order to generate considerable economic growth. Therefore, unless the zone succeeds in developing local value-added activities linked to transit cargo or in developing an effective local industrial and logistics cluster, the economic impact will remain very limited and "the geographical dispersion of economic effects is very apparent" (Notteboom, 2002, p.17).

However, in order to achieve these goals, the Aqaba Special Economic Zone Authority (ASEZA), as the government body entrusted to manage the ASEZ, contracted APM Terminals to operate and manage the Port of Aqaba Container Terminal. The two year concession, which started officially on July 1st 2004, "may be extended to further 25 years, if both parties are satisfied with the initial trial period" (Thomas, 2004 March 8, p.14). Under this agreement APM Terminals Jordan will implement a number of upgrades to the terminal including new updated equipment, terminal operating and financial accounting systems and other infrastructure development.

3.2.1.4 The Role of Aqaba Port

Since the sharp drop in port traffic, many studies have been made to improve the port activities and transport sector in Jordan as a whole. Within the scope of all these studies, which were performed by reputable international consulting bodies, the future role of Aqaba Port was a major point of concern. Surprisingly, the outcomes of these studies reflected different opinions concerning this role. A comprehensive study on the "Improvement Plan of the Port of Aqaba in The Hashemite Kingdom of Jordan" by Japan International Cooperation Agency (JICA) (February 1996, p.85) concluded that "Port of Aqaba already has a lot of roles and functions. In addition, with the progress of the peace process in the Middle East, the port is to enjoy much

prosperity". The study proposed a development plan in order to meet future growth. Likewise, another "Diagnostic Study on Goods Trade and Transport Facilitation" by the European Consortium GOPA Consultants and DOXIADIS Associates and BCOEM in association with a local Jordanian consulting firm concluded that "Port of Aqaba plays a key role in Jordan's current and future transport sector development". The study also emphasised the positive impact of the peace process in generating "additional freight flows to and from Israel via Aqaba" and pointed out that the "future role of the port should be to facilitate trade and transport activities especially to the south-east Asia countries". (April 1996, p.72).

On the other hand, the most recent study on "Aqaba, Jordan Special Economic Zone Master Plan" by the US Consortium Wilbur Smith Associates, Moffatt and Nichol and Gensler in association with local Jordanian consulting firm reported in their final report (March 2001, p.2.8) that "Port of Aqaba is located in a non-strategic region from a standpoint of intermodal access to other countries" and therefore, "Aqaba is not seen as a major transit port for non-Jordanian cargoes".

While some studies claimed that changes in the geo-political scene in the Middle East will lead to changes in the regional patterns of transport and trade, non of these studies used any microeconomic theoretical or empirical approach to support their conclusions about the future transport demand on Aqaba Port or why such changes are expected or which markets will be affected. Nevertheless, the consultants' conclusions were based on informal methods of analyzing the port's historical cargo traffic such as experts' judgement, use of scenarios and building up their own prospects and assessments of the economic and political future of the region.

However, such informal judgments, which do not allow for development and tests of hypotheses, may also not allow third parties to understand the relative importance of the key factors and assumptions relied upon, and how total cost might change if any or all of the underlying variables change.

Consequently, this research, which uses a simple formal method that utilizes a simple econometric approach to identify the port's potential in generating transport demand for the Aqaba Port, particularly for containerized cargo, is viewed as a needed effort that complements the missing research about the potential role of Aqaba Port thus, the ASEZ in the region.

Table 3.1 Total Jordanian Exports and Imports by Mode of Transport (2002)

MODE OF TRANSPORT	EXPORTS		IMPORTS		TOTAL EXPORTS & IMPORTS	
	TON	Share of Total **Exports** %	TON	Share of Total **Imports** %	TON	Share of Total **Trade** %
Trucks	2,499,800	25.1%	7,469,700	71.60%	9,969,500	48.88%
Airplanes	8,700	0.1%	1,690	0.02%	10,390	0.05%
Vessels	7,456,600	74.8%	2,961,600	28.38%	10,418,200	51.07%
G. Total (Ton)	9,965,100	100%	10,432,990	100%	20,398,090	100%

Source: Ministry of Transport (Jordan)

On the other hand, the importance of Aqaba Port on the national level can be viewed from the port's share of Jordan's total imports and exports. As can be seen from Table 3.1 that more than 50% of Jordan's foreign trade is seaborne trade (75% exports and 28% imports). However, the port's importance has enhanced after the country began importing its needs of crude oil by sea following the 2003 Iraq war.

Accordingly, Table 3.2 compares Aqaba Port's traffic between years 2000-2003 and shows the jump in domestic imports from 4.37 million tons to 8.63 million tons (about 98% growth).

Table 3.2 Cargo traffic via Aqaba Port (2000-2003)

YEAR	JORDAN CARGO ('000,000 TON)			TRANSIT CARGO ('000,000 TON)			TOTAL CARGO HANDLED (000,000 TON)
	INBOUND	OUT-BOUND	TOTAL	INBOUND	OUT-BOUND	TOATL	
2000	4.93	7.15	12.08	0.42	0.04	0.46	12.54
2001	4.61	7.76	12.37	0.64	0.03	0.67	13.04
2002	4.37	8.84	13.21	0.92	0.03	0.95	14.16
2003	8.63	8.20	16.83	0.98	0.04	1.02	17.85

Source: Aqaba Ports Corporation (Jordan)

3.2.2 Over-land Transport Infrastructure

The over-land transport physical infrastructure in ASEZ consists mainly of an extensive highly important network of roads and highway linkages in addition to a very limited scope railway connection.

3.2.2.1 Roads Network

The roads network inside the ASEZ, which serves the zone and connects it with mainland and the neighbouring countries, is an integral part of the national network of highways. While ASEZ has direct road links with neighbouring Saudi Arabia and Israel, its links with hinterland markets in other countries like Syria, Iraq, Lebanon, Israel and the West Bank and Gaza is through the country's main network of highways. Therefore, it is necessary to highlight the national network of highways in order to understand its significance to the ASEZ.

Jordan's developed highway network comprises of 7360 km of roads of different levels of service (Ministry of Transport, 2003). Over 40% are classified as primary roads while the rest includes secondary and rural roads. The network includes key strategic regional corridors; therefore, it is considered very important to international, regional and national trade and transport activities. A most recent study (World Bank, 2004) about the missing links in the road network reports that commercial truck traffic utilizing the major north-south and east-west corridors, connecting Saudi Arabia with Syria and Israel/West Bank with Iraq has increased considerably (5.8 percent a year). In short, Jordan's network, which offers good coverage supports the ASEZ's road network and provides the zone with linkages to regional corridors, logistics platforms and commercial and industrial activities in the country.

To demonstrate, the Dead Sea Highway (Route #65) and the Desert Highway (Route #15) link the port and airport inside ASEZ with the central and northern parts of Jordan, particularly the capital Amman and from there to the major highways leading to Syria, Iraq, the West Bank and Israel. Actually, the Dead Sea Highway connects

the port and the airport with the potash and chemicals industrial complex on the Dead Sea (a major source of imports and exports via the port). Likewise, the Desert Highway connects Aqaba Port with the phosphate mines site in the southern-central part of the country (also source of the largest share of exports via the port).

Figure 3.4 Jordan's highway and railway networks
Source: http://www.lib.utexas.edu/maps/middle_east_and_asia/jordan_pol_2004.jpg

Similarly, the Jafr-Azraq highway (bypass on the Desert Highway – 100 km north of Aqaba) provides ASEZ with a direct link to Iraq and allows traffic service between the zone and Iraq directly rather than via Amman. Likewise, three primary roads

connect the zone to these links and neighbouring country borders; the Airport Road leads to both a bypass to the Israeli border and to the Dead Sea Highway, Amman Road leads to the Desert Highway and the Aqaba Coastal Road leads to the Saudi Arabia border. These roads and highways coupled with other primary and secondary roads inside ASEZ form the backbone of the logistics activities in the zone and provide efficient connection between ASEZ and the domestic and transit markets.
In fact, the port activities grew every time the network expanded and covered new hinterland markets. After the expansion and reconstruction of the national highway network in the mid 1970s, whereby more hinterland markets were covered, the ports activities grew considerably (from about 0.38 million tons in 1970 to about 6.6 million tons in 1980). Similarly the rehabilitation and construction of the highway link with Iraq in the early 1980s, resulted in a significant growth in Aqaba port activities (from about 6.6 million tons in 1980 to about 20.1 million tons in 1988, which was the highest throughput the port has ever reached before the drop in traffic due to the Gulf Crisis in mid 1989). Annex B shows the historical cargo traffic via Aqaba Port from 1952 when the port was established up to 2003, and how these infrastructure developments reflected on considerable rise in port traffic.

However, the road network in ASEZ and in Jordan in general is considered sufficient and can accommodate the transport demand for the next fifteen years. A capacity and sensitivity analysis by Wilbur Smith Associates (2001) revealed that "highway and road network show no capacity problems and expected to carry future north-south projected traffic up to 2020".

3.2.2.2 Railways Network

Although a very important logistics backbone, rail transport in ASEZ is not fully utilized and limited to the movement of phosphates from areas about 300 km north of ASEZ. The single line of 295 km narrow gauge track, which dates back to the Ottoman Empire, is used for transporting phosphate rocks to Aqaba port for exports.

Surprisingly, when this service started its operations in 1975 after constructing a 117 km link to the Aqaba Port, the declared objective was to transport imported goods from Aqaba Port to main consumption centers in the country in addition to transporting phosphate exports to the port. Since that date the service has not carried any imported goods at all. In fact, this situation represents a major shortage and under investment in the country's transport logistics infrastructure and undermines the port's competitiveness for distant markets.

An improved low cost rail connection enhances the logistics infrastructure efficiency and enables the port to gain competitive edge and expand its hinterlands markets and generate growth to its region. Many container ports in the world benefited considerably from integrating their activities with railway networks. For example, Los Angeles and Long Beach ports gained a competitive advantage when the coast-to-coast intermodal service was established. Similarly, a study by the Economic and Social Commission for Asia and the Pacific (ESCAP) emphasises the crucial role that intermodal strategies can play in expanding port markets. The study points out that "with nearly 80% of its container traffic being ultimately distributed across the US by a combination of rail and road" the port of Seattle succeeded in becoming a gateway port to hinterland markets through the US, which could never have used this port without the intermodal connections, particularly the rail. (ESCAP, 2003, p.17).

It is clear that without a railway connection to transport the imported goods, specifically containers between Aqaba Port and hinterland markets, the ASEZ is in shortage of a major physical logistics infrastructure component. Needless to say, the need for rail transport for imports will become a social and environmental urgency in near far future. To illustrate, if the projected volume of more than 600,000 TEU throughput is reached within the next few years as planned, then the highway between Amman and Aqaba, (330 km) will become heavily congested by trucks, particularly those carrying containers. Accordingly around 1000 trucks need to be

cleared daily and with each truck of 12 meters in length requiring at least a 100 meter safe driving distance on the road, then a simple calculation shows that about 110 km of the highway will be occupied by trucks carrying containers daily. The scenario will become worse if trucks carrying other goods like grains, steel, cereals and other types of cargoes are added. However, for the port the picture will be even darker as congestion inside the terminal yards will become a daily reality considering that on average every 50 seconds, one TEU needs to be loaded on a truck and cleared to leave the yard.

However, the Government has taken many steps to privatize the railway service in an effort to improve and expand the service. In 1998 a long term management and operation contract was concluded with an international consortium of two US railways (Wisconsin Central International Incorporation and Raytheon Infrastructure Incorporation) and a Japanese trading house (Mitsubishi Corporation), but the consortium withdrew from the deal following the collapse of a joint venture negotiations between the government and Norse Hydro Company for building a $600 million exporting chemical plant in Aqaba (Wilber, 2001). Nevertheless, rehabilitation needs of the railway network in Jordan seem to be recognised but action does not seem to be among the priorities.

3.2.3 Air Transport Infrastructure

Unlike the other modes of transport, the main competitive edge of air transport is in the international passenger transport and transportation of high value and perishable goods for which speed, reliability and service quality matter most. However, such service would not be possible without airports that provide sufficient infrastructure capacity and supply airlines with the required services. To this end, the air transport infrastructure in the ASEZ is reflected basically in its airport facility.

3.2.3.1 Airports

Air transport is significant to cross border tourism, thus a very important sector to Jordan's economy. In 2000 the tourism receipt amounted to $800 million, which was equivalent to a 23% share of the exports. There are three airports in Jordan and King Hussien International, which is the country's regional airport, is located inside the ASEZ. Currently the airport is undergoing intensive modernisation and upgrading work to be prepared for the expected increase in air traffic following the government's decision of free skies policy for airlines using this airport, in its effort to encourage tourism.

The contribution of King Hussien International Airport in the logistics industry inside the zone is limited to passengers' traffic with almost no airfreight activities. However, in the last three years there has been a noticed growth in the number of aircraft landing at this airport mainly for tourists coming from Europe. Table 3.4 shows the aircraft and passenger traffic in King Hussien International airport for the period 2001-2003.

Table 3.3 Traffic via King Hussien International Airport (2001-03)

Year	Aircraft Movement (In&out)	Passengers (arrivals & departures)	Airfreight (Ton) (in&out)
2001	1912	58528	37
2002	2442	48258	77
2003	2735	90081	263

Source: Ministry of Transport (Jordan)

From the figures in this table, there seems to be a good logistics opportunity to be invested to increase the contribution of this sector in the value chain. Most flights to the zone are tourist charters, which transport tourists to Aqaba. In all the cases airplanes return empty to Europe with plenty of unutilized space.

3.2.3.2 Sea/Air Transhipment

The idea here is to integrate air cargo into the multimodal logistics chain through capitalizing on the location advantage of Aqaba Port to offer sea-air transhipment. For instance high value goods destined from Asia to Europe can be shipped by sea first to Aqaba Port and from here to final destination in Europe by air. In fact, if this study can show that Aqaba Port has a potential to position itself as the Mashrek's gateway port by capturing Asian cargo destined for Mashrek east Mediterranean ports, then the chances for the success of offering a sea-air transhipment service should be high, mainly because of the underutilized air traffic in the airport for cargo purposes. Another supporting factor is the fact that the distance between the container terminal and the airport in the zone is less than 10km.

Similarly, not benefiting from chartered flights coming to Aqaba and using them to transport Jordan's airfreight imports represents another unrealised logistics and multimodal opportunity. Currently, all airfreight imports come through Queen Alia International Airport in Amman on board regular passenger and special air cargo planes. Naturally, carrying freight in the belly-holds of tourist charters is less expensive than using regular and special cargo planes. Then, airfreight can be trucked from Aqaba to Amman with less total cost.

In fact, this logistics solution has been implemented successfully by the port of Dubai and is now under study by the port of Aden (Muller-Jentsch, 2002). Similarly, Malysian seaport Tanjung Pelepas has also succeeded in implementing the same concept, whereby the port in conjuction with MASkargo arm of Malaysia Airlines System Bhd, offer shippers and forwarders cheaper (up to 40 per cent) and faster delivery to North America, Europe, Australia and East Asia. (UNCTAD, 2003).

Certainly this represents a tremendous opportunity for the airport to grow and create value added services and become more functional in ASEZ logistics network.

CHAPTER 4
4. AN ECONOMETRIC ANALYSIS OF LOGISTICS POTENTIAL

4.1 Open Transport Market

With all the international political and economic determination and support, it has become evident that, sooner or later, political and artificial barriers to trade will be reduced in the Mashrek region. Therefore, an enlarged integrated transport market will emerge, which will increase the competition between logistics platforms and intermodal nodes in the region, and therefore an early review of present efficiency levels of logistics infrastructure would be necessary to maintain competitiveness. Hesse (2004) points out that due to increased competition between logistics platforms, all ports and freight hubs are currently committed to expanding their infrastructure. Similarly, the reduction of tariff and non-tariff barriers to trade, stresses that efficiency of transport logistics has increasingly become an important determinant of the success of any trade liberalization and regional integration process. Micco (2003) reports that reduction in artificial trade barriers has emphasized the importance of transport costs as a remaining barrier to trade.

Previously, this study showed that Mashrek economies are incurring high transport costs due to inefficient management of transport logistics and underutilization of regional logistics networks. Since ASEZ is part of the multimodal transport network in Mashrek, it is the main interest of this research to analyse from an economic point of view where and how ASEZ can contribute to the efficient utilization of this network and therefore reducing the high transport costs incurred by region's international trade. Similarly, UNCTAD (2003) reports that in light of changes in global production system and transport services structure and advancement of information technology,

traditional transport services are no longer sufficient. Instead a more comprehensive and efficient utilization of multimodal transport logistics services are required.

Therefore, the author believes that the total transport logistics cost concept can be the best instrument to develop an economic and cost comparison for using ASEZ's logistics platforms with other platforms in the region. Also, following the system approach will assist in analysing the value chain for moving goods from the source to different markets in the Mashrek through the available entry points in the region.

4.2 Total Logistics Cost Concept

Logistics is understood as the efficient management and optimization process for "getting the right goods needed for consumption or production to the right place at the right time in the right condition at the right cost" (Ellram, L.M.; Lambert, D.; and Stock, J.R. 1998, p.11). Through optimization of these integrated logistics activities, the concept of minimizing the total cost developed as a strategic management tool, which can considerably increase domestic and global trade competitiveness. Limao and Venables (2000) show that trade volume can be reduced by more than 20% when transport costs (one element of logistics costs) increase by 10%. Total cost concept is one of the main four logistics concepts (total system, customer service and trade-offs concepts) which aims at minimizing the overall costs related to both the motion and holding of goods all through the supply chain. In technical terms, these costs include transportation costs, inventory carrying costs, order processing costs, material handling costs on a total basis.

However, this research looks at the total transport logistics cost from the perspectives of both the total transport costs and the time costs of holding the goods in transit. Since the use of the other logistics components along the transport chain varies from one country in the region to another and from one shipper to another even within the same country. For instance, while some shippers use their own warehousing facilities

there are others who outsource this activity. In contrast, all shippers outsource the maritime transport of their goods and the port services to these goods.

Similarly, this research analyses the total transport logistics costs for door-to-door transport from a selected source to different markets in Mashrek countries. In this context, Amman (Jordan), Damascus (Syria), Beirut (Lebanon), Jerusalem (West Bank and Gaza) and Tel Aviv (Israel) are identified as the major economic centers in the region where the majority of population, commercial and industrial activities are concentrated. Since shippers are assumed to select the least cost route for delivering their goods from sources to their respective markets in the region, then the objective is to examine whether Aqaba Port (ASEZ's maritime entry point) can be the port that minimizes the total transport logistics cost.

Likewise, this research chooses to focus on containerised transport for several reasons. Logistics services are better suited with containerised transport, which was one of the major driving forces behind its revolution. Progressively, international trade is witnessing an explosive growth in containerization worldwide, which reflects the increasingly growing demand on multimodal transport and therefore logistics services. According to Drewry Shipping Consultants, international container traffic increased from 79 to 225 million twenty-foot equivalent units (TEU) between 1989 and 2000. Similarly, UNCTAD (2003, p.3) recognises that growth of containerized transport "has considerably affected modern transport patterns and practices".

Accordingly, two approaches will be used in this study to estimate the direct economic feasibility of ASEZ's logistics platforms. First, the author will develop a general transport econometric model for the least cost transport route through which a set of relevant variable will be identified and several functional relationships will be derived. Secondly, the author will use more explicit practical data from primary sources on the different elements of the costs involved in the door-to-door transport process and perform a set of computational transactions.

However, it must be pointed out that there are several other factors beside the total cost concept, which shippers and carriers take into consideration when choosing the transport routes for shipments. Similarly, major developments have taken place in the transport industry and influenced the structure of such decision. These changes are explained further in the next section.

4.2.1 Transport Routes

Increasingly, shippers demand door-to-door service, which makes the final point of delivery determine the total distance and therefore the total transport cost. This growing change in shippers' behaviour has shifted the port selection and route for shipment from shippers to carriers. Furthermore, the deregulation of the maritime industry in the early 1980s in different parts of the world (1984 Shipping Act in the US and 1986 Shipping Regulations in Europe) has accelerated the development of port selection logistics and multimodal transport. According to Malchow (2001), prior to these organisational changes maritime carriers could not establish contracts for inland transport. He also reports that as a result of introducing the door-to-door rates, shippers, who were concerned more about the overall service than shipments specific route, began allowing the carriers to select routes. Consequently, the carriers' interest is no longer focused on direct measures of cost and time; instead it becomes more involved in the indirect system that focuses on economies of scale and just-in-time transport. Progressively, the carriers began to expand their services to control more activities in the transport chain. (ESCAP, 2003).

Again, although this research uses the total cost concept but carriers have other factors such as; the size of the local market, the quality and quantity of the multimodal network, the efficiency of the logistics chain and the port efficiency and productivity. Although, the total transport cost is important but these factors also influence the carriers' decision.

Since each of the Mashrek countries uses its own port/s as the main entry point/s for its cross-border trade, then it can be said that with the opening of the transport market in the region more than one transport route could be established for any particular trade. Looking at the distribution of the ports in the region, Aqaba Port is the only major port located on the Red Sea considering that Israel's Eilat Port is a small port with limited capabilities for containerised transport.

Figure 4.1 Portion of Middle East Map
Source: http://www.lib.utexas.edu/maps/middle_east_and_asia/middleeast_ref01.pdf

Since demand on transport is derived from international trade, apparently, the Indian Ocean and East Asia represent the best markets potential for Aqaba Port. On the other hand Europe and the north and south Americas represent the best markets

potential for the other Mashrek east Mediterranean ports. Malchow (2001, p.94) reports that it is not wise for ports to concentrate marketing on shipments beyond their market potential. To illustrate he suggests that "US ports in the Pacific Northwest should not focus marketing on shipments for Europe or South America".

Accordingly, trade between the region and Asian economies or in other shipping terms the "east of Suez" trade is where ASEZ should theoretically have its potential advantage and therefore, this research focuses on this trade to explore how such advantage can be achieved and optimized.

To this end the theoretical framework of this part is based on the fundamental microeconomic theory and assumes that shippers tend to minimize the total cost of moving containers from sources to markets.

4.2.1.1 First– Transport Model Approach

In principle, many routes can be used to transport a container from a source in Asia to a market in a Mashrek country or vice versa. Shippers select the route that minimizes the total cost in the transport process from the origin to the destination. Therefore, by identifying the least-cost transport route, the port the containerized cargo will go through, is also determined.

The concept here is based on set of assumptions and variables, which comprise the components of the total transport logistics cost for a door-to-door transport process as previously defined. This method allows the visibility to understand the relative importance of the key identified variables and how changes in these variables affect the total cost and the choice of port and route.

To illustrate, we assume the followings:

F_{hei} FEU container of cargo ***i*** to be imported from port ***h*** to ***e*** destination,

h refers to Hong Kong port as the selected hub port in Asia,

e refers to the destination ($e \in [1, 4]$) in the Mashrek region (economic centers),

a ship cost in dollars per ***F*** per mile (US$/FEU/mile) excluding canal dues,

n refers to container port in Mashrek region (Aqaba, Beirut, Lattakia & Haifa),

D_{hn} Ocean distance in nautical mile between port ***h*** to the n^{th} container port

R_n port charges in dollars per ***F*** container at the n^{th} port (ship agents fees included),

ß$_{ne}$ Inland transportation cost per container in dollars per km by each mode from the n^{th} port to the destination ***e.*** The total inland cost is the sum of costs spent for each transportation mode ***j*** (***j***$\in$ [truck, rail]). However, in our case there is no rail there is a transfer from one mode of inland transport (truck) to a similar mode as the case will show that during its inland voyage between n^{th} port to ***e*** destination, the container ***F*** is transferred from one truck to another on borders between certain countries in the Mashrek region,

O_x cross-border charges and expenses per container ***F*** at the x^{th} cross-border,

D_{ne} inland transportation distance in km,

S_s sea transportation speed is miles per hour,

S_j Inland transportation speed is km per hour,

H_n port dwelling time at n^{th} port in days,

H_x waiting time on x^{th} cross-border in days between n^{th} port destination ***e***,

H_z time for transiting the Suez canal in days between ***h*** and n^{th} ports,

H_b time in days at the hub port between ***h*** and n^{th} ports,

F Terminal handling charges in dollars per ***F*** in hub port (US$/FEU) all moves,

? Suez Canal dues in dollars per ***F*** (US$/FEU), (applies to east Med. Ports)

V_i the value of the cargo ***i*** in a container,

? prevailing perfect capital market rate of interest on capital invested in cargo,

In the following parts the transport and time costs are defined and mathematical formulas are derived accordingly to demonstrate how these costs can be determined.

4.2.1.1.1 Transport Costs: is defined as the sum of all expenses paid along the transport logistics chain for transporting the goods (inside the container) from origin to the final destination including those paid to intermodal nodes and cross-borders. Therefore, in this case, it includes the ocean freight, port expenses including terminal handling charges, overland transport (trucking in our case) costs and cross-border charges and expenses.

For one container ***F*** to be transported from Hong Kong Port, as the selected hub port**,** to one economic center ***e*** in the Mashrek region via n^{th} port, the transport cost (C_1) consists of two parts; the sea and overland costs. Sea transport costs include: a) container's share of the ship costs excluding Suez canal dues, 2) container's share of the Suez canal dues, 3) terminal handling charges at the hub port and 4) port charges per this container. The overland costs include the sum of trucking costs per container and the charges paid during the overland transport trip per container such as cross border expenses and charges in some cases of this modal. Therefore:

Transport cost through n^{th} port = Ocean freight + Port charges & expenses + Hub port THC + Suez canal dues + Cross-border expenses + Sum of overland costs

$$C_1(n) = (\alpha * D_{an}) + R_n + O_x + F + ? + \sum \beta_{nej} * D_{nej} \quad \text{..... (1)}$$

4.2.1.1.2 Time Cost: represents the opportunity cost of time for the capital invested in the cargo (inventory). The total time spent during the transport process includes the time spent in sea seaming and the time for transiting the canal, the inland travel time, days in both the entry and the hub ports and the waiting time at cross-border/s in some cases.

Total number of days = days at sea steaming + Suez canal transit + entry port (in days) + hub port (in days) + cross-border/s (in days) + inland transport leg (in days)

$$H_{total} = (D_{hn}/24S_s) + H_z + H_n + H_b + H_x + \sum (D_{nej}/24\, S_j) \quad \text{..... (2)}$$

The cost of time (C_2) = terminal value of V_i during the in transit
for V_i through n^{th} port period at interest rate **?**

$$\mathbf{C}_2(n) = V_i * [(1+ ?)^{Htotal} - 1] \quad \text{.....} \quad (3)$$

4.2.1.1.3 Total Transport Logistics Cost (TLC) in the transport process of cargo ***i*** using the n^{th} port is represented by the cost of transport and the cost of time, therefore, $\mathbf{TLC}_i(n)$ is the sum of costs from the above (1) and (3):

$$\mathbf{TLC}_i(n) = \mathbf{C}_1(n) + \mathbf{C}_2(n) = a * D_{an} + R_n + O_x + \sum ß_{nej} * D_{nej} + V_i * [(1+ ?)^{Htotal} - 1] \quad \text{.....} \quad (4)$$

Since the underlying theoretical framework is based on assumption that shippers seek to minimize the total transport logistics cost, this module makes it possible to determine the least-cost route for delivering goods from sources to markets among the available choices in the transportation network within the Mashrek region.

Therefore, shipper selects the the n^{th} port that minimizes the total transport logistics cost $\mathbf{TLC}_i(n)$ for the containerized good ***i*** by:

$$\mathbf{min}\ [TLC_i(n)] \quad \text{.....} \quad (5)$$

The above equations show clearly how changes in different factors such as location, vessel speed, costs of different modes of transport, value of goods, or interruption of services at ports and roads will all affect the total cost of transportation via the port and therefore, affect the demand for container transport services through that port.

These formulas are applied on the available routes from Hong Kong to all identified economic centers in the region and resulted in several conclusions:

a) For shipping to Amman, Aqaba Port is the least total cost route;
b) For shipping to Beirut city, Beirut Port is the least total cost route under the present inefficient logistics conditions along the transport chain from Aqaba to Beirut. The simulation shows that in case dwell time in Aqaba and the waiting time at cross-borders are reduced to one day each, then total cost via Aqaba can be less and more competitive for high value goods and under high interest rates market;
c) For shipping to Damascus and at the current logistics conditions, Beirut Port is the least total cost route only for goods with value less than $125,000 and at an interest rate of 5 percent; for goods with value higher than this amount then total cost via Aqaba Port is less even at the above interest rate. However, under improved logistics conditions Aqaba route to Damascus becomes the least total transport logistics cost;
d) For shipping to Tel Aviv and under the current logistics conditions, Haifa Port is the least total cost route only for goods of value less than $65,000 and at an interest rate of 5 percent; for goods with higher value than this amount, then total cost via Aqaba Port is less even at above rate. Same thing can be said here about Aqaba route becoming the least total cost under improved logistics conditions.

Certainly, from manipulating with the different variables in this simulation model, it can be seen that ASEZ's potential to compete with other intermodal nodes in the region for trade with the Indian Ocean and East Asia can be enhanced if the present logistics inefficiencies are improved. For illustration see tables in Appendix C.

However, it should be pointed out that the data used in this model is according to actual market rates except for the ports charges and the Suez Canal dues, which are assumed equally for all options. In reality, port and terminal handling charges (THC) are important and can significantly affect the competitiveness of any port.

4.2.1.2 Second – Actual Market Rates Approach

This approach uses the current actual market rates, which are collected from primary sources, to compare the total transport cost for delivering containerized goods from the source to economic centers in Mashrek countries via each country's own entry port/s with the costs of delivering the same container to the same locations but via Aqaba Port. This process involves three stages; namely ocean transport stage, port interface stage and the over-land transport stage.

Nevertheless, it must be noticed that the current market's rates used in this approach include different elements in their structure like market situation, competition, structure of the service, port efficiency. However, the objective is to build an economic analysis on present actual market rates in order to determine which transport route that can minimize the total cost.

4.2.1.2.1 Multimodal Transport Network

An imported 40-foot container from Hong Kong Port to a domestic distribution facility inside any of the defined economic centers in Mashrek involves both an overland and sea transport. In between these two stages the shipment goes through several activities, such as unloading from vessel, terminal handling, customs clearance and national border crossing procedures in some cases. To illustrate the logistics of this process and the effects of land and sea distance separately, the journey of the container is broken into overland and ocean components.

4.2.1.2.2 Ocean transport costs

Acknowledging that the import process starts when the importer opens a Letter of Credit (L/C) in favour of the exporter and that the total logistics cost concept traces the path of goods along the supply chain, particularly from production to

consumption, this research is only concerned with that part of the path, which involves the region's logistics infrastructure facilities in order to compare efficiency and competitiveness. Therefore, the starting point of tracing the supply chain for imports will be from the time the goods are loaded onboard the vessel in a selected hub port in Asia and sailing on its voyage to the port of discharge in the region.

On the contrary, the starting point of tracing the supply chain for region's exports is from the stage when the L/C is opened by the buyer and accepted by the exporter in a Mashrek country. While Hong Kong Port is selected as the starting point of the supply chain for imports from different Asian economies to the economic and consumption centers in the region, it is to be considered also the end point for exports from the same economic and production centers in the region to the different Asian economies. In any case, this research focuses only on the transport logistics of imports to the Mashrek countries.

Table 4.1 **FEEDER** freight rates from Hong Kong to Mashrek ports / (June/04)

From	To	Container Size/Type	Base Ocean Freight	War Risk Surcharge (Asia-Europe)	(OHC) Hong Kong	BAF (Asia to Europe)	CAF (FEA to Europe)	Doc. Fee (Hong Kong)	TOTAL
Hong Kong	Aqaba	20' Dry	2150	0	264.94	90	0	14.75	2519.69
		40' Dry	4200	0	352.83	180	0	14.75	4747.58
	Haifa	20' Dry	2000	9	264.73	106	0	14.74	2394.47
		40' Dry	4000	18	352.55	212	0	14.74	4597.29
	Beirut	20' Dry	2000	24	264.73	90	108	14.74	2501.47
		40' Dry	3900	48	352.55	180	210.6	14.74	4705.89

Source: Global Sales Director of Maersk-Sealand Line and company's website (www.maersk-sealnad.com)

Since Aqaba Port is connected with Asia particularly China through various Asian ports by both direct and feeder connections, the research examines each type of connection separately to demonstrate the effect of type of service on ocean freight and transit time. Maersk-Sealand Line, which connects most Mashrek ports with Asia by feeder connection, has provided a very detailed breakdown for their freight charges. These quotes were obtained directly from the Global Sales Department of the Maersk-Sealand shipping line company and from the company's website.

Table 4.1 shows that the basic freight rate for shipping a 40-foot container from Hong Kong to Aqaba is 5% higher than the rate to Haifa although Aqaba is closer to Hong Kong. These findings, which will be explained in details in the next chapter, are attributed to the feeder service structure to the region.

Surprisingly, other shipping lines that connect Aqaba *directly* with Hong Kong, such as EVERGREEN, APL and COSCO have quoted lower freight rates. They charge US$3,000 for shipping a 40-foot container from Hong Kong to Aqaba on liner out bases (port terminal handling charges are included). With this rate Aqaba port is 14% less than Haifa and Beirut ports, which quoted a freight rate of US$3,600 on the same bases. It should be pointed out that the quoted rates in table 4.2 are basic rates and in reality shippers negotiate with the shipping lines or freight forwarders.

Table 4.2 Freight rates for 40-foot container with **DIRECT** service

From	To	Liner out Ocean Freight US$/40'
Hong Kong	Aqaba (Jordan)	3,000
	Lattakia (Syria)	3,600
	Beirut (Lebanon)	3,600
	Haifa (Israel)	3,600

Source: COSCO Line, APL Line & ESCWA .

Obviously, these results confirms with the geographic location differences of those ports. While the feeder connection to Aqaba abolished its geographic location advantage, the direct service connection on the other hand proved that Aqaba Port could capture a competitive position with respect to maritime transport with Asia. Therefore, the type of connection between ports proved to be a very important factor, which may offset the potential cost advantage from a shorter distance.

As a result, this research is going to use the direct connection rates from as the bases for comparison and the total transport cost calculations. However, maritime transport forms one part of the transport cost and therefore the effect of this factor cannot be generalized until all the other transport cost components are taken into consideration.

4.2.1.2.3 Intermodal transfer process (Handling costs)

This process covers the stage from the time the container is unloaded from the vessel on the quayside until it is loaded on a truck to be transported to the importer's warehouse or distribution point. During this stage, many activities take place such as transferring the container to the storage area, submitting of manifests to ports and customs by the ship agent and the submitting of official declaration and invoices to customs and arranging for a truck to transport the container by the clearing agent, who is appointed by the cargo owner. When all relevant port and customs charges are paid and paper work formalities are cleared, customs officials examine the information on the cargo manifest with contents of the containers according to certain procedures and once approved, the truck is allowed to enter the storage area inside the port and at this point the goods are officially released to the clearing agent on behalf of the cargo owner. Normally, these procedures are almost the same in all ports of the region except maybe in Syria (Containerization, April 1999) where the state owns and controls everything including the shipping agency activities.

This stage, which ends when the overland transport activity of the container begins, involves costs and time as it may take days and even weeks in some ports. On the contrary, the international best practice benchmark for this stage is measured by hours. According to ESCWA (2003) the average total time a container spends inside Aqaba Port before it is cleared by customs can reach up to 3 days, while it takes 5 days in Lattakia and in Beirut port 2 days. However, according to other sources in Haifa port it takes 2 days for transit cargo.

4.2.1.2.4 Overland transport costs

However, cost efficiency of sea freight to the port is no longer the only determinant of a port's competitiveness and the best route shippers or carriers will choose. In fact, inland transport cost is becoming noticed as an important cost factor to be

considered. Hummels (1999) noticed that inland transport costs make up a large share of the total international shipping expenses. In the same study he concludes that inland transport costs can reach between 40 to 60 percent of the total door to door transport cost. Similarly Malchow (2001) emphasizes the significance of both the inland and oceanic distances between a shipment's origin and a shipment's destination as the most influential geographic factors represented by cost and time.

Accordingly, with the fact that most economic centers in Mashrek are inland located except Beirut, the overland distance is equally important component in determining the transport cost. Venables (2001, p.5) concludes that "an extra 1000 km in land distance adds $1,380" per standard 40 foot container. An increase in overland distance will increase the cost of using the relevant infrastructure. Therefore, efficiency and effectiveness of hinterland connections between Mashrek ports and inland markets becomes a very vital factor linked with the location impact.

As explained earlier this stage starts from the time the container is loaded on the truck and exits the port's gate on its way to the final destination of the shipment. Data used under this section were obtained from the UN-ESCWA and other primary sources. Accordingly, this stage involves two levels of costing analysis:

a) the trucking cost of the container from Aqaba to economic centers in the region,
b) the trucking cost of similar containers to the same economic centers but via their own domestic ports. Although some cases include border crossing, the time cost element will be considered later.

For containers transported from the domestic port to the economic center in the same country, normally the process goes very smoothly and takes few hours only depending on the topography of the area. A truck journey from Aqaba to Amman takes less than 5 hours to travel a distance of 335 km. On the other hand, it takes 8 hours for a truck to travel the 350 km from Lattakia to Damascus in Syria.

Table 4.3 Road transport costs for 40-foot container to economic centers in Mashrek

From (port)	To (city)	Road Distance (km)	Transport cost (US$)	Cost US$ per km	Trip's time (days)*
Aqaba (Jordan)	Amman (Jordan)	335	550	1.64	0.21
Beirut (Lebanon)	Beirut (Lebanon)	5	50	**10	0.05
Lattakia (Syria)	Damascus (Syria)	350	600	1.72	0.21
Haifa (Israel)	Tel Aviv (Israel)	120	700	5.83	0.08
Gaza*** (WB/Gaza)	Jerusalem (WB/Gaza)	n/a	n/a	n/a	n/a

Source: ESCWA & other sourcess. ** Waiting time in port or at cross-borders not included,*
The port is within the same city zone* * Gaza port has no containers facilities*

Table 4.3 shows the cost of road haulage between economic centers in the Mashrek region and the domestic port in the same country. It also shows variant costs per km, which is attributed to the difference in the region's economies and in the structure of the road transport market and conditions of demand and supply in each country.

On the other hand, for the second part of this analysis the situation becomes a little complicated where transporting the container from Aqaba to the same locations in Mashrek countries includes border crossings. Usually this process consumes time and involves cross-border checkpoints formalities and inspection of vehicle and cargo by customs officials of the two bordering countries each separately. In some cases the truck transporting the same shipment goes through more than one cross-border point as the case from Aqaba to Beirut in Lebanon. Trucks enter a transit country in a convoy accompanied by customs officials or police in most cases. Therefore, trucks are asked to wait at the cross-border point until there is enough number of trucks for the convoy and in most cases the waiting time extends due to fixed working hours at the border. A specialized study for the Jordan Government regarding transport problems and bottlenecks showed that, at one of the highly frequent cross-border points "during peak hours truck queues can reach 6 km, with some 500 to 600 trucks in waiting position" (GOPA, 1996, p.75). The study reports that transporters often have to calculate at least 6-8 hours waiting time before entering the first checkpoint. Although most border points in Mashrek region operate with similar procedures, this process is important in the transport chain therefore its efficiency can determine the competitiveness of the cross-border logistics chain.

Table 4.4 shows the average waiting time that a truck transporting a 40-foot container spends at the cross-borders between Jordan and other Mashrek countries. The ESCWA study reports that a truck transporting a container from Beirut to Amman in Jordan will spend at least 5 days as waiting time on the two cross-border checkpoints (Lebanon-Syria and Syria-Jordan 2.5 days each).

Table 4.4 Waiting time/costs at cross-border/s from Aqaba to Mashrek countries

From	To	No. of Cross-Borders	Border charges & costs (US$)	Average Waiting Time (days)*
Aqaba (Jordan)	Amman (Jordan)	-	-	-
	Beirut (Lebanon)	2	450	5
	Damascus (Syria)	1	350	2.5
	Tel Aviv (Israel)	1	*	0.5-1
	Jerusalem (WB/Gaza)	2	*	0.5-1

Source: ESCWA & other sources. ** Included in the road transport cost.*

At the Israeli side of the Jordan-Israel cross border, the Israeli officials have a limit of 15 trucks which they process daily; other trucks would have to wait for their turn the next day (Muller-Jentsch, 2002). Therefore, the average waiting time was given as a range between 12 to 24 hours depending on the load of work on that day.

While the cross border expenses and time used are important, the transport costs from Aqaba to final destinations in Mashrek countries are equally important. Table 4.5 shows the costs for transporting a 40-foot container from Aqaba Port to economic centers of Mashrek countries. It also shows the time needed for the truck to make such trips. The cost to distance (km) ratio seems within a reasonable margin for all destinations except for Israel and the West Bank due to certain requirements.

Table 4.5 Road transport costs for 40-foot container from Aqaba Port

From (port)	To (city)	Road Distance (km)	Transport cost (US$)	Cost US$ per km	Trip's time (days)*
Aqaba / Jordan	Amman / Jordan	335	350	1.04	0.2
	Beirut / Lebanon	640	650	1.02	0.4
	Damascus / Syria	550	550	1.00	0.3
	Tel Aviv / Israel	490	950	1.94	0.3
	Jerusalem / WB/Gaza	470	950	1.94	0.3

Source: ESCWA & other sources (Survey with local freight forwarders and shipping agents)
** Waiting time in port or at cross-borders not included,*

So far, the figures in tables 4.3, 4.4 and 4.5 can be summarized to give us the total transport cost for the available options. Accordingly, Table 4.6 summarizes these figures and compares the transport cost of shipping a 40-foot container from Hong Kong to the economic centers in Mashrek countries through their domestic ports on the Mediterranean with shipping via Aqaba port on the Red Sea.

Table 4.6 Total Transport Cost for 40-foot container from Hong Kong Port

Shipment's Route	Transport COST via Mediterranean			Transport COST via Red Sea (Aqaba Port)				Saving Red Sea vs. Mediterranean	
	Sea	Land	**Total**	Sea	Land	Cross-Border costs	**Total**		
	US$								%
Hong Kong - Beirut (city)	3,600	50	**3,650**	3,000	650	450	**4,100**	-450	**-11%**
Hong Kong - Damascus	3,600	600	**4,200**	3,000	550	350	**3,900**	300	**8%**
Hong Kong - Tel Aviv	3,600	700	**4,300**	3,000	950	*	**3,950**	350	**8%**

Source: Compiled by the Author. * Border costs are included in land transport cost.

Clearly, except for Beirut, and even with the current low efficient logistics conditions, saving of 8-9 percent in transport cost can be achieved when shipping to Damascus and Tel Aviv via Aqaba Port. Obviously, the high charges on the two cross-borders between Aqaba and Beirut and the fact that Beirut city is a port city made the transport cost via the Red Sea option uncompetitive for shipping to Beirut.

4.2.1.2.5 Time Cost

As explained earlier this cost, which is an important component of inventory carrying cost, represents the opportunity cost of time for capital invested in cargo (inventory).

In this analysis, the 40-foot container represents a capital tied up in the goods inside that container. Likewise, these goods are in fact inventory in transit and as time passes, the cost of capital invested in these goods grows (Ma, 2003). As investors seek to minimize the capital turn over time, management of time becomes very vital logistics activity for investor's profitability and supports the minimization of the total

cost. This can only be achieved by designing the most appropriate logistics system, which takes into consideration the inventory related costs as an integrated part of the total cost concept.

Accordingly the author reviews the total elapsed time in transporting the 40-foot container on the two routes in order to demonstrate the significance of time in this process. Table 4.7 shows the total time used in the transport process of the 40-foot container from Hong Kong up to its final destination in the different economic centers in Mashrek countries via their national ports on the Mediterranean. Clearly, Aqaba Port has an advantage when direct shipping connection with Hong Kong is used. It takes a shipment 17 days to reach Aqaba Port compared with 19.5 days to Beirut, Lattakia and Haifa. Otherwise Aqaba Port is on the same level with those east Mediterranean ports when feeder service is used.

On the other hand, with the feeder connection more time is used for all routes, which makes this service uncompetitive with the direct connection. Therefore from now on the research will use the direct service rates and figures.

Table 4.7 Total time elapsed for transporting 40-foot container from Hong Kong Port to economic centers via DOMESTIC ports

Shipment's Route	Ocean (Day)		Port	Road	Cross-borders	TOTAL TIME (Day)	
	Feeder	Direct	(Day)	(Day)	(Day)	Feeder	Direct
Hong Kong - Aqaba - Amman	21	17	3	0.2	0	24.2	20.2
Hong Kong - Beirut (port) - Beirut (city)	22	19.5	3	0.05	0	25.05	22.55
Hong Kong - Lattakia - Damascus	30	19.5	5	0.2	0	35.2	24.7
Hong Kong - Haifa - Tel Aviv	22	19.5	2	0.1	0	25.1	21.6

Source: ESCWA & other sources (Survey with local freight forwarders and shipping agents)

Likewise, Table 4.8 focuses on shipping via Aqaba Port on the Red Sea and shows the total time needed to transport the 40-foot container from Hong Kong up to its final destination in the different economic centers in Mashrek countries on this route under the current logistics conditions.

Table 4.8 Total time elapsed for transporting 40-foot container via AQABA

Shipment's Route	Ocean Transport (Day)		Port	Road	At Cross-borders (Day)	TOTAL TIME (Day)	
	Feeder	Direct	(Day)	(Day)		Feeder	Direct
Hong Kong - Aqaba - Amman	21	17	3	0.2	0	24.2	20.2
Hong Kong - Aqaba - Beirut	21	17	3	0.4	5	29.4	25.4
Hong Kong - Aqaba - Damascus	21	17	3	0.3	2.5	26.8	22.8
Hong Kong - Aqaba - Tel Aviv	21	17	3	0.3	0.5	24.8	20.8

Source: ESCWA & other sources (Survey with local freight forwarders and shipping agents)

Clearly, the feeder option reduces Aqaba Port's time saving advantage and therefore the focus must be on the direct connection.

Table 4.9 summarizes the two tables (4.7 and 4.8) and compares the total time of the shipment using direct connection via Aqaba Port and via east Mediterranean ports. Clearly, except for Beirut, shipping via the Red Sea route saves time only in the case of direct connection. It takes 21.6 days to transport this container from Hong Kong to Tel Aviv via Haifa (the country's own port) while only 20.8 days via Aqaba Port. Similarly, it takes 24.7 days to transport same container to Damascus via the country's national port of Lattakia compared to 22.8 days via Aqaba Port. On the contrary it takes less time to ship to Beirut via the domestic port of Beirut than to ship via Aqaba Port (22.55 days via Beirut Port while 25.4 days via Aqaba Port). As can be seen the differences in favour of Aqaba Port are not wide and vary from few hours in the case of Haifa and less than two days in the case of Lattakia.

Table 4.9 Total Time elapsed for transporting 40-foot container from Hong Kong Port

Shipment's Route	Shipping TIME via Mediterranean				Shipping TIME via Red Sea (Aqaba Port)					Saving TIME Red Sea vs. Mediterranean	
	Sea	Port	Road	**Total**	Sea	Port	Road	Cross-Border costs	**Total**		
	DAYS										%
Hong Kong - Beirut (city)	19.5	3.0	0.05	**22.55**	17	3	0.40	5.00	**25.40**	-2.85	**-11%**
Hong Kong - Damascus	19.5	5.0	0.20	**24.70**	17	3	0.30	2.50	**22.80**	1.90	**7%**
Hong Kong - Tel Aviv	19.5	2.0	0.10	**21.60**	17	3	0.30	0.50	**20.80**	0.80	**4%**

Source: Compiled by the Author.

Although the final conclusion has not been reached yet, it could be explained that with respect to the saving in time, the Aqaba-Beirut (Red Sea) route does not compete with the Beirut's (Meditteranean) route due to the fact that Beirut is a port city and there is no overland transport needed when shipping via its port, while via Aqaba Port there is time lost during the overland transport and obviously at the two cross-border points. Although there is no border crossing for the other two economic centers when shipping via their own ports, overland transport is needed.

However, Table 4.10 concludes the results of both Table 4.6 and Table 4.9 and compares the total transport cost and the total transit time for shipping a 40-foot container from Hong Kong to economic centers in Mashrek between shipping via their own ports on the Mediterranean and via Aqaba Port on Red Sea. Although the present logistics conditions in Aqaba Port and along its transport chain to local and regional markets are not efficient still savings in both time and transport cost can be achieved when shipping to Damascus and Tel Aviv.

Table 4.10 Comparison of transport cost & transit time (Mediterranean vs. Red Sea)

Route Options	Hong Kong-Beirut		Hong Kong-Damascus		Hong Kong-Tel Aviv	
	Cost US$	Time (Days)	Cost US$	Time (Days)	Cost US$	Time (Day)
MEDITERRANEAN	3650	23	4200	25	4300	22
RED SEA	4100	26	3900	23	3950	21
Saving Red Sea vs. Mediterranean	-450	-3	300	2	350	1
% of Red Sea saving vs. Mediterranean	**-11%**	**-12%**	**7%**	**8%**	**8%**	**5%**

Source: Author's calculations **N.B: Number of days are rounded off therefore, slight differences may be noticed with figures in previous tables.*

So far, it has become clear what time savings can be achieved and via which route, but the actual financial value of this saving must be determined and integrated with the other actual transport costs in order to accomplish the total transport logistics cost concept. Ma, (2003) reports that the cost of capital invested in transit inventory is the rate of return that will be foregone on that amount of money. Similarly, Hummels (2001) defines the per day cost of goods as a function of the per day interest rate on the goods in transit and the depreciation rate for the goods.

Therefore, the selected route depends on both the total transport cost and the capital cost. However, determining the capital cost depends on the value of the goods inside the transported container and the market interest rate. As most Mashrek countries import manufactured goods from Asian economies, then the value of a typical imported container (filled with such goods) could be $500,000 to $600,000.

Since the purpose of this research is not the determination of exact total cost but to give objective information and general conclusion on the saving in time and total transport cost, three values are assumed for goods in the 40-foot container (US$100,000, 250,000 and 500,000). While different values of interest rates (7.5, 12.5 and 17.5%) are also assumed to estimate the capital cost, the depreciation rate is not recognised in this analysis since it involves defining specific goods and therefore, different depreciation rates, which is not the purpose of this study as mentioned before. However, this rate can be very significant especially for perishable goods.

Table 4.11 Daily capital costs for the different proposed inventory investment values

Interest rates	7.5%	12.5%	17.5%
	US$		
Daily Capital cost for inventory investment of US$ 100,000	21	34	48
Daily Capital cost for inventory investment of US$ 250,000	51	86	120
Daily Capital cost for inventory investment of US$ 500,000	103	171	240

Source: Author's calculations

Accordingly Table 4.11 calculates the daily capital costs for the different proposed inventory investment values on the basis of the suggested three different interest rates. Based on these figures, a spreadsheet simulation model is used to incorporate these values in order to calculate the total transport logistics costs for this case.

4.2.1.2.6 Total Savings

Aside from Beirut, Table 4.12 clearly shows that depending on the value of the shipped goods, a saving of as high as US$780 per containers can be achieved when shipping to Damascus and Tel Aviv via Aqaba Port.

Therefore, for Syria, Israel and the West Bank the advantage of using the Red Sea route rather than the Mediterranean route for Asian trade is evident. Although these savings accounts for less than 0.5 percent of the goods value, they account for 8-18% of the total transport cost when shipping via the domestic ports. Therefore, shippers can choose whether to pay or save this 8-18% transport logistics cost.

Table 4.12 Total saving via Aqaba on Red Sea vs. east Mediterranean ports/**Present Condition**

Capital invested in inventory	Daily Capital Cost	Beirut	Damascus	Tel Aviv
US$				
100,000	21	**-513**	**342**	**371**
100,000	34	-552	368	384
100,000	48	-594	396	398
250,000	51	-603	402	401
250,000	86	-708	472	436
250,000	120	-810	540	470
500,000	103	-759	506	453
500,000	171	-963	642	521
500,000	240	**-1170**	**780**	**590**

Source: Author's calculations

Interestingly, how would the situation be if the prevailing logistics conditions on the Aqaba transport chain, to local and regional hinterland markets, are improved. For instance, if the dwell time in Aqaba Port is reduced to 1 day instead of 3 days and the waiting time at the Jordanian-Syrian and at the Syrian-Lebanese cross-borders is reduced to 1 day each and to 6 hours on the Jordanian-Israeli cross-border, how would these improvements affect the total cost via Aqaba. Accordingly, Table 4.13 calculates the savings that can be achieved when the logistics conditions along the transport chain are improved to better levels. While the savings to Damascus and Tel Aviv are increased, shipping to Beirut via Aqaba produces saving for the high value goods.

Table 4.13 Total saving via Aqaba vs. east Mediterranean ports / **Improved Condition**

Capital invested in inventory	Daily Capital Cost	Beirut	Damascus	Tel Aviv
US$				
100,000	21	**-387**	**384**	**434**
100,000	34	-348	436	486
100,000	48	-306	492	542
250,000	51	-297	504	554
250,000	86	-192	644	694
250,000	120	-90	780	830
500,000	103	-141	712	762
500,000	171	**63**	984	1034
500,000	240	**270**	**1260**	**1310**

Source: Author's calculations

CHAPTER 5
5. THE LOCATION ADVANTAGE & MULTIMODAL SOLUTIONS

The previous econometric analysis revealed that ASEZ has a potential logistics advantage attributed to its geographic location. However, this advantage is not absolute but limited to certain maritime trade routes. While the location advantage of the Red Sea Aqaba Port is for trade with Asian markets (east of Suez trade) it can be said that the advantage of the other east Meditarranean ports is for trade with Europe and Americas markets. How has ASEZ's location created this competitive advantage? What are the current logistics shortages along ASEZ's transport chain, which can limit this advantage? What transport and logistics opportunities can be utilized from this strategic location? These are the questions that this section covers.

5.1 ASEZ's Location Advantage

As explained, this advantage, which gives Aqaba Port a relatively competitive edge for the growing trade with Asia, is reflected in savings in freight and shipping time to ASEZ compared to other Mashrek ports on the Mediterranean. This advantage, which is gaining importance due to current changes in world trading patterns, originates from two major sources; namely maritime distance and shipping time.

5.1.1 Maritime Distance

Bond E. (2001) in his study identifies geography, particularly distance, and transport infrastructure quality as the most important factors that affect the level of transport costs and ultimately the overall logistics costs. Similarly, Venables (2001) realises

that transport cost reflects the distance cost and this appears clearly when he categorizes the costs of distance into four kinds: the direct shipping costs (cost of moving goods internationally), searching costs (cost of finding potential trading partner), management and control costs and the cost of time used in shipping goods.

Located on the Gulf of Aqaba at the northern part of the Red Sea puts ASEZ at a relatively closer distance to Asian markets than other major nodes in the Mashrek region. Trade between Asia and the region or what is called "east-of-Suez" trade, can be channelled via Aqaba Port whereby vessels do not need to travel more distance and pass the Suez canal to call the east Mediterranean ports. Many researchers have found a direct relationship between distance and transport cost whereby more distance reflects in higher transport cost. Micco (2003) finds that doubling the distance increases maritime transport costs by around 20 per cent.

Table 5.1 Maritime distances between **Hong Kong** and Mashrek ports

ROUTE	Maritime Distance	Maritime Distance between Aqaba & Hong Kong	Difference	
	Nautical Miles			%
Hong Kong Port - Beirut (Lebanon)	6607	6223	384	6.2%
Hong Kong Port - Latakia (Syria)	6688	6223	465	7.5%
Hong Kong Port - Tartous (Syria)	6656	6223	433	7.0%
Hong Kong Port - Ashdod (Israel)	6502	6223	279	4.5%
Hong Kong Port - Haifa (Israel)	6548	6223	325	5.2%
Hong Kong Port - Gaza (WB&Gaza)	6490	6223	267	4.3%

Source: Fairplay World Shipping Encyclopedia - Veson Nautical Distance calculation engine & author's calculations and verification.

Table 5.1 shows the maritime distances in nautical miles between Hong Kong Port, as a major hub center in Asia and ports in the Mashrek region. Aqaba is 267-465 nautical miles (494-861 km) closer to Hong Kong than the other ports in the region. Although the differences are very small and could be considered marginal in the maritime industry, Venables (2001, p.5) calculates that "an extra 1000 km by sea distance adds $190" per standard 40-foot container. Proportionally applying Venable's conclusion the maritime transport cost of a 40-foot container to Aqaba should be US$94-164 less than the Mediterranean ports of the region. On the other hand, it should be mentioned that the above table does not show the actual maritime

distance between Aqaba Port and the east Mediterranean ports; it shows the additional nautical miles that a vessel coming from "east of Suez" needs to travel to reach these ports. Accordingly, Table 5.2 shows the actual maritime distance between Aqaba Port on the Red Sea and other ports on the east Mediterranean.

Table 5.2 Maritime distances between **Aqaba** Port and Mashrek ports

East Mediterranean Ports in The Mashrek Region			Maritime Distance Nautical Miles
Aqaba Port (Jordan)	-	Beirut Port (Lebanon)	563
Aqaba Port (Jordan)	-	Latakia Port (Syria)	644
Aqaba Port (Jordan)	-	Tartous Port (Syria)	612
Aqaba Port (Jordan)	-	Gaza (WB&Gaza)	420
Aqaba Port (Jordan)	-	Ashdod Port (Israel)	458
Aqaba Port (Jordan)	-	Haifa Port (Israel)	504

Source: Fairplay World Shipping Encyclopedia - Veson Nautical Distance calculation engine

Therefore, from a theoretical point of view Aqaba should enjoy less maritime transport cost for trade with Asia than east Mediterranean ports. Accordingly, the same argument theoretically applies on the potential geographic advantage of the east Mediterranean ports when discussing trade with Europe and the US (west of Suez).

However, the previous analysis showed that the distance and transport cost theory does not hold with the feeder connection to Aqaba whereby the actual freight rates from Hong Kong to east Mediterranean ports were lower than to Aqaba. Different opinions were sought to explain this contradiction. According to H. R. Hansen, Director of Global Sales, Maersk-Sealand Line, the difference in "mother vessels/ feeder vessels connect and layover days at intermediate hub ports" could be the reason behind such variance (personal communication, April 19, 2004). On the other hand, Celestino and Inmaculada (2002, p.4) argue that "most distance-related costs tend to decrease with the continuous development of new technologies". However, they also report that higher levels of transport infrastructure tend to slightly decrease the effect of distance related costs. Similarly, Ward and Huang (1999) show that the cost of moving information about "transported goods" has declined steadily in the second half of the last century (92% between 1969-1998), which reduces the distance

effect. Hummels (2001) acknowledges that distances remained the same while the cost of moving goods by sea has declined.

While, the effect of technology is general and reduces the distance related costs on maritime transport in general and not on certain routes, the author believes that Maersk-Sealand's explanation is relevant since it refers to an important element in this equation that is the cost and distance of the feeder connection. Further investigations revealed that the above rates were quoted by the line which feeders to Aqaba and to east Mediterranean ports through Damietta in Egypt. This means Asian cargo is shipped first to Damietta on the Mediterranean, north of the Suez Canal and then back around the Sinai Peninsula to Aqaba, which increase the distance to levels that offset Aqaba's advantage over the east Mediterranean ports from the difference in the oceanic distance to Hong Kong. Another point to be considered is the fact that vessels calling Aqaba needs to deviate from an international maritime route and sail a distance of 180 km (97 nautical miles) from Teiran Straits up to the port on the Jordanian coast. Same distance will be travelled before the vessel returns back to a position where it can proceed on international maritime routes.

However, in the case of direct connection the distance effect is realized and reflected in less transport prices, which corresponds with the savings from the shorter distance travelled. In short, the impact of geography on logistics cost is reflected in freight rate mark-up. However, since the difference in distance between Aqaba and east Mediterranean ports is relatively small there must be another factor that justifies the proportionally higher difference in freight from Hong Kong to these ports.

5.1.2 Shipping Time

Hummel (2001, p.23) concludes that lengthy shipping times increase transport logistics cost, particularly through imposing inventory holding and depreciation costs on shippers. He shows that "each day saved in shipping time is worth 0.8 percent ad-

valorem for manufactured goods", which means that a 25 day ocean voyage imposes costs equal to a 20 percent tariff on the shipped goods.

However, shipping time and maritime distance are closely related. A basic navigational and physics rule states that time and speed are inversely proportional. But earlier the author showed that difference in maritime distances between the ASEZ and east Mediterranean ports is relatively small; therefore, its impact on the shipping time is also low. Actually, shipping time between Aqaba and east Mediterranean ports is higher than the usual time needed to travel the short distance between these ports. In fact, the need to pass the Suez Canal in order to call the east Mediterranean ports has a major impact on both the shipping time and transport cost.

Vessels travelling between Asia and Europe choose to go through the Red Sea and transit the Suez Canal to the Mediterranean or vice versa since this route saves time and cost in comparison to if vessels had proceeded via Cape of Good Hope route. Yet vessels planning to pass through the canal must comply with the rules and regulations of the Suez Canal Authority and pay some significant dues. While transiting the canal in a convoy, vessels steam at low speed due to navigational and safety reasons. Therefore, shipping time increases in accordance with above rule. Usually the transit time takes 24 hours although actual steaming is only 16 hours (Elassy, 2000). Similarly, there are certain scheduled times for transiting the canal and vessels arriving after the set time limits must wait until the next convoy. While there is one convoy from the Red Sea to the Mediterranean, which starts at seven o'clock every morning there are two convoys from the Mediterranean to the Red Sea every day. Still, vessels are always at risk of not catching the scheduled convoys and have to wait for the next convoy the next day.

Therefore, from a transport cost view a vessel coming from east, which chooses to call at Aqaba Port rather than an east Mediterranean port will save the sea voyage cost for the extra distance and the Suez Canal dues. Similarly, from a time cost view a vessel also saves the extra distance steaming time and the time used in transiting

the canal in addition to the risk of not catching the convoy and losing extra time and cost. Table 5.3 calculates the shipping time for a direct sea voyage of a container vessel from Hong Kong Port to ports of the region at a speed of 24 knots and shows a comparison with shipping time to Aqaba Port. For the east Mediterranean ports one day is added for transiting the Suez Canal. Clearly, there is a saving of two days 18 percent of the total sea voyage time.

Table 5.3 Shipping time between **Hong Kong** and Mashrek ports

ROUTE	Shipping Time	Shipping Time for Hong Kong-Aqaba	Difference	
	Days			%
Hong Kong - Beirut (Lebanon)	13	11	2	18.2%
Hong Kong - Latakia (Syria)	13	11	2	18.2%
Hong Kong - Tartous (Syria)	13	11	2	18.2%
Hong Kong - Ashdod (Israel)	13	11	2	18.2%
Hong Kong - Haifa (Israel)	13	11	2	18.2%
Hong Kong - Gaza (WB&Gaza)	13	11	2	18.2%

Source: Fairplay World Shipping Encyclopedia - Veson Nautical Distance calculation engine & author's calculations and verification.

5.2 International Trade Patterns

Evidently the new changes in world trade patterns may have a positive effect on traffic growth to Aqaba. Drewry shipping consultants (2004) report that since joining the WTO in late 2001, China is increasingly taking on the role as the "factory of the world". Therefore, foreign direct investments are soaring into China and boosting its economic development and growth rates. This development is leading to a complete shift in world trading patterns. Certainly, the foreign trade of Mashrek countries as part of this global pattern is witnessing a shift along this trend. Therefore, from a global trade pattern point of view, the ASEZ also enjoys a favourable position with regard to the rising external trade of Mashrek countries with Asian economies. The increasingly shifting of world production to China gives ASEZ the greatest locational advantage and enhances its chances to market itself as a potential gateway and a distribution destination to the region for trade with the fast growing Asian economies, China in particular.

While this analyses highlights certain advantages for the ASEZ, it also reveals several shortages in the transport logistics system of the country and the region.

5.3 Logistics shortages

The analysis of the actual market logistics costs in the previous chapter, which reflects the current logistics conditions in Jordan and the region, revealed several deficiencies and constraints in the multimodal transport and logistics network. The long dwell time in Aqaba Port, lack of proper rail transport network and lengthy cross-border formalities and procedures are significant hindrances, which undermine and limit ASEZ's potential as a gateway. The aim here is to pinpoint those constraints, disclosed in the previous analysis, which affect the total logistics cost.

5.3.1 Cross-Border Trade Flow

WTO (1998) reports that the "time lost waiting for border release in many regions accounts for up to 25 per cent of total transport costs" (ESCAP, 2003, p.44). In fact this case confirms to some extent WTO's remark. While the whole transport voyage from Hong Kong to Beirut via Aqaba takes 25 days, the waiting time at cross-borders takes 5 days accounting for 20 percent of the total transport time. Certainly, this unnecessary lost time, which is high by international standards adds up to the total transport cost and minimizes efficient utilization of multimodal transport network.

However, it is believed that once the political barriers are removed and the Euro-Mediterranean free trade agreement becomes effective all these restrictions will be streamlined and harmonized and therefore time at the cross-borders between Jordan and its neighbours will be reduced to the normal international standards. As a result the region's cross-border logistics efficiency will improve considerably and enable the region's economies, importers and exporters in the region to benefit from this improvement and savings in time and cost. This case shows a live example on the

missing opportunities, which countries in the region could capture had the quality of the region's logistics infrastructure network been more efficient.

5.3.2 Road Haulage

The same analysis showed that trucking costs between Jordan and Israel is much higher than to those in other countries. While the same truck which loaded the container in Aqaba Port transports it to its final destination in Syria and Lebanon, it is not the case with Israel, where the container needs to be transferred from the Jordanian truck to the Israeli truck at the cross-border bridge before being trucked to its final destination in Tel Aviv once formalities are approved. The transport cost for the Jordanian truck is according to the haulage market structure in Jordan, which has very low rates compared to transport rates in Israel. For example, the cost of trucking a 40-foot container from the bridge (cross-border checkpoint) to the Port of Haifa (distance of less than 200 km) is nearly US$1000 while for a longer distance in Jordan (Aqaba to Amman) the cost is much less (US$350 for 330 km).

5.3.4 Dwell time in port

Similarly, the minimum 3 days dwell time before the container is released from Aqaba Port (ESCWA, 2003) is too high and reflects poor port infrastructure quality. Likewise, this unnecessary lost time limits Aqaba Port logistics potential and increases the inventory carrying cost which adds up to the total transport cost. Several researches have concluded that port efficiency is an important factor in transport cost. Venables (2001) shows that low infrastructure quality accounts for more than 40% of the predicted transport costs. Additionally, he reports that poor quality infrastructure increases the waiting time for goods to clear ports or other intermodal nodes, which results in higher capital costs. In the same way, Micco (2003) concludes that maritime transport costs can be reduced to more than 12% by improving port efficiency from the 25^{th} to the 75^{th} percentiles. However, it is expected that container port efficiency will improve considerably after AP Moller

Terminals were given a 25 years concession contract to manage and operate the terminal (Thomas, 9 March 2004)

5.4 Multimodal Transport Solutions

No doubt that opening up of transport market and smoothing cross-border transport flows in Mashrek region can initiate and revive different transport logistics solutions and opportunities. Among these solutions is an intermodal land bridge to link between ports on the Mediterranean with Aqaba Port on the Red Sea.

5.4.1 Red Sea - Mediterranean Land-bridge

This concept was utilized in the region during the closure of the Suez Canal during 1967-75. Cargo shipped from Europe to Lebanese and Syrian ports on the east Mediterranean then trucked to Gulf countries. Similarly, "Negev Continental Bridge" (NCB) between Eilat on the Red Sea and Haifa on the Mediterranean was used to facilitate containers and cars transport between Europe and the Mediterranean at one end and the Indian Ocean and East Asia at the other end (Elassy, 2000). However, this activity was suspended once the Suez Canal reopened in 1975.

Therefore, the idea here is to create an intermodal solution besides the Suez Canal, where container vessels coming from the east call at Aqaba Port to unload the European and Mediterranean cargo and have it transported by rail and road to one of the ports in the region on the east Mediterranean where it will be reloaded on another

Figure 5.1 Red Sea – Mediterranean land bridge
*Source:*http://www.judaicaheaven.com/stores/judaicaheaven/catalog/JP332.jpg

vessel to transport the cargo to the different ports in Europe and vice versa. The economic viability of such initiative originates from the established fact that savings in time and freight can be achieved by shipping from Asia to Aqaba instead of transiting the canal to east Mediterranean ports. However, could this viability hold for shipments to further destinations in Europe and the Mediterranean that is what this part of the research will try to cover?

Naturally, shipping between east and west over the Red Sea – Mediterranean "Red–Med" land bridge is viable if savings in cost and time can be achieved to carriers and shippers up to the last destination. In this research the author examines the total time for shipping from Shanghai Port in China as a major growing hub port in Asia to two different destinations: directly to Rotterdam Port in the Netherlands as a major center in northern Europe and via a hub port to Istanbul Port as a growing port in the Black Sea/east Mediterranean region.

Accordingly, viability of this approach can only be examined by applying the total transport logistics cost concept on all available options and compare them with the "Red-Med" land bridge option. Therefore:

1) The direct "Shanghai-Rotterdam" maritime connection will be examined against the "Shanghai-Aqaba-land-bridge-east Med. port-Rotterdam", and
2) The feeder maritime connection "Shanghai-Port Said-Istanbul" will be examined against the "Shanghai-Aqaba-land-bridge-east Med. port-Istabul",

In the Mashrek region, there are several east Mediterranean ports with land distance between them and Aqaba ranging from 200 km to about 650 km. Therefore, the following two conditions are assumed for the land bridge option:

Efficient Condition: representing the *shortest* path with potentially highly efficient logistics conditions as the best situation. Actually, this path is the Aqaba – Gaza path (about 200 km) but presently no port infrastructure exists in Gaza, neither an overland connection to Aqaba. For the research purposes it is assumed that a highly efficient container port exists in Gaza and a highly efficient railway

connection between Aqaba and Gaza also exists. Therefore, under such conditions the containers are transported by railway and trucks to the port in Gaza on the same day the vessel was unloaded in Aqaba. For instance, the total time needed to unload a 7500 TEU vessel in Aqaba and transport the boxes over the 200 km land-bridge and reload in Gaza Port, on another container vessel, take about 2 days. (using 4 gantry cranes each capable of 70 moves per hour).

Low efficiency Condition: representing the *longest* path with low logistics efficiency as the extreme situation. Actually the longest path is the Aqaba – Lattakia path and in this case there is no need for assumptions since currently this path has low efficient logistics conditions according to the ESCWA study (2003). A container is cleared after 3 days from the time vessel commenced unloading in Aqaba Port then it is trucked to Lattakia (650 km) where in between at the cross border it waits another 2.5 days. After arriving at Lattakia Port, it stays for another 2 days before reloading on another vessel. Therefore, the total time used in this path is 8 days including the time on the road.

While direct maritime connection involves only the time of sea voyage including the Suez canal transiting time, the feeder via the hub port connection on the other hand involves the time of the two sea voyages (Shanghai–Port Said) and (Port Said – Istanbul) in addition to the time used for handling of containers at the hub port.

Naturally, it is assumed that the container vessel used for the three options is the same with the same conditions and specifications, speed, carrying capacity and all other operational cost elements per unit per mile except the canal dues, which do not apply to the Aqaba option. Furthermore, it is also assumed that this vessel sails from Shanghai Port in China directly to the specified ports according to each option without any interruption or stoppage at intermediate ports except as mentioned for the options. Vessel speed for all options is assumed 24 knots and therefore shipping time of each voyage is calculated according to maritime distance travelled on each route, but for those routes, which include transiting the Suez canal one day is added.

Table 5.4 Shipping time between Shanghai and Rotterdam via various routes

SHIPMENT'S ROUTE	Maritime Distance (n. miles)	Sea Voyage	Suez Canal	Hub Port/s	Land-Bridge	Cross-Border	TOTAL TIME
		Days					
Direct Connection (Shng.-Rtdm)	10392	19	1	0	0	0	**20.00**
"Red-Med" Land Bridge (Shng.-Aqb.=Gz- Rtdm)	10328*	18.7	0	1.8	0.20	0	**20.70**
"Red-Med" Land Bridge (Shng.-Aqb=Ltk- Rtdm)	10325*	18.7	0	5	0.50	2.50	**26.70**

Source: compiled by author from Fairplay World Shipping Encyclopedia - Veson Nautical Distance calculation engine) and other sources. **: overland distance not included.*

Accordingly, the total time used for transporting a container from Shanghai Port to Rotterdam Port using the above three options is illustrated in the Table 5.4. Clearly, it shows a saving of less than a day in favor of the direct maritime connection Shanghai-Rotterdam over the "Red-Med" land bridge via Gaza, which means that the saving in time from Shanghai to Aqaba was offset by the time spent in unloading and reloading of containers in Aqaba and Gaza respectively. However, this result also indicates that the determinant factor is the transport cost since the time cost showed no significant saving in time could be achieved. Unless the container transport cost over the Red Sea- Mediterranean land bridge is considerably less than the transport cost through the Suez Canal, then the land bridge cannot compete with the canal on direct maritime connections. On the other hand, the "Red-Med" land bridge via Lattakia is clearly very inefficient on this route even if the lost time in port and at border is eliminated and logistics infrastructure is improved.

Table 5.5 compares total transport time for shipping a container from Shanghai Port to Istanbul Port via Port Said as the hub port with the land bridge options.

Table 5.5 Shipping time between Shanghai and Istanbul via various routes

SHIPMENT'S ROUTE	Maritime Distance (n. mile)	Sea Voyage	Suez Canal	Hub Port/s	Land-Bridge	Cross-Border	Total Time
		Days					
Feeder Connection via hub (Shng.-PSD-Istl.)	7904	14.4	1	2	0	0	**17.40**
"Red-Med" Land Bridge (Shng.-Aqb.=Gz-Istl)	7802*	14.3	0	2	0.10	0	**16.40**
"Red-Med" Land Bridge (Shng.-Aqb=Ltk-Istl)	7752*	14.1	0	5	0.50	2.50	**22.10**

Source: compiled by the author from Fairplay World Shipping Encyclopedia - Veson Nautical Distance calculation engine) and other sources. **: overland distance not included.*

It can be seen there is a 6 percent saving in time for the land bridge via Gaza compared to shipping to Mediterranean ports via a hub port. Although this saving is relatively low, it emphasizes the need to study the transport cost via the land bridge to find out the true viability of the Red Sea-Mediterranean land-bridge route.

However, the increasingly expansion of hub ports in the region indicates that these ports are becoming a significant part of the transport chain. To a certain extent the "Red-Med" land bridge concept is similar to the hub port concept with one exception that in the first case two ports (Red Sea and Mediterranean) are playing jointly the role of the one hub port in the second case.

Clearly, under the present international shipping conditions the "Red-Med" land bridge option cannot be considered for the direct maritime connections. However, this option can become very significant in case the size of container vessels grows to levels beyond the Suez Canal capabilities. Then various "Red-Med" land bridges will emerge as a strategic solution for more efficient maritime trade on the east-west route. Alassi (2000) has proposed another similar bridge between Egyptian ports Sukhna on the Red Sea and Dammiata or Port Said on the Mediterranean. As container vessels are becoming increasingly larger and more expensive, time is an important factor in the success of operating such vessels. Therefore, any saving in time is an opportunity to improve the vessels' operational utilization and maximizing earnings. Besides providing a solution to any Suez Canal limitations, "Red-Med" bridge offers shipping lines a better opportunity to serve the same markets but with shorter distances and transit time.

CHAPTER 6
6. CONCLUSION

This research reveals the effectiveness of total transport logistics cost in identifying the true picture about ports' potential markets. While many experts predicted low chances for Aqaba Port in competing with other ports in the region, this research concludes the opposite and showed through the total cost concept that Aqaba Port has the potential to be the region's gateway for trade with the Indian Ocean and East Asian markets. Evidently the research illustrates that even under the current low efficient logistics conditions, total transport logistics cost for transporting a standard container from Asia to Syria and Israel, even to Lebanon under certain conditions, via Aqaba is less than via these countries' own ports. However, the research points out that total cost is not the only factor, which carriers take into consideration when they select the shipment's route. In many cases, there are other factors equally important which the research lists.

Also the research reveals a few transport infrastructure under-investments and other logistics shortages, which can undermine ASEZ's logistics potentials. The long dwell time for cargo in the port and the long waiting time on cross borders minimize the port's competitive advantage in distant markets. Likewise the lack of a railway service between Aqaba Port and its markets for imported cargo, containers in particular demonstrates a serious shortage and significant missing link in the Zone's multimodal transport network, which is required to make an important contribution to the economy. Certainly a combination of rail and road is necessary for Aqaba Port to build its capacity as a gateway to hinterland markets in the Mashrek region.

However, the research demonstrates that improving the transport infrastructure and logistics conditions in Aqaba Port and along the port's transport chain to hinterland markets, can considerably enhances the port's potential as a gateway to the region. Table 6.1 compares the percentage of the saving that can be achieved by using the Red Sea versus the Mediterranean route under the present logistics conditions with the potential saving under assumed improved conditions. This table, which reflects the saving in time only, shows significance jump in savings for the three destinations.

Table 6.1 Comparison of savings in percentage (%)-Red Sea vs. Mediterranean route

Condition	Beirut	Damascus	Tel Aviv
Under **PRESENT** conditions	-13%	8%	5%
Under **IMPROVED** conditions	13%	16%	18%
Difference	**26%**	**8%**	**13%**

Source: Concluded from other tables in this research

Similarly, the research reveals the importance of the maritime route, service connection type and maritime distance in influencing both freight and total transport cost. While it is true that distance increases transport cost, in maritime transport the circumstances of the travelled route have an effect on the total cost as well. For instance the transport cost and shipping time for a vessel travelling a distance with passing the Suez Canal are not the same when travelling the same distance but without any canals along the path. Accordingly, shipping directly from "east of Suez" markets without the need to transit the canal gives Aqaba the distance and time advantages over the east Mediterranean ports.

Furthermore, this research confirms and demonstrates how the following factors can influence the total transport logistics cost:

1. Port's geographical location with respect to sources and markets, which emphasizes the importance of the conditions along the maritime route between these points. Naturally, the location of Aqaba Port before the Suez Canal on the Red Sea resulted in less freight and shorter shipping time from Asia in comparison with the east Mediterranean ports.

2. The availability of sufficient multimodal transport network: without the highway network connecting the ASEZ with hinterland markets in the region, Aqaba Port would not be considered as a gateway to those markets. Although few ports in Mashrek enjoy both a railway and road connections with their captive local markets, non-existence of a regional railway network prevents the region from the railway cost advantages and ultimately capturing the less total cost benefit.

3. The quality of transport infrastructure and efficiency of logistics chain. The research demonstrates how the total cost concept provides understanding of the relative importance of its components and how total cost is altered whenever any of these components changes. Evidently the simulation model illustrates how transport cost to Beirut via Aqaba Port can only be feasible if certain factors along the transport chain between Aqaba and Beirut are improved and become efficient.

Progressively, the research discusses certain multimodal transport solutions for Jordan and the region. It presents a land bridge between Aqaba Port on the Red Sea and an east Mediterranean port as a multimodal transport solution for containerised transport between the Indian Ocean and east Asia markets at one end and Europe and Mediterranean markets at other end. Although no significant savings are concluded, the viability of this bridge would enhance considerably in case the size of container vessels grows to levels beyond the Suez Canal capabilities. On the other hand, the air/sea and air/road intermodal solutions represent another opportunity for Jordan to utilize the empty space on tourists' charters, which call Aqaba increasingly.

On the other hand, the research points out that the ongoing economic and political developments in the world are expected to bring stability to the Mashrek region and ultimately political and technical barriers will be removed and the transport market will open. As a result, shifting of activities between ports is evident, as changes in the regional patterns of transport and trade are expected. Although some ports might reject this fact, in reality this shifting provides theses ports with a better chance to meet the normal projected growth in traffic with less infrastructure investments.

Nevertheless, the research concludes that the localisation of logistics and distribution activities in the ASEZ is supported by many factors, out of which: **a)** the huge concentration of transport and cargo handling activities created by the traditional activities of the Aqaba Port, **b)** the developed network of roads and highways that provide an efficient hinterland connections between ASEZ and both domestic and transit markets, and **c)** the geographic location of ASEZ at the intersection of two continents and four countries.

Evidently, the research shows that the ASEZ has the potential to become a gateway to the region but certainly some work needs to be done. Firstly, the Government of Jordan needs to take the necessary actions as soon as possible to improve the efficiency of the transport logistics system in Aqaba Port and to eliminate the shortages along the port's transport chain particularly those pinpointed by this research. While many of these bottlenecks can be fixed through policy reforms with almost no real investment cost, the efficiency of most of the other port and related activities can be improved significantly through certain investment in the information and communication technologies and human resources building capacities with an average cost around $2 millions. Secondly, the Aqaba Port needs to join efforts with leading shipping lines to build on this research to develop a marketing plan to penetrate the potential hinterland markets in the region to become a gateway to the region. This research shows how many studies view such gateway ports as "engines of economic growth" for their region and the country. Consequently, the success of these efforts will enable the Jordanian economy to capture the economic benefits of becoming a gateway to the region and furthermore saving the $216-260 million, which the research shows that Jordan is incurring annually as freight cost above the international best practice benchmark.

Finally, the author is confident that with the wise, determinant and visionary Hashemite leadership of Jordan and the dedication of its people, the future of the ASEZ is prosperous and promising not only on the national level but on the regional as well.

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APPENDICES

APPENDIX A

APPENDIX B

APPENDIX C

APPENDIX A

BERTHING FACILITIES AND DIMENTIONS AT AQABA PORT

Table (A.1) Berthing facilities and dimensions at the **MAIN** Port

BERTH No./Name	WATER DEPTH (meter)	LENGTH (meter)	VESSEL DISPLACEMENT (Ton)
No. 1 General Cargo Berth	11	160	45,000
No. 2 General Cargo Berth	11	180	45,000
No. 3 General Cargo Berth	13	180	53,000
No. 4 General Cargo Berth	12	180	53,000
No. 5 General Cargo Berth	11	180	53,000
No. 6 General Cargo Berth	11	180	53,000
No. 7 General Cargo Berth	8	150	8,000
No. 8 General Cargo Berth	5.8	150	8,000
No. 9 General Cargo Berth	5.4	150	8,000
No. 10 Barges & Tugboat Berth	4	210	400
PH-A Phosphate Berth A	11	210	25,000
PH-B Phosphate Berth B	15	180	125,000

Source: Aqaba Ports Corporation (Jordan)

Table (A.2) Berthing facilities and dimensions at the **CONTAINER** Port

BERTH No./Name	WATER DEPTH (meter)	LENGTH (meter)	VESSEL DISPLACEMENT (Ton)
Container Berth No. 1	15.1	180	84,000
Container Berth No. 2	15.2	180	84,000
Container Berth No. 3	20	180	84,000
RO-RO Berth	12	40	35,000
Passenger Floating Berth	15	150	15,000
Mo'tah Floating Berth	15	150	53,000
Bulk Cement Berth	11	120	50,000

Source: Aqaba Ports Corporation (Jordan)

Table (A.3) Berthing facilities and dimensions at the **INDUSTRIAL** Port

BERTH No./Name	WATER DEPTH (meter)	LENGTH (meter)	VESSEL DISPLACEMENT (Ton)
Industrial Berth seaward	15	200	70,000
Industrial Berth landward	11	190	40,000
Oil Jetty	25	140	406,000
Timber Berth	6.8	80.6	14,000

Source: Aqaba Ports Corporation (Jordan)

APPENDIX B

TABLE OF HISTORICAL CARGO TRAFFIC OF AQABA PORT

YEAR	INBOUND ('000 TONS)	OUT-BOUND ('000 TONS)	TOTAL ('000TONS)	GROWTH (annually)
1952	6.6	0.1	6.7	---
1953	56.2	4.0	60.2	802%
1954	80.1	12.3	92.5	54%
1955	134.6	66.3	200.9	117%
1956	76.8	67.3	144.1	-28%
1957	47.6	99.2	146.8	2%
1958	272.4	137.8	410.2	179%
1959	453.7	136.6	590.3	44%
1960	461.3	223.6	684.9	16%
1961	420.3	311.4	731.7	7%
1962	368.6	286.5	655.1	-10%
1963	451.7	275.2	726.9	11%
1964	340.3	493.1	833.5	15%
1965	408.2	521.6	929.8	12%
1966	590.3	657.2	1,247.5	34%
1967	353.8	650.9	1,004.7	-19%
1968	161.4	694.7	856.2	-15%
1969	205.0	538.5	743.5	-13%
1970	195.6	186.3	381.9	-49%
1971	278.1	387.2	665.2	74%
1972	518.6	704.9	1,223.6	84%
1973	433.8	811.2	1,245.0	2%
1974	367.4	1,116.2	1,483.6	19%
1975	682.8	870.6	1,553.4	5%
1976	1,368.7	1,631.8	3,000.5	93%
1977	1,389.4	1,722.3	3,111.7	4%
1978	1,550.8	2,108.3	3,659.1	18%
1979	2,301.4	2,708.7	5,010.1	37%
1980	3,024.1	3,574.5	6,598.6	32%
1981	5,804.7	3,530.1	9,334.7	41%
1982	7,837.2	3,835.5	11,672.7	25%
1983	6,098.8	5,059.1	11,157.9	-4%
1984	6,448.3	7,158.1	13,606.5	22%
1985	6,370.1	8,177.6	14,547.7	7%
1986	7,153.2	9,697.4	16,850.6	16%
1987	8,743.7	11,271.6	20,015.4	19%
* 1988 *	9,143.2	10,953.0	**20,096.1**	0%

1989	8,694.7	9,986.0	18,680.6	-7%
1990	6,164.6	8,871.9	15,036.5	-20%
1991	5,548.0	7,677.5	13,225.5	-12%
1992	6,021.7	7,361.8	13,383.5	1%
1993	5,252.7	6,381.2	11,633.9	-13%
1994	3,923.9	6,648.4	10,572.3	-9%
1995	5,076.0	6,679.0	11,755.0	11%
1996	4,608.0	7,396.0	12,004.0	2%
1997	4,778.0	7,535.0	12,313.0	3%
1998	5,333.0	7,310.0	12,643.0	3%
1999	5,374.0	7,480.0	12,854.0	2%
2000	5,359.6	7,192.9	12,552.6	-2%
2001	5,251.6	7,791.4	13,043.1	4%
2002	5,286.2	8,872.7	14,158.9	9%
2003	9,607.3	8,239.9	17,847.1	26%

Source: Compiled by Author from various sources

APPENDIX C-1

Total Transport Logistics Cost for shipping from Hong Kong to BEIRUT via different routes

	a	D_{hn}	R_n	ß$_{ne1}$	ß$_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	50,000	0.05	100	12	1	2	100	2992.8	17.0	$116.78	**$3,109.58**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	50,000	0.05	100	12	1	2	100	3532.2	20.4	$139.73	$3,671.93	$3,109.58
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	50,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**3**	**5**	50,000	0.05	0	11	0	0	0	3742	19.7	$135.10	$3,877.10	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	250,000	0.05	100	12	1	2	100	2992.8	17.0	$583.90	**$3,576.70**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	250,000	0.05	100	12	1	2	100	3532.2	20.4	$698.63	$4,230.83	$3,576.70
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	250,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**3**	**5**	250,000	0.05	0	11	0	0	0	3742	19.7	$675.51	$4,417.51	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	500,000	0.05	100	12	1	2	100	2992.8	17.0	$1,167.81	**$4,160.61**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	500,000	0.05	100	12	1	2	100	3532.2	20.4	$1,397.26	$4,929.46	$4,160.61
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	500,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**3**	**5**	500,000	0.05	0	11	0	0	0	3742	19.7	$1,351.02	$5,093.02	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	750,000	0.05	100	12	1	2	100	2992.8	17.0	$1,751.71	**$4,744.51**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	750,000	0.05	100	12	1	2	100	3532.2	20.4	$2,095.89	$5,628.09	$4,744.51
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	750,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**3**	**5**	750,000	0.05	0	11	0	0	0	3742	19.7	$2,026.54	$5,768.54	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	1,000,000	0.05	100	12	1	2	100	2992.8	17.0	$2,335.61	**$5,328.41**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	1,000,000	0.05	100	12	1	2	100	3532.2	20.4	$2,794.52	$6,326.72	$5,328.41
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	1,000,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**3**	**5**	1,000,000	0.05	0	11	0	0	0	3742	19.7	$2,702.05	$6,444.05	

Total Transport Logistics Cost for shipping from Hong Kong to BEIRUT via different routes

	a	D_{hn}	R_n	ß$_{ne1}$	ß$_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	500,000	0.1	100	12	1	2	100	2992.8	17.0	$2,335.61	**$5,328.41**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	500,000	0.1	100	12	1	2	100	3532.2	20.4	$2,794.52	$6,326.72	$5,328.41
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	500,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	500,000	0.1	0	11	0	0	0	3742	13.7	$1,880.13	$5,622.13	

Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	550,000	0.1	100	12	1	2	100	2992.8	17.0	$2,569.17	**$5,561.97**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	550,000	0.1	100	12	1	2	100	3532.2	20.4	$3,073.97	$6,606.17	$5,561.97
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	550,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	550,000	0.1	0	11	0	0	0	3742	13.7	$2,068.15	$5,810.15	

Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	600,000	0.1	100	12	1	2	100	2992.8	17.0	$2,802.73	**$5,795.53**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	600,000	0.1	100	12	1	2	100	3532.2	20.4	$3,353.42	$6,885.62	$5,795.53
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	600,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	600,000	0.1	0	11	0	0	0	3742	13.7	$2,256.16	$5,998.16	

Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	700,000	0.1	100	12	1	2	100	2992.8	17.0	$3,269.86	**$6,262.66**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	700,000	0.1	100	12	1	2	100	3532.2	20.4	$3,912.33	$7,444.53	$6,262.66
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	700,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	700,000	0.1	0	11	0	0	0	3742	13.7	$2,632.18	$6,374.18	

Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	800,000	0.1	100	12	1	2	100	2992.8	17.0	$3,736.98	$6,729.78	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	800,000	0.1	100	12	1	2	100	3532.2	20.4	$4,471.23	$8,003.43	$6,729.78
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	800,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	800,000	0.1	0	11	0	0	0	3742	13.7	$3,008.21	**$6,750.21**	

Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	1,000,000	0.1	100	12	1	2	100	2992.8	17.0	$4,671.22	$7,664.02	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	1,000,000	0.1	100	12	1	2	100	3532.2	20.4	$5,589.04	$9,121.24	$7,502.26
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	1,000,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	1,000,000	0.1	0	11	0	0	0	3742	13.7	$3,760.26	**$7,502.26**	

APPENDIX C-3

Total Transport Logistics Cost for shipping from Hong Kong to BEIRUT via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	500,000	0.15	100	12	1	2	100	2992.8	17.0	$3,503.42	**$6,496.22**	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	500,000	0.15	100	12	1	2	100	3532.2	20.4	$4,191.78	$7,723.98	$6,496.22
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	500,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	500,000	0.15	0	11	0	0	0	3742	13.7	$2,820.20	$6,562.20	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	550,000	0.15	100	12	1	2	100	2992.8	17.0	$3,853.76	$6,846.56	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	550,000	0.15	100	12	1	2	100	3532.2	20.4	$4,610.96	$8,143.16	$6,844.22
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	550,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	550,000	0.15	0	11	0	0	0	3742	13.7	$3,102.22	**$6,844.22**	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	600,000	0.15	100	12	1	2	100	2992.8	17.0	$4,204.10	$7,196.90	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	600,000	0.15	100	12	1	2	100	3532.2	20.4	$5,030.14	$8,562.34	$7,126.24
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	600,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	600,000	0.15	0	11	0	0	0	3742	13.7	$3,384.24	**$7,126.24**	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	700,000	0.15	100	12	1	2	100	2992.8	17.0	$4,904.78	$7,897.58	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	700,000	0.15	100	12	1	2	100	3532.2	20.4	$5,868.49	$9,400.69	$7,690.28
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	700,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	700,000	0.15	0	11	0	0	0	3742	13.7	$3,948.28	**$7,690.28**	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	800,000	0.15	100	12	1	2	100	2992.8	17.0	$5,605.47	$8,598.27	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	800,000	0.15	100	12	1	2	100	3532.2	20.4	$6,706.85	$10,239.05	$8,254.32
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	800,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	800,000	0.15	0	11	0	0	0	3742	13.7	$4,512.32	**$8,254.32**	
Beirut-Beirut	0.4	6607	100	5	0	10	0	0	24	70	70	2	0	1,000,000	0.15	100	12	1	2	100	2992.8	17.0	$7,006.83	$9,999.63	
Lattakia-Beirut	0.4	6688	100	1.02	0	350	0	200	24	70	70	4	1	1,000,000	0.15	100	12	1	2	100	3532.2	20.4	$8,383.56	$11,915.76	$9,382.40
Haifa-Beirut	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	0	1,000,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Aqaba-Beirut	0.4	6223	100	1.02	0	640	0	500	24	70	70	**1**	**1**	1,000,000	0.15	0	11	0	0	0	3742	13.7	$5,640.40	**$9,382.40**	

APPENDIX C-4

Total Transport Logistics Cost for shipping from Hong Kong to DAMASCUS via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	50,000	0.05	100	12	1	2	100	3570.2	19.4	$132.88	$3,703.08	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	50,000	0.05	100	12	1	2	100	3346.8	19.7	$134.68	**$3,481.48**	$3,481.48
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	50,000	0.05	0	11	0	0	0	3389.2	17.2	$117.61	$3,506.81	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	50,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	75,000	0.05	100	12	1	2	100	3570.2	19.4	$199.32	$3,769.52	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	75,000	0.05	100	12	1	2	100	3346.8	19.7	$202.02	**$3,548.82**	$3,548.82
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	75,000	0.05	0	11	0	0	0	3389.2	17.2	$176.42	$3,565.62	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	75,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	100,000	0.05	100	12	1	2	100	3570.2	19.4	$265.75	$3,835.95	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	100,000	0.05	100	12	1	2	100	3346.8	19.7	$269.36	**$3,616.16**	$3,616.16
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	100,000	0.05	0	11	0	0	0	3389.2	17.2	$235.22	$3,624.42	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	100,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	125,000	0.05	100	12	1	2	100	3570.2	19.4	$332.19	$3,902.39	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	125,000	0.05	100	12	1	2	100	3346.8	19.7	$336.70	**$3,683.50**	$3,683.23
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	125,000	0.05	0	11	0	0	0	3389.2	17.2	$294.03	**$3,683.23**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	125,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	150,000	0.05	100	12	1	2	100	3570.2	19.4	$398.63	$3,968.83	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	150,000	0.05	100	12	1	2	100	3346.8	19.7	$404.04	$3,750.84	$3,742.04
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	150,000	0.05	0	11	0	0	0	3389.2	17.2	$352.84	**$3,742.04**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	

APPENDIX C-5

Total Transport Logistics Cost for shipping from Hong Kong to DAMASCUS via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	50,000	0.08	100	12	1	2	100	3570.2	19.4	$199.32	$3,769.52	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	50,000	0.08	100	12	1	2	100	3346.8	19.7	$202.02	**$3,548.82**	$3,548.82
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	50,000	0.08	0	11	0	0	0	3389.2	17.2	$176.42	$3,565.62	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	50,000	0.08	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	75,000	0.08	100	12	1	2	100	3570.2	19.4	$298.97	$3,869.17	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	75,000	0.08	100	12	1	2	100	3346.8	19.7	$303.03	**$3,649.83**	$3,649.83
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	75,000	0.08	0	11	0	0	0	3389.2	17.2	$264.63	$3,653.83	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	75,000	0.08	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	100,000	0.08	100	12	1	2	100	3570.2	19.4	$398.63	$3,968.83	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	100,000	0.08	100	12	1	2	100	3346.8	19.7	$404.04	$3,750.84	$3,742.04
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	100,000	0.08	0	11	0	0	0	3389.2	17.2	$352.84	**$3,742.04**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	100,000	0.08	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	125,000	0.08	100	12	1	2	100	3570.2	19.4	$498.29	$4,068.49	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	125,000	0.08	100	12	1	2	100	3346.8	19.7	$505.04	$3,851.84	$3,830.25
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	125,000	0.08	0	11	0	0	0	3389.2	17.2	$441.05	**$3,830.25**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	125,000	0.08	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	150,000	0.08	100	12	1	2	100	3570.2	19.4	$597.95	$4,168.15	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	150,000	0.08	100	12	1	2	100	3346.8	19.7	$606.05	$3,952.85	$3,918.46
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	150,000	0.08	0	11	0	0	0	3389.2	17.2	$529.26	**$3,918.46**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.08	100	12	1	2	100	n/a	n/a	n/a	n/a	

APPENDIX C-6

Total Transport Logistics Cost for shipping from Hong Kong to DAMASCUS via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	50,000	0.1	100	12	1	2	100	3570.2	19.4	$265.75	$3,835.95	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	50,000	0.1	100	12	1	2	100	3346.8	19.7	$269.36	**$3,616.16**	$3,616.16
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	50,000	0.1	0	11	0	0	0	3389.2	17.2	$235.22	$3,624.42	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	50,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	75,000	0.1	100	12	1	2	100	3570.2	19.4	$398.63	$3,968.83	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	75,000	0.1	100	12	1	2	100	3346.8	19.7	$404.04	$3,750.84	$3,742.04
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	75,000	0.1	0	11	0	0	0	3389.2	17.2	$352.84	**$3,742.04**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	75,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	100,000	0.1	100	12	1	2	100	3570.2	19.4	$531.51	$4,101.71	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	100,000	0.1	100	12	1	2	100	3346.8	19.7	$538.71	$3,885.51	$3,859.65
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	100,000	0.1	0	11	0	0	0	3389.2	17.2	$470.45	**$3,859.65**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	100,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	125,000	0.1	100	12	1	2	100	3570.2	19.4	$664.38	$4,234.58	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	125,000	0.1	100	12	1	2	100	3346.8	19.7	$673.39	$4,020.19	**$3,977.26**
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	125,000	0.1	0	11	0	0	0	3389.2	17.2	$588.06	**$3,977.26**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	125,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	150,000	0.1	100	12	1	2	100	3570.2	19.4	$797.26	$4,367.46	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	150,000	0.1	100	12	1	2	100	3346.8	19.7	$808.07	$4,154.87	$4,094.87
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	150,000	0.1	0	11	0	0	0	3389.2	17.2	$705.67	**$4,094.87**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	

APPENDIX C-7

Total Transport Logistics Cost for shipping from Hong Kong to DAMASCUS via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	50,000	0.15	100	12	1	2	100	3570.2	19.4	$398.63	$3,968.83	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	50,000	0.15	100	12	1	2	100	3346.8	19.7	$404.04	$3,750.84	$3,742.04
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	50,000	0.15	0	11	0	0	0	3389.2	17.2	$352.84	**$3,742.04**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	50,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	75,000	0.15	100	12	1	2	100	3570.2	19.4	$597.95	$4,168.15	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	75,000	0.15	100	12	1	2	100	3346.8	19.7	$606.05	$3,952.85	$3,918.46
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	75,000	0.15	0	11	0	0	0	3389.2	17.2	$529.26	**$3,918.46**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	75,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	100,000	0.15	100	12	1	2	100	3570.2	19.4	$797.26	$4,367.46	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	100,000	0.15	100	12	1	2	100	3346.8	19.7	$808.07	$4,154.87	$4,094.87
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	100,000	0.15	0	11	0	0	0	3389.2	17.2	$705.67	**$4,094.87**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	100,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	125,000	0.15	100	12	1	2	100	3570.2	19.4	$996.58	$4,566.78	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	125,000	0.15	100	12	1	2	100	3346.8	19.7	$1,010.09	$4,356.89	$4,271.29
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	125,000	0.15	0	11	0	0	0	3389.2	17.2	$882.09	**$4,271.29**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	125,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	150,000	0.15	100	12	1	2	100	3570.2	19.4	$1,195.89	$4,766.09	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	150,000	0.15	100	12	1	2	100	3346.8	19.7	$1,212.11	$4,558.91	$4,447.71
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	150,000	0.15	0	11	0	0	0	3389.2	17.2	$1,058.51	**$4,447.71**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.15	100	12	1	2	100	n/a	n/a	n/a	n/a	

Total Transport Logistics Cost for shipping from Hong Kong to DAMASCUS via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	150,000	0.05	100	12	1	2	100	3570.2	19.4	$398.63	$3,968.83	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	150,000	0.05	100	12	1	2	100	3346.8	19.7	$404.04	$3,750.84	$3,742.04
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	150,000	0.05	0	11	0	0	0	3389.2	17.2	$352.84	**$3,742.04**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	200,000	0.05	100	12	1	2	100	3570.2	19.4	$531.51	$4,101.71	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	200,000	0.05	100	12	1	2	100	3346.8	19.7	$538.71	$3,885.51	$3,859.65
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	200,000	0.05	0	11	0	0	0	3389.2	17.2	$470.45	**$3,859.65**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	200,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	250,000	0.05	100	12	1	2	100	3570.2	19.4	$664.38	$4,234.58	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	250,000	0.05	100	12	1	2	100	3346.8	19.7	$673.39	$4,020.19	$3,977.26
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	250,000	0.05	0	11	0	0	0	3389.2	17.2	$588.06	**$3,977.26**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	250,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	300,000	0.05	100	12	1	2	100	3570.2	19.4	$797.26	$4,367.46	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	300,000	0.05	100	12	1	2	100	3346.8	19.7	$808.07	$4,154.87	$4,094.87
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	300,000	0.05	0	11	0	0	0	3389.2	17.2	$705.67	**$4,094.87**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	300,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	350,000	0.05	100	12	1	2	100	3570.2	19.4	$930.14	$4,500.34	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	350,000	0.05	100	12	1	2	100	3346.8	19.7	$942.75	$4,289.55	$4,212.49
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	350,000	0.05	0	11	0	0	0	3389.2	17.2	$823.29	**$4,212.49**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	350,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	

APPENDIX C-9

Total Transport Logistics Cost for shipping from Hong Kong to DAMASCUS via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	150,000	0.1	100	12	1	2	100	3570.2	19.4	$797.26	$4,367.46	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	150,000	0.1	100	12	1	2	100	3346.8	19.7	$808.07	$4,154.87	$4,094.87
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	150,000	0.1	0	11	0	0	0	3389.2	17.2	$705.67	**$4,094.87**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	200,000	0.1	100	12	1	2	100	3570.2	19.4	$1,063.01	$4,633.21	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	200,000	0.1	100	12	1	2	100	3346.8	19.7	$1,077.43	$4,424.23	$4,330.10
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	200,000	0.1	0	11	0	0	0	3389.2	17.2	$940.90	**$4,330.10**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	200,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	250,000	0.1	100	12	1	2	100	3570.2	19.4	$1,328.77	$4,898.97	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	250,000	0.1	100	12	1	2	100	3346.8	19.7	$1,346.78	$4,693.58	$4,565.32
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	250,000	0.1	0	11	0	0	0	3389.2	17.2	$1,176.12	**$4,565.32**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	250,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	300,000	0.1	100	12	1	2	100	3570.2	19.4	$1,594.52	$5,164.72	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	300,000	0.1	100	12	1	2	100	3346.8	19.7	$1,616.14	$4,962.94	$4,800.55
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	300,000	0.1	0	11	0	0	0	3389.2	17.2	$1,411.35	**$4,800.55**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	300,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Damascus	0.4	6688	100	1.7	0	350	0	0	24	70	70	4	0	350,000	0.1	100	12	1	2	100	3570.2	19.4	$1,860.27	$5,430.47	
Beirut-Damascus	0.4	6607	100	1.02	0	200	0	200	24	70	70	2	2.5	350,000	0.1	100	12	1	2	100	3346.8	19.7	$1,885.50	$5,232.30	$5,035.77
Aqaba-Damascus	0.4	6223	100	1	0	550	0	250	24	70	70	3	2.5	350,000	0.1	0	11	0	0	0	3389.2	17.2	$1,646.57	**$5,035.77**	
Haifa-Damascus	0.4	6548	100	n/a	0	n/a	0	0	24	70	70	2	n/a	350,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	

Total Transport Logistics Cost for shipping from Hong Kong to TEL AVIV via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	50,000	0.05	100	12	1	2	100	3459.2	17.0	$116.49	**$3,575.69**	$3,575.69
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	50,000	0.05	0	11	0	0	0	3489.2	13.6	$93.03	$3,582.23	
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	50,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	50,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	65,000	0.05	100	12	1	2	100	3459.2	17.0	$151.44	**$3,610.64**	$3,610.14
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	65,000	0.05	0	11	0	0	0	3489.2	13.6	$120.94	**$3,610.14**	
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	65,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	65,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	80,000	0.05	100	12	1	2	100	3459.2	17.0	$186.39	$3,645.59	$3,638.04
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	80,000	0.05	0	11	0	0	0	3489.2	13.6	$148.84	**$3,638.04**	
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	80,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	80,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	95,000	0.05	100	12	1	2	100	3459.2	17.0	$221.34	$3,680.54	$3,665.95
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	95,000	0.05	0	11	0	0	0	3489.2	13.6	$176.75	**$3,665.95**	
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	95,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	95,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	110,000	0.05	100	12	1	2	100	3459.2	17.0	$256.28	$3,715.48	$3,693.86
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	110,000	0.05	0	11	0	0	0	3489.2	13.6	$204.66	**$3,693.86**	
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	110,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	110,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	125,000	0.05	100	12	1	2	100	3459.2	17.0	$291.23	$3,750.43	$3,721.77
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	125,000	0.05	0	11	0	0	0	3489.2	13.6	$232.57	**$3,721.77**	
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	125,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	125,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	

Total Transport Logistics Cost for shipping from Hong Kong to TEL AVIV via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	50,000	0.075	100	12	1	2	100	3459.2	17.0	$174.74	$3,633.94	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	50,000	0.075	0	11	0	0	0	3489.2	13.6	$139.54	**$3,628.74**	$3,628.74
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	50,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	50,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	65,000	0.075	100	12	1	2	100	3459.2	17.0	$227.16	$3,686.36	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	65,000	0.075	0	11	0	0	0	3489.2	13.6	$181.40	**$3,670.60**	$3,670.60
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	65,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	65,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	80,000	0.075	100	12	1	2	100	3459.2	17.0	$279.58	$3,738.78	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	80,000	0.075	0	11	0	0	0	3489.2	13.6	$223.27	**$3,712.47**	$3,712.47
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	80,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	80,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	95,000	0.075	100	12	1	2	100	3459.2	17.0	$332.00	$3,791.20	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	95,000	0.075	0	11	0	0	0	3489.2	13.6	$265.13	**$3,754.33**	$3,754.33
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	95,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	95,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	110,000	0.075	100	12	1	2	100	3459.2	17.0	$384.42	$3,843.62	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	110,000	0.075	0	11	0	0	0	3489.2	13.6	$306.99	**$3,796.19**	$3,796.19
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	110,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	110,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	125,000	0.075	100	12	1	2	100	3459.2	17.0	$436.85	$3,896.05	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	125,000	0.075	0	11	0	0	0	3489.2	13.6	$348.86	**$3,838.06**	$3,838.06
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	125,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	125,000	0.075	100	12	1	2	100	n/a	n/a	n/a	n/a	

Total Transport Logistics Cost for shipping from Hong Kong to TEL AVIV via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	50,000	0.1	100	12	1	2	100	3459.2	17.0	$232.98	$3,692.18	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	50,000	0.1	0	11	0	0	0	3489.2	13.6	$186.06	**$3,675.26**	$3,675.26
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	50,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	50,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	65,000	0.1	100	12	1	2	100	3459.2	17.0	$302.88	$3,762.08	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	65,000	0.1	0	11	0	0	0	3489.2	13.6	$241.87	**$3,731.07**	$3,731.07
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	65,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	65,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	80,000	0.1	100	12	1	2	100	3459.2	17.0	$372.78	$3,831.98	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	80,000	0.1	0	11	0	0	0	3489.2	13.6	$297.69	**$3,786.89**	$3,786.89
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	80,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	80,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	95,000	0.1	100	12	1	2	100	3459.2	17.0	$442.67	$3,901.87	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	95,000	0.1	0	11	0	0	0	3489.2	13.6	$353.51	**$3,842.71**	$3,842.71
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	95,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	95,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	110,000	0.1	100	12	1	2	100	3459.2	17.0	$512.57	$3,971.77	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	110,000	0.1	0	11	0	0	0	3489.2	13.6	$409.32	**$3,898.52**	$3,898.52
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	110,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	110,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	125,000	0.1	100	12	1	2	100	3459.2	17.0	$582.46	$4,041.66	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	125,000	0.1	0	11	0	0	0	3489.2	13.6	$465.14	**$3,954.34**	$3,954.34
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	125,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	125,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	

Total Transport Logistics Cost for shipping from Hong Kong to TEL AVIV via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	150,000	0.05	100	12	1	2	100	3459.2	17.0	$349.48	$3,808.68	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	150,000	0.05	0	11	0	0	0	3489.2	13.6	$279.08	**$3,768.28**	$3,768.28
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	150,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	175,000	0.05	100	12	1	2	100	3459.2	17.0	$407.72	$3,866.92	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	175,000	0.05	0	11	0	0	0	3489.2	13.6	$325.60	**$3,814.80**	$3,814.80
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	175,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	175,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	200,000	0.05	100	12	1	2	100	3459.2	17.0	$465.97	$3,925.17	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	200,000	0.05	0	11	0	0	0	3489.2	13.6	$372.11	**$3,861.31**	$3,861.31
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	200,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	200,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	225,000	0.05	100	12	1	2	100	3459.2	17.0	$524.22	$3,983.42	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	225,000	0.05	0	11	0	0	0	3489.2	13.6	$418.63	**$3,907.83**	$3,907.83
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	225,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	225,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	250,000	0.05	100	12	1	2	100	3459.2	17.0	$582.46	$4,041.66	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	250,000	0.05	0	11	0	0	0	3489.2	13.6	$465.14	**$3,954.34**	$3,954.34
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	250,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	250,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	350,000	0.05	100	12	1	2	100	3459.2	17.0	$815.45	$4,274.65	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	350,000	0.05	0	11	0	0	0	3489.2	13.6	$651.20	**$4,140.40**	$4,140.40
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	350,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	350,000	0.05	100	12	1	2	100	n/a	n/a	n/a	n/a	

Total Transport Logistics Cost for shipping from Hong Kong to TEL AVIV via different routes

	a	D_{hn}	R_n	$ß_{ne1}$	$ß_{ne2}$	D_{nxt1}	D_{xet2}	O_x	S_s	S_t	S_t	H_n	H_x	V_i	?	?	H_s	H_z	H_h	F	C_1	H_{total}	C_2	TC	min (TC)
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	150,000	0.1	100	12	1	2	100	3459.2	17.0	$698.95	$4,158.15	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	150,000	0.1	0	11	0	0	0	3489.2	13.6	$558.17	**$4,047.37**	$4,047.37
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	150,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	150,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	175,000	0.1	100	12	1	2	100	3459.2	17.0	$815.45	$4,274.65	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	175,000	0.1	0	11	0	0	0	3489.2	13.6	$651.20	**$4,140.40**	$4,140.40
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	175,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	175,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	200,000	0.1	100	12	1	2	100	3459.2	17.0	$931.94	$4,391.14	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	200,000	0.1	0	11	0	0	0	3489.2	13.6	$744.22	**$4,233.42**	$4,233.42
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	200,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	200,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	225,000	0.1	100	12	1	2	100	3459.2	17.0	$1,048.43	$4,507.63	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	225,000	0.1	0	11	0	0	0	3489.2	13.6	$837.25	**$4,326.45**	$4,326.45
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	225,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	225,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	250,000	0.1	100	12	1	2	100	3459.2	17.0	$1,164.92	$4,624.12	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	250,000	0.1	0	11	0	0	0	3489.2	13.6	$930.28	**$4,419.48**	$4,419.48
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	250,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	250,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Haifa-Tel aviv	0.4	6548	100	4.5	0	120	0	0	24	70	70	2	0	350,000	0.1	100	12	1	2	100	3459.2	17.0	$1,630.89	$5,090.09	
Aqaba-Tel aviv	0.4	6223	100	1	4.5	400	100	50	24	70	70	1	1	350,000	0.1	0	11	0	0	0	3489.2	13.6	$1,302.39	**$4,791.59**	$4,791.59
Beirut-Tel aviv	0.4	6607	100	n/a	0	n/a	0	0	24	70	70	2	n/a	350,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	
Lattakia-Tel aviv	0.4	6688	100	n/a	0	n/a	0	0	24	70	70	4	n/a	350,000	0.1	100	12	1	2	100	n/a	n/a	n/a	n/a	