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# THE PANAMA CANAL

# THE GATEWAY BETWEEN THE ATLANTIC AND THE PACIFIC OCEAN

**A case study**

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**Master Profile: International Business**

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# ABSTRACT

The Panama Canal is established as one of the major service providers in the maritime business today. However, with an annual demand growth of 3% and the trend in international shipbuilding industry being to produce larger and larger vessels, the requirements toward the Canal is changing. The Panama Canal has responded to these new challenges with launching a transit booking slot auction service, together with an expansion plan for the Canal, which will more than double the capacity when finalized in 2014. This thesis discusses the background for the expansion plan and the question about how the new transit booking slot auction can be used to handle the demand for transits through the Canal when the demand eventually becomes larger than the maximum capacity.

# PREFACE

This master thesis is written as part of my Master of Science in Economics and Business Administration at the Norwegian School of Economics and Business Administration. The process of selecting the area to focus on, specifying the topic, collecting information and the writing process itself has been an interesting challenge which I now can look back on as a process filled with new learning's.

It has been a long process from when I first decided on which area to focus on, with modifications and innovations along the road. However, I am happy with the result and I think the thesis will give the reader a deeper understanding of the importance of the Panama Canal in international trade and the services it provides towards its customers. As some of the highlights of the thesis I would like to mention the more in-dept calculations where the Panama Canal is compared with alternative routes and the part looking at the transit booking slot auction and how this can be used to handle the growing demand for canal transits before the expansion is finalized.

In my work with this thesis there are certain persons that have made a special contribution, so I would like to use this opportunity to thank my supervisor, Siri Pettersen Strandenes, which has given me advises from the first beginning, when I still had not decided on the topic, and followed me during the process with feedback and tips. The other special contributor is my dear Lillian Akselvoll Solsvik, which has played a priceless role as motivator and given me assistance. In the end I would like to thank my family, fellow students and friends for their helpful comments.

Vienna, June 2008

Jon Tarjei Kråkenes

# Table of Contents

## List of Figures



## List of Tables

# Abbreviations

| | |
|---|---|
| **ACP** | **The Panama Canal Authority** |
| **DWT** | **Dead Weight Tonnage** |
| **PCUMS** | **The Panama Canal Universal Measurement System** |
| **TEU** | **Twenty-foot Equivalent Unit** |
| **ULCC** | **Ultra Large Crude Carrier** |
| **VCF** | **Voyage Cash Flow Analysis** |
| **VLCC** | **Very Large Crude Carrier** |
| **WTO** | **World Trade Organisation** |

# INTRODUCTION

The Panama Canal has established itself as a major service provider for the maritime business and is today the most important all-water-way connection between the Pacific Ocean and the Atlantic Ocean. After the return of the Canal on the 31st of December 1999 to the Republic of Panama from the United States, who controlled the Canal since it opened in 1914, the Authority of the Panama Canal has changed the objectives for the operations of the Canal toward more market oriented operations. This has given good economic results, as well as more stable and reliable services are provided to its customers.

What makes the Panama Canal an interesting case to study is related to its position as a leading service provider for the maritime business and the challenges the Canal faces with a growing demand for its services and the trend of larger and larger vessels making the Canal impose a size restriction on the vessels using the Canal. The Authority the Panama Canal has taken action to meet the growing demand and to handle the new restrictions imposed by the new post-Panamax vessels, with the expansion plan for the Panama Canal. This project, which was accepted by the Panamanian people through a referendum on the 22nd of October 2006, will when finished in 2014 be able to handle the new post-Pannamax vessels and have a capacity twice as high as today, and will make the Panama Canal an even more important service provider for the maritime business.

This paper aims to educate the reader about the role of the Panama Canal in the maritime business, with giving an understanding of the maritime business that is relevant for the Canal and how the Canal provides its services towards its customers. It describes how the Authority the Panama Canal handles the challenges the Panama Canal faces with a growing demand, which will exceed the maximum capacity sometime between 2009 and 2012, and the challenge regarding the size restrictions the Canal imposes on routes operated by post-Panamax vessels.

The paper is divided into three parts; part I gives a general understanding of the market the Panama Canal offer its services towards and look at the different market segments that are of importance to the Panama Canal. Part II focuses more specific on the Panama Canal, giving an understanding of how the Canal is operated, what is seen as the Canal's main competitors and the already mentioned expansion plan. The operations of the Canal is covered in details with a chapter outlining the Transit Reservation System of the Panama Canal, with the different ways the customers are able to book a transit through the Canal. Here, the part about the transit booking slot auction is of special interest due to the possibilities this booking option could offer when the Canal will face a demand higher than its capacity. These possibilities are further discussed in the third part of this paper. In addition to discussing the possibilities the transit booking slot auction offers, with a higher than maximum demand, Part III consists of concluding remarks on the earlier discussed topics, with the authors own key points regarding the expansion of the Panama Canal.

# PART I

## 1. International Trade

### *1.1 International and Seaborne Trade History*

One of the most important factors in international trade has been the development of seaborne trade. From the very first beginning when mankind started to explore the sea, the importance of shipping and seaborne trade have only grown and today shipping accounts for almost two thirds of the transportation related to world trade (Kumar & Hoffman, 2002). From the beginning of the world history of shipping, which can be traced back more than 5000 years, and until today, it has been a journey with a huge impact on the world history in general and especially for the development in world trade. As the world as a whole has developed through history and become more globalised, the history of shipping has developed in similar patterns. This connection can be seen in the Westline-theory, outlined by Stopford (1997), which shows that the centre of the trading world, which is also the centre of the shipping world, has shifted westward from its point of origin in the area of the Middle East in year 2000-3000 BC, through different places in Europe, represented with Athens and Corinth in the Greek era, Rome as the main centre of the Roman Empire, before Venice became the natural trading center of Europe, followed by a shift to the Northern part with a centre in the cities representing the Hanseatic League. Further, when the history of shipping entered a more global stage, nations with great merchant fleets, the Dutch and the English, followed each other as the centre of world trade and kept the trend moving westward. Following the rise of the east coast and later the rest of the U.S. as a world power, a shift across the Atlantic Ocean can be seen around the entrance to the 20$^{th}$ century. The westward trend kept on, with Japan becoming a major player in international trade after the Second World War, followed by mainland Asian states in the latest decades. Today's new main player of international trade, China, together with a cluster of rising economies in the South East Asia, are today forming a centre of international and seaborne trade in the area in and around the Chinese Sea.

Together with the shifts of the centre of international trade that the Westline-theory outlines, the international trade can be seen in relation to the globalization process of the world. The trend of increasing international trade is often seen as a consequence and/or a driver for the globalization process of today's world. Globalization in itself can be described in different ways; a common argument is that globalization is linked with the economic development of the world. This leads to an argument that the globalization of the world is unevenly distributed throughout the world.

The link between international trade and globalization can be seen in the historic development of how cities and countries have changed their trade patterns. With a very simplified picture of the world history we can describe three different periods in trade history based on Kumar and Hoffman (2002) theories. The first period which we name the "no-trade period", was a time where all cities and nations produced what they needed and lived by a self serve system. The second period is named the "comparative advantage period" after David Ricardo's trade theory, a period which is characterized by specialization. Each city/nation specialized in producing one kind of goods and traded this with other cities/nations. This period made cities/nations famous for producing special products, such as Detroit for car production and Switzerland for production of watches. The third period, which we name the "global trade period" of today, is characterized by parts of products being produced at different locations, and then assembled at a new location for being shipped to different markets. These three different periods show the world's development from an era without globalization and international trade, through a process with more and more international trade to the globalized world we know today.

### *1.2 The Four Cornerstones of Globalization*

The drive towards a more globalized world is led by different factors, where telecommunication, trade liberalization, international standardization together with transportation has been named the four cornerstones by Kumar and Hoffman (2002). Inventions and developments in telecommunication and transportation techniques make travel, transportation and communication across long distances faster, easier and cheaper. The standardization process makes different markets more alike and foster global competition by simplifying the process of specifying products and services for different markets. Trade liberalization helps opening up access to new markets and resources by reducing trade barriers which are slowing the globalization process.

The growing trend of international trade is of great importance to the transportation business, which heavily depends on international trade in merchandise. The transportation sector was named one of the cornerstones in the process towards a more globalized world by Kumar and Hoffman (2002), and the developments in the transportation sector can be seen as a main factor in the process going from the first time period through the second and to the global trade period of today, as mentioned above. This development is especially related to recent reductions in transportation time and transportation costs. The ability to reduce the cost of transportation for a commodity compared to the finished consumer price and at the same time maintain or lower the time spent on transportation, is one of the main factors behind the growth in international trade and in the globalization process.

With respect to the Panama Canal, all of the four cornerstones are highly relevant due to their importance related to the growth in international trade, and then especially in seaborne trade which influence the Panama Canal directly. The first two cornerstones, telecommunication and trade liberalization are indirectly influencing the Panama Canal through their importance in technology development and new markets taking part in the world trade. The last two corner stones, international standardization and transportation techniques, are directly influencing the Canal. The introduction of international standardization in the field of transportation, which led to the beginning of the container-era in the history of world transportation, had a huge impact on world seaborne trade. This special sector of seaborne trade, containerized cargo, is showed in the official ACP statistics (ACP, 2007i) to be the biggest sector of goods transported through the Panama Canal today, both when looking at revenues generated for the Canal and the numbers of transits through the Canal. Related to the development of transportation techniques the direct impact on the Panama Canal is easily seen from the trend in growing vessel sizes, which is today seen as a barrier for the Canal, since the largest vessels operating in today's seaborne trade are too large to sail through the canal and has to use alternative routes.


**Figure 1.1: World Merchandise Import, 2006**

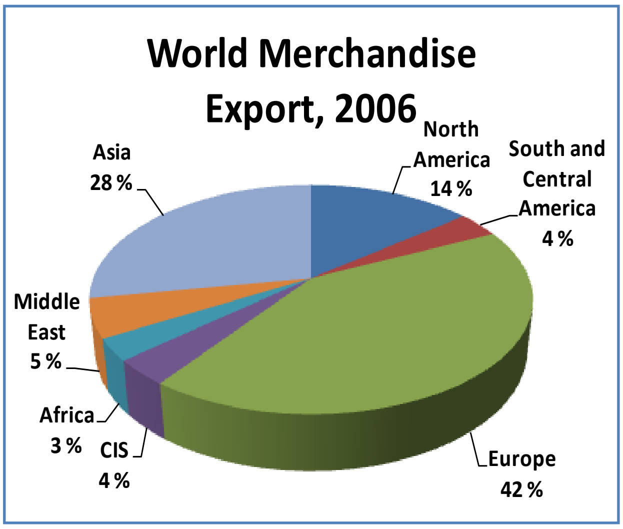


**Figure 1.2: World Merchandise Export, 2006**

Notes:
1. CIS = Commonwealth of Independent States.
2. Both intra- and inter- regional merchandise trade is included.
3. Total World trade: US $ 11.783 bn. = 100%

Source: WTO (2007). Table 1.4. Retrieved 05 16, 2008, from WTO, Resources, Trade Statistics, International Trade Statistics 2007, World trade developments in 2006; Trade by region; Table 1.4 Intra- and inter-regional merchandise trade, 2006: http://www.wto.org/english/res_e/statis_e/its2007_e/its07_world_trade_dev_e.htm

### *1.3 Trade Statistics and Future Outlook*

Looking at the future prospects of international trade it is a clear trend of further growth. The WTO (2007c) shows that the world trade in merchandise has grown by more than 8% in 2006, which outperformed the 3.5% growth in world GDP in 2006. The case with higher growth in merchandise trade than world GDP has been the trend for the last decades, with some exceptions, such as the year 2001, which could be traced back to the September 11th tragedy (Brooks, 2002). When looking more in dept into the trade statistics it is a clear pattern that the world trade is mainly driven by the three core regions Europe, North America and Asia. These three regions are, as we can see in Figure 1.1 and 1.2, involved in more than 87% of the world's imports and 84% of the world's exports of merchandise in 2006, when looking at the value of the trade. A deeper look into the statistics show that out of the total merchandise trade, the intra-regional trade, which is the trade inside one region, in total for these three core regions are as high as 52.6%, with the different regions counting for 7.7% for North America, 30.9% for Europe and 14% for Asia.

The large amount of intra-regional trade represents a huge market for transportation business, but since it is shorter distances and very often trade routes between inland cities, this is a trade segment which in many cases is better handled by land- or air- based transportation, than by seaborne transportation. This can be seen in the North American market, where the geographical layout favors other transportation modes than seaborne transportation. In Europe, which has a geographical layout friendlier toward seaborne trade, seaborne transportation has captured a bigger market share, and has gained an important position in the intra-regional trade (WTO, 2007c). In inter-regional trade, seaborne transportation is suspected to have a favorable position compared to alternative transportation modes, due to the advantages with lower unit-costs and the possibilities of larger volumes. Still with these natural advantages, a negative growth rate was predicted in the demand for seaborne transportation by Brooks (2002). She argued that seaborne transportation would lose market shares in the market of high value goods to airborne transportation, due to the high pressure on short time deliveries, just in time deliveries, cargo security and cargo damages which airborne transportation are argued to handle better than seaborne transportation. These factors are clearly becoming more and more important in the transportation business today, but as they are all important, the seaborne transportation still has the unit-cost advantage which has proven, together with other reasons, to keep the growth rates for seaborne transportation rising. The WTO statistic WTO (2007c) show that Brooks (2002) predictions has only been partly fulfilled in the latest years. They report of a significant increase in seaborne trade since 2000, with a record volume level of transported goods of 7.1 billion tons in 2005. The RS.Platou (2008a) statistics for annual changes in the merchant fleet, which shows the total volume capacity for the world's merchant fleet, shows the same developments. The growth rate for the total volume of the merchant fleet was between 2.8 and 4 percentages in the years between 1992 and 2002, for then after 2002 increasing largely every year, reaching its peak year in 2007, with a growth rate of approximately 8.5 percentages from the year before. It has also been seen a growing trend in the airborne transportation demand as Brooks (2002) predicted, but instead of taking market shares from the seaborne transportation, it has increased simultaneously. The growth in the demand for both seaborne and airborne transportation reflects a shift in the demand curve for transportation in general, where the demand curve is expected to have shifted outward reflecting the growing market for transportation. The growing market can be traced back to the profitable economic times that have been seen in the last years, which have increased the number of consumers and the total volume of goods traded, and therefore the demand for transportation in total.

### *1.4 The World Trade's influence on the Panama Canal*

The increase in total volume transported by sea is a positive trend for the Panama Canal and gives promising outlook for a growing demand for the Canals services. The Panama Canals main customers comes from the segments of seaborne transportation serving the inter-regional trade, however with its location in the region of South and Central America and close to the core region of North America, the Canal also offer an option toward intra-regional trade in these two regions. The intra-regional market in North America is not expected to be a large market, due to the geographical layout as mentioned before. WTO (2007c) reports that seaborne transportation accounted for less than 10% of the value of export of transportation services in the United States in 2005. The ACP (2007a) and ACP (2007b) confirm that the intra-regional market in the United States only accounts for a very small share of the volume transiting the Canal, in 2005 the amount was 0.72% of total volume in routes from the East Coast to the West Coast of the United States and 0.88% in the opposite direction.

The other region which naturally influences the demand for canal transits is the region of South and Central America. This region is reported by the WTO (2007a) to have had a higher growth in volume of merchandise trade in the last six years, from 2000 to 2006, than both Europe and North America. The growth is recorded to be on average 6.1% for imports and 6.4% for exports, with two very strong years in 2005 and 2006, where the growth was recorded to be higher than 14% for the import of merchandise. The high import growth of merchandise is related to higher commodity prices, which gives the markets in South and Central America more favorable trade patterns (WTO, 2007c). The growing trend of merchandise trade observed in the South and Central American market gives positive prospects for the Panama Canal, since this is a market of high importance to the Canal.

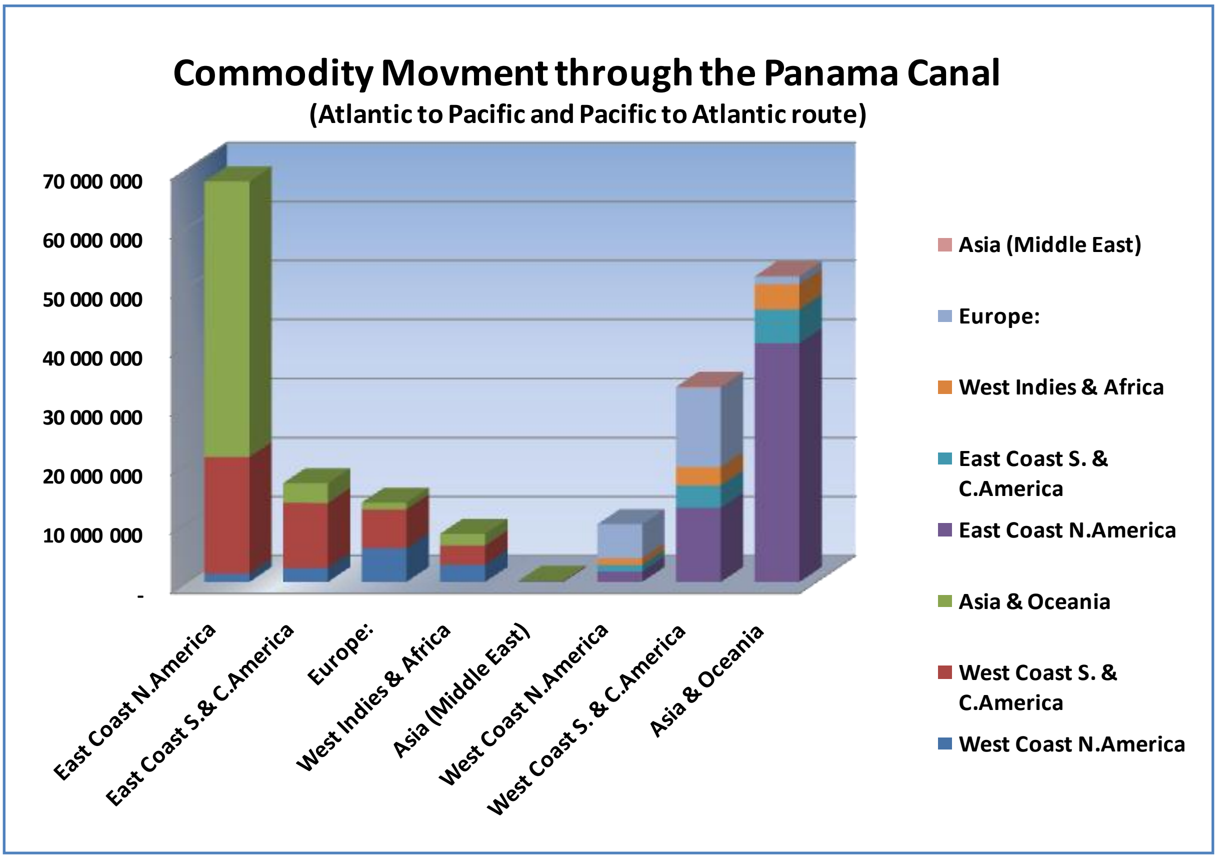


**Figure 1.3: Commodity Movements through the Panama Canal**

Notes:
1. X-axis = exporting country/region.
2. Y-axis = volume transported in long tons for the Fiscal year 2007.
3. The first five posts from the left represent the Atlantic to the Pacific trade routes.
4. The first three posts from the right represent the Pacific to the Atlantic trade routes.

Source: ACP (2007). Commodity Movement, by Country of Origin and Destination (Atlantic to Pacific). Retrieved 05 16, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table08.pdf
ACP (2007). Commodity Movement, by Country of Origin and Destination (Pacific to Atlantic). Retrieved 05 16, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table09.pdf

We can see in figure 1.3 above that South and Central America is ranked as number two from the left, which shows trade routes going through the Canal from the Atlantic side, and as number two from the right side, which shows transits from the Pacific side. In the trade that origins from the East Coast of South and Central America we see that the intra-regional trade within the South and Central America accounts for the largest share; consisting mainly of petroleum and petroleum products, coal and containerized cargo (ACP, 2007c). For the commodity origin from the West Coast of South and Central America we see that the intra-regional trade accounts for a much smaller share, where the inter-regional trade heading toward Europe and the East Coast of North America are the main contributors. These two trade routes, from West Coast South and Central America to Europe and to the East Coast of

North America, are the second and third ranked routes in volume transported through the Canal, in the direction from the Pacific to the Atlantic Ocean, accounting together for approximately 13% of the total goods transported through the Canal (ACP, 2007c) and (ACP, 2007d).

The leading contributors to the demand for transits of the Panama Canal we can see 0are transporters operating between the East Coast of North America and Asia & Oceania, or more specific between the East Coast of the United States and Asia. The total volume of goods between these two destinations accounts for close to 45% of the total goods transported through the Canal, with the route from the East Coast of North America to Asia accounting for 3% more than its return route (ACP, 2007c) and (ACP, 2007d). The fact that the route from the East Coast of North America to Asia has a higher share than the return route could be surprising to some. However looking at the type of goods transported we see that half of this routes volume contains of grain, a cargo type requiring large volumes, where in the other direction cargo with less volume requirements are carried, such as containerized goods, which captures approximately 38% of the total volume on this route. The differences in types of goods transported largely affect such rankings and with another measurement, for example value of goods, the ranking would have looked different.

We see that the demand patterns for intra-regional and inter-regional trade, which we find in seaborne trade today, are reflected in the demand for transits through the Panama Canal, with the inter-regional trade holding a much more important role than the intra-regional trade. It is therefore important for the Panama Canal to focus on the inter-regional trade, which clearly represent the largest potential for the Canal. A focus on inter-regional trade clearly consists of following the trends in this segment, which among others can be found to be a growth in vessel sizes, reflecting the economy of scale advantage which is found here. The growth in vessel sizes that can be seen in seaborne trade in general, but more heavily in inter-regional trade can be seen as a growth potential for the Panama Canal, but also as a disadvantage when the vessel sizes reach a larger size than the Canal can handle. This conflicting outcome makes it very important for the ACP to turn the potential of this trend into an advantage for the Canal. As we know today, this is what the ACP is trying to do with their planned expansion of the Canal, which is covered more in depth later in this paper.

## 2. Segments of Seaborne Trade and their Importance for the Panama Canal

Seaborne trade can be divided into different market segments which each have their own characteristics and represent their own trend. The Panama Canal Authority, APC, are using eight market segments to classify the transport going through the Canal, these segments are (1) the containership, (2) the dry bulk, (3) the vehicle carrier, (4) the liquid bulk, (5) the reefer, (6) the cruise ship, (7) the general cargo vessel and (8) the miscellaneous vessel segment. Out of these eight segments the first four are the ones representing the largest volumes and number of transits through the canal, and play the largest impact on the Canal's revenue (ACP, 2006b). Historically the statistics from the ACP shows that the segment generating most revenue has been the dry bulk segment, consisting of grains, minerals, fertilizers and coal. Next follows the liquid bulk segment, consisting of chemical products, gases and oil derivates. The ranking of the revenue generated by the different segments have changed in the later years and the container segment have gone from being third on the list in mid 1990's, to an undisputable top ranking today (ACP, 2006b). Already in 1997 the container segment passed the liquid bulk segment in revenue generation and in 2002 it had also passed the dry bulk segment and has afterwards followed a steep upward trend in growth. In the fiscal year of 2007 a share of 55 % of the Canals revenues was generated by the containership segment, followed by the dry bulk segment generating 12.5 % of the revenues. In the third spot on the revenue ranking we find today the vehicle carrier segment, which bypassed the liquid bulk segment in 2001, and contributed with 9.5% of the total revenue of the Panama Canal in 2007 (ACP, 2007i). In the following chapter general outlines of the different segments of seaborne trade which are of importance to the Panama Canal are given.

### *2.1 The Dry and Liquid Bulk Segment*

The dry and liquid bulk segments are in many statistics, such as the one presented by the ACP, divided into two segments. However these two segments have some very similar basic components, which make it easy to explain them together as a general bulk segment. The general bulk segment consists of transportation of natural resources such as oil, coal, iron ore and grain. And the patterns of trade in these commodities are mainly decided by where the commodities are located and the demand by the worlds market (Fleming, 2002) s. As seen in the Westline theory outlined earlier, the center for international trade have changed during history, and are closely linked to the industrialization and globalization of different areas of the world. The industrialization process has played an important role in the demand for natural resources and has largely influenced the trade patterns in the bulk segment. It started with the Industrial Revolution in Britain in the $18^{th}$ century, which created an industrial area in Western Europe, and led to a rise in demand for different resources. The industrialization process followed the Westline theory pattern and led to demand for resources rising on the East and the West Coast of America, followed by Asian countries, to a pattern we see today with three core regions, Europe, North America and Eastern Asia. These three regions are today representing the main markets for the different bulk commodities and the demand from these markets largely influence the patterns of seaborne trade in the bulk segment.

The different bulk commodities are characterized by different origin, which give different patterns for the trade routes for each commodity. The trades in crude oil are mainly coming from the huge suppliers in the Middle East, with some supplement from countries in the Caribbean, West and Northern Africa and around the North Sea (Fleming, 2002). These exporters are supplying the three core markets in Europe, North America and Eastern Asia. The trade in crude oil is characterized by the economies of scale in vessel size, and has led to the introduction of VLCC vessels, which carry about 280 000 tons of oil, and ULCC vessels, carrying about 350 000 tons of oil, to serve the trade routes. Such large vessels require special port infrastructure and also set restrictions on which trade routes they can follow. Due to these restrictions the Panama Canal is not a possible trade route for the main trade routes in the crude oil market. The Panama Canal serve some smaller crude oil trade routes, but it only accounts for a very small share of the total volume transported through the Canal. When including other petroleum products, such as gasoline, petroleum coke, and diesel oil, the group becomes more valuable for the Canal, and in the fiscal year of 2007 the group consisting of petroleum and petroleum products accounted for as much as 15% of the total volume transported through the canal (ACP, 2007g).

From the main dry bulk commodities, grains, minerals, fertilizers, coal etc, trade with grain has the biggest impact on the Panama Canal. The grain commodity group has on average for the last three years, 2005-2007, been responsible for approximately 15.5% of the total volume transported through the Canal (ACP, 2007g). Under the grain commodity group, soybeans and corn are the two most important commodities, which both mainly derive from the large export of corn and soybeans from the East Coast of United States to China (ACP, 2007c). Out of the other main dry bulk commodities, the group consisting of ores and metals play an important role. With two trade routes, one origin from the West Coast of South and Central America and one from Asia & Oceania sailing through the Canal with copper and iron, are the most important once. For the transportation of iron ore Fleming (2002) report that a trend similar to the one seen in transportation of crude oil can be found, with a growing volume capacity for the vessels, due to economy of scale in the transportation. This has made the Panama Canal too small to handle the large carrier used in the main trade routes for iron ore, for example between Brazil and the Far East, which is one of the biggest iron ore trade routes.

### *2.2 The Vehicle and Containership segment*

The ACP statistics also divide these two segments in different groups, but the trade patterns have many similarities that make it convenient to explain them together. Both markets are operated by special vessels designed to maximize the loading ability and also to smoothen the loading/offloading work for the vessels. This can be seen from special car carriers that have adjustable decks to maximize the loading capacity of vehicles and from container vessels designed to maximize their capacity of containers so no space are wasted. Another typical similarity and important characteristic of the vehicle and container segment is the liner-service operation. This is a way of operating the vessels by following an around-trip principle that repeats itself; this could be around-the-world journeys or shorter journeys visiting special ports or areas. The liner business depends heavily on punctuality, where the vessels needs to arrive in given ports at given times to be able to serve the customers which again rely on the punctuality for further transportation. With such importance on the time schedule to be followed, these vessels need to rely on smooth service from canal and port providers, such as the Panama Canal. This requires that ACP is able to serve these customers without delays on the time spots pre-booked for the transitions.

The vehicle transportation segment is dominated by the huge manufacturers located in Japan and South Korea and the trade pattern goes mainly from these two East Asian countries to the markets in US and Western Europe (Stopford, 1997). This gives a trade pattern of the main routes from Eastern Asia to Europe through the Suez Canal, from Eastern Asia to the US ports located on the West Coast, or through the Panama Canal to the ports on the East Coast. Another well-used alternative is an around the world route, handling both the European and the American market on one journey. The (ACP, 2007b) statistic confirm the trade patterns of the routes using the Panama Canal, where most of the transits from the vehicle segment transits in the direction from the Pacific towards the Atlantic Ocean, where the trade route from Asia to the East Coast of the US accounts for the largest share. For the Panama Canal, transits in the vehicle segment have in the last years experienced an increase in volume and number of transits, where the number of transits recorded a growth of 9% from 2006 to 2007 (ACP, 2007i). The total tolls paid by the customers in this segment have an even higher increase, recorded to be 11.8% from 2006 to 2007. Making the amount paid by the vehicle segment in 2007 equal to $ 111.584.000, which makes the vehicle segment the third highest contributor to the Canals toll revenue. The number of transits by the vehicle segment only accounted for approximately 6% of the total number of transits and places it as the fifth largest segment on this ranking (ACP, 2007i). The high contribution in tolls compared to the number of transits, is explained by the high PCUMS net tonnage related with the cargo transported in the vehicle segment and the tariff ACP charges for this segment.

The container segment has similar trade patterns as the vehicle segment with a huge supply of goods from the Asian region and two large demanding markets in Northern America and Europe, but here Northern America and Europe also supply an important amount of goods to be delivered in the other core markets. The Asian market is also reported to have a rising demand (Fleming, 2002). The establishment of three core regions for the trade in containerized goods is similar to the establishment of three industrialized regions in the world trade picture. Fleming (2002) reports that the inter-core container transportation in and between these three regions are responsible for more than 70% of the world's seaborne container trade. This shows that the importance of the three core regions is even bigger in the world trade in containerized goods, than it is as a demanding market for the trade in natural resources and bulk traded commodities.

For the Panama Canal the container segment is, as mentioned before, of very high importance. This is easily seen from the contribution to the total amount of tolls generated by the Canal in 2007, where the container segment accounted for 55% (ACP, 2007i). It is not only when it comes to tolls the container segment is topping the ACP rankings, it is also the segment responsible for most transits through the Canal and second when it comes to total volume carried through the Canal, only beaten by the dry bulk segment. Out of the 12.879.000 TEU-containers transported through the Canal in 2007, approximately 60% was transported from the Pacific side through to the Atlantic Ocean. With the Asian market as the clear leader on the supply ranking, followed by the East Coast of the United States, the West Coast of South America and Europe, in this order (ACP, 2007c) and (ACP, 2007d). We see that all the three core regions are important suppliers of containerized goods, and that they also are topping the rankings for deliveries, with the East Coast of the US as the main receiver of the Asian goods, Asia as the main receiver of containerized goods from the East Coast of the US and the West Coast of the US as the main receiver of goods from Europe.

### *2.3 Trade patterns in the Containership market*

With the great importance of the inter core container transportation it is interesting to look at the different trade routes which are relevant for inter core trade. Fleming (2002) constructed three different scenarios from the trade statistics for TEU-containers transported between the three core regions, which can be seen in Table 2.1 below. In Table 2.1 we can see that the busiest route is route 1, which goes between North America and East Asia and with the direction from Asia to America as the busiest directional route. From the load factor estimate we can confirm the assumption of huge supply from East Asia to both North America and Europe. Both these routes represent a load factor of 100, while their return routes only accounts for 58 and 70% of that amount, which confirm that there is more goods transported from Asia to North America and Europe than in the opposite direction.

| | | TEU | Load Factor Est. |
|---|---|---|---|
| Route 1 | North America – East Asia (westbound) | 3,249,809 | 58 |
| Route 1 | East Asia – North America (eastbound) | 5,589,968 | 100 |
| Route 2 | East Asia – Europe (westbound) | 3,893,219 | 100 |
| Route 2 | Europe – East Asia (eastbound) | 2,709,931 | 70 |
| Route 3 | Europe – North America (westbound) | 2,944,063 | 100 |
| Route 3 | North America – Europe (eastbound) | 2,192,503 | 74 |

**Table 2.1: Inter-core container traffic in year 2000**

Notes:

(1) North America includes Canada, US and Mexico
Europe includes all European coasts
East Asia includes northeast and southeast Asia

(2) Route 2 totals do not include en route cargo generated in South Asia and Middle East and carried on vessels not providing end-to-end East Asia – Europe service.

(3) The estimated load factors are simply based on the premise that they are proportional to comparative directional traffic densities. The highest volume direction of each of the three routes is assigned a load factor of 100.

Source: Fleming, D. K. (2002). Patterns of International Ocean Trade. In C. T. Grammenos (Ed.), The Handbook of Maritime Economics and Business (pp. 63-89). London: Lloyds of London Press.

The first scenario Fleming (2002) constructed was a shuttle service operating back-and-forth on each of the three routes as seen in Figure 2.1. In this scenario the Panama Canal plays an important role by imposing a size constraint for route 1 and 3, when East Coast North American ports are served on route 1 and West Coast North American ports are served on route 3. Looking at route 1, where the Panama Canal acts as a constraint due to the vessel size allowed passing through the Canal, post-Panamax containerships are only possible to use when ports on the West Coast of North America are handled. This constraint has acted as one of the strongest arguments for the

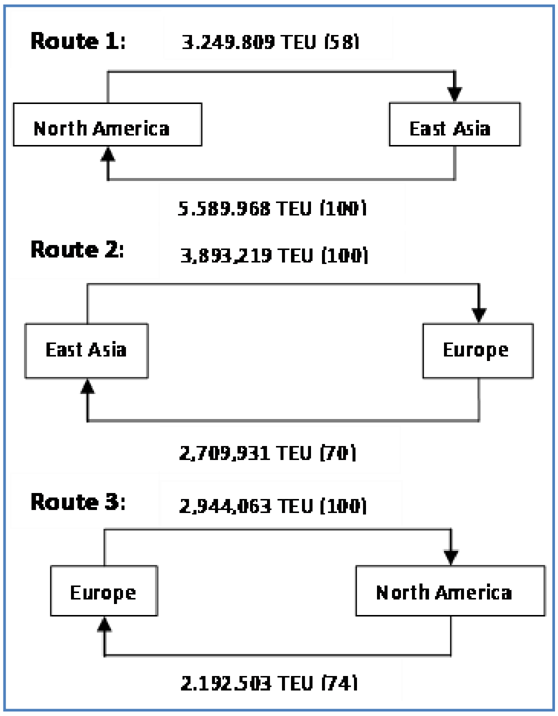


**Figure 2.1: Container Shuttle Service**

Source: Fleming, D. K. (2002). Patterns of International Ocean Trade. In C. T. Grammenos (Ed.), The Handbook of Maritime Economics and Business (pp. 63-89). London: Lloyds of London Press.

expansion of the Panama Canal, since the containership segment see a growing trend in vessel sizes due to the large economies of scale related to transportation of containers. Another problem with the shuttle service is the directional imbalances in the routes, which clearly shows that Asia is shipping out more goods than they imports.

The second scenario from Fleming (2002) is the round-the-world (RTW) service as seen in Figure 2.2. This is a service which is largely influenced by the constraints the Panama Canal opposes upon such services. The Canal is today able to handle vessels with a capacity of about 4800 TEU, while the huge operators in the containership segment already uses vessels with more than double this capacity, with Emma Maersk, with a capacity of 11.000 TEU, as one of the largest in the world today. These mega ships face other constraints than the Panama Canal, such as port access, since it is still only a few container ports that are able to handle vessels of this size. But McGowan (2005) reports a trend of expanding port infrastructure to make the ports able to handle the new mega ships, which again works as an argument for expansion of the Panama Canal. Another potential constraint can be found in the Suez Canal, which offers a similar possibility for vessels as the Panama Canal, only between the Mediterranean Sea and the Red Sea. However the Suez Canal has an advantage compared to the Panama Canal, due to the possibility to handle container vessels with capacities of about 8000 TEU, which makes the Suez Canal a perfect passage way for the route between Asia and Europe, and potentially the East Coast of North America.

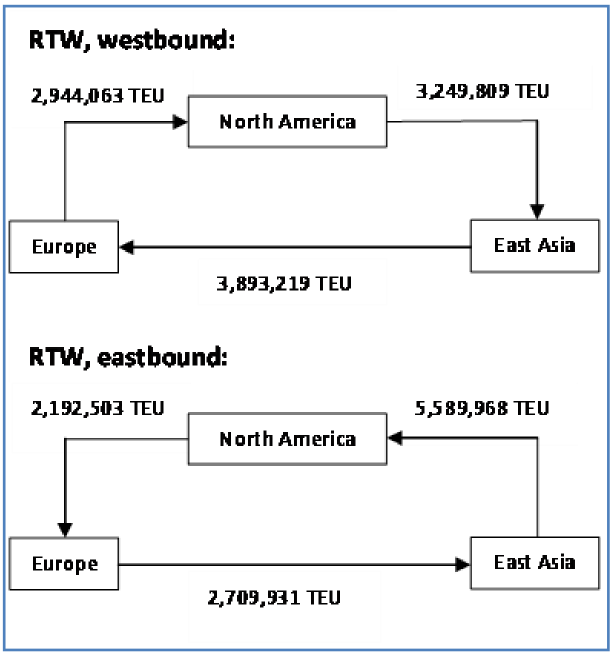


**Figure 2.2: Round-the-World Container Routes**
Source: Fleming, D. K. (2002). Patterns of International Ocean Trade. In C. T. Grammenos (Ed.), The Handbook of Maritime Economics and Business (pp. 63-89). London: Lloyds of London Press.

As the third scenario Fleming (2002) has pendulum services, which is, as Figure 2.3 shows, a service centered on one of the three core regions serving the other two core regions one after another. So each of the three core regions offer an option for a pendulum service, either centered on Europe, North America or East Asia. When combining the three different options with the data from year 2000 presented in Table 2.1 above, we get option a) centered on Europe, b) centered on East Asia and c) on North America. Option a) will have no constraints, except for port constraints, since it does not use the Panama Canal. It will also be the option with the highest load factor on the whole route, since it does not operate on the route from North America to East Asia which have the lowest load factor of the six different routes at 58%. Option b) does not have any other constraints than the port constraints either, when serving the ports on the West Coast of the North America. When East Coast North American ports are served, a constraint on the vessels size applies, due to the transit of the Panama Canal. Option b) is the pendulum route with the lowest total load factor, due to the North America – East Asia route which have far from the same demand as its return route, and leads to a low load factor for the whole pendulum route. On the other hand, option b) is serving the three highest volume routes of the six routes, which means it handles the highest total volume. Option c) is the route heaviest influenced by the size constraint imposed by the Panama Canal, if the route is served by an all-water-way service and does not use the North American intermodal system. Option c) has a bit higher load factor than option b), but it also has a lower total volume to handle than option b) offer, due to the lower volume transported on the North America – Europe trade than on the East Asia – Europe trade.

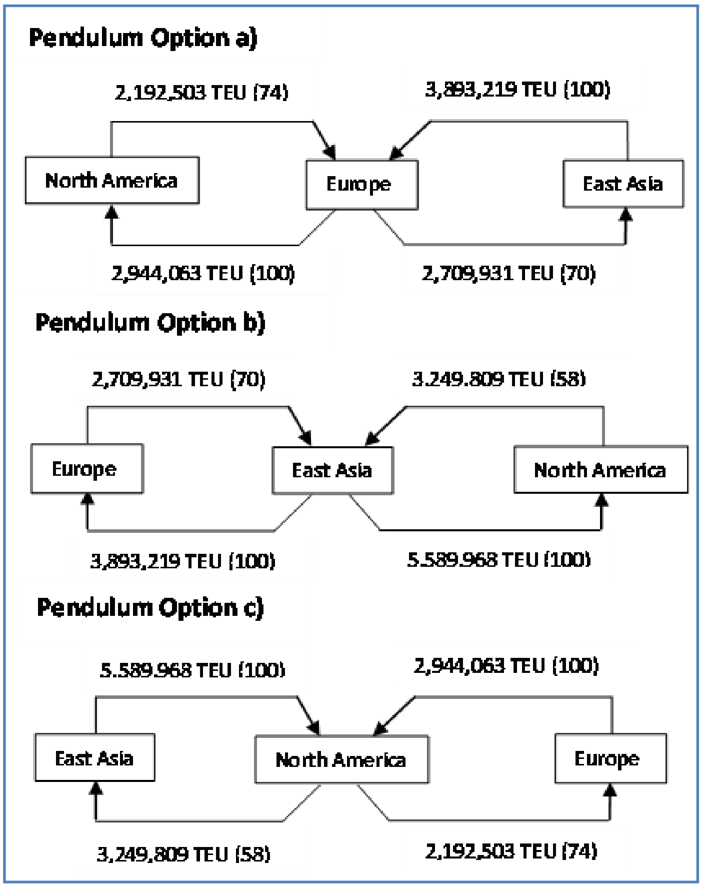


**Figure 2.3: Pendulum Container Routes**

Source: Fleming, D. K. (2002). Patterns of International Ocean Trade. In C. T. Grammenos (Ed.), The Handbook of Maritime Economics and Business (pp. 63-89). London: Lloyds of London Press.

The decision of which type of service, the shuttle, the round-the-world or the pendulum service and which of the different route alternatives for each of the services which is the best to chose for a container operator is very difficult to decide on a general basis, since it depends on many more factors than the trade volume, the load factor and the size constraints related to the different routes mentioned above. Other factors influencing such decisions includes break-even load factors for the vessel used in the operations, revenue yields per filled slot, competition on the different routes and the opportunities and choices of transshipment hubs to serve more markets (Fleming, 2002). The importance of the different route options for the Panama Canal is clearly related to the size constraints the Canal imposes on some of the routes. The container segment, with its huge contribution to Canal revenues, represent a market the ACP has to serve as good as it can, in order not to lose customers to other route alternatives. The size constraints imposed by the Canal on some of the liner-service alternatives was one of the main factors behind the approval of the expansion plan of the Canal.

### *2.4 Other segments with relevance to the Panama Canal*

The four segments outlined above is clearly the most important ones for the Panama Canal, accounting for close to 67% of all the transits of the Canal in 2007 and as much as 85% of the Canal tolls generated in 2007 (ACP, 2007i). Out of the other segments which ACP specifies in their statistics, the refrigerated segment, where bananas and other fruits transported from the West Coast of South America to Europe are the main trade group and route, is the only segment comparable to the big four. The three other segments, named the cruise ship, the general cargo and the miscellaneous segment, accounts for approximately 17% of the total transits of the Canal, with the miscellaneous responsible for 9% of these transits. When it comes to tolls generated by these three segments they only sum up to 9.3% of the total tolls generated, which still is a big number, equal to $ 109.905.000 (ACP, 2007i). They are therefore clearly of value to the Canal, but compared to the other segments they only make a small contribution.

Looking at the statistics from a different angle, and comparing the number of transits with the tolls paid for these transits, it gives a different picture. The container segment remains clearly on top, contributing twice as much to the total tolls paid than to the total numbers of transits. Second follows the vehicle segment just above the passenger segment, which contributes 1.5 and 1.4 times as much to the total tolls as to the total transits. These three segments are the segments consisting of the most valuable goods per volume, and ACP charges a higher toll compared to the other segments. On the other end of this ranking we find the refrigerated and general cargo segment, only contributing 0.3 and 0.4 times to the total tolls compared to the total number of transits. The ACP (2007i) also reveals that the dry bulk segment and the passenger segment are the only two segments which are reported to have a decrease in number of transits of the Canal in 2007 compared to 2006, with the decrease in the dry bulk segment most drastic, reported to be of 12.7%. The dry bulk segment has also seen a decrease in the tolls paid to the ACP, worse than the decrease in number of transits, equal to 13.5%.

The different segments of seaborne trade have clearly different importance to the Panama Canal, and as outlined above the segment which is number one today for the Canal is the container segment. There are different factors that decide if a segment is of importance to the Canal. It is a question about possible trade routes, where are the goods produced? And where is the main market? And the size dimension on the vessels used in this segment. In some of the segments in seaborne trade today the usage of VLCC and ULCC vessels are common on the main trade routes, which then put restrictions on where these vessels can go. The size factor dimension is influencing many of the segments, and is clearly seen as a trend in the container segment as well. This is something which could put the container segments contribution to the Panama Canal in question and has acted as a main driver behind the expansion of the Canal.

# PART II

## 3. The Panama Canal

The Panama Canal have established itself as a major player in the international shipping business, and every year handles more than 14.000 vessels using the Canal's service of transiting the Central American Isthmus from the Atlantic Ocean to the Pacific Ocean or the other way around. In this chapter the basic historical background of the Panama Canal is presented, together with facts about the Canal's dimensions and location. In the end it is given a short explanation of how the administration of the Canal is done.

### *3.1 Canal History*

The history of the Panama Canal as we knows it today goes back to 1904 when the construction of today's Canal started, but long before this date there had been discussions, talks and dreams about a passageway through the narrow land separating the Atlantic and the Pacific Ocean in the Central America. The ACP official Canal History traces these discussions back to the 16th century when the Holy Roman Emperor Charles V, also known as Charles I of Spain, requested a survey of the possibility of a water-route from the Atlantic Ocean to the Pacific Ocean across the Central America Isthmus (ACP, 2001a). This survey concluded that this was an impossible project, but the idea and the dream of a water-way connecting the two Oceans were borne.

ACP (2001a) further outlines that the United States interest in a water-way connecting the two Oceans through the Central America Isthmus did not become very strong before the 19th century. One of the main factors for a growing American interest for a canal was the discovery of gold in California around 1848, which created a tremendous volume of goods to be transported from California to the East part of America. This volume was mainly transported by the Panama Railroad, which was completed at that time, but it the idea about a water-way through the Central America Isthmus was borne. The growing interests for a possible canal led to surveys exploring possible alternatives, with today's canal path only as one of the options. The conclusions of the American surveys were presented in 1876 and favoured an alternative route through Nicaragua, before the Canal route we know today. However the Americans were not alone in showing interest in the possibilities of an all-water-way through the Central America Isthmus. The French performed their own surveys and in March 20, 1878 they signed a treaty with the Colombian Government that ruled over Panama at that time, this gave France an exclusive right to build an inter-oceanic canal through the Panamanian territory.

The French attempt on building the all-water-way canal started the 1st of January 1880, but it ended in a failure, due to different reasons, but with a disagreement about which plan to follow between main engineers as a major reason (ACP, 2001a). The construction era lead to the loss of more than 20.000 workers before the French abounded their plans and sold the remaining of the project to the United States. In the United States the Nicaragua alternative was still a favourite, but after lengthy political processes the Americans agreed with the French about a price for the existing project and also signed a treaty with the newly independent Panamanian government. The treaty granted the United States a 10 miles wide canal zone through the Republic of Panama, to be controlled by the United States and kept under United State sovereignty. Together with a down payment off $ 10 million to the Government of Panama before the signing of the treaty, the support given by the United States to the Panamanian Government when declaring independent from Colombia, were the major reasons for the favourable agreement that the United State signed with Panama (ACP, 2001a).

The construction of the Canal itself was at that time the single most expensive construction project in the United States history, reaching a total cost of $ 375 million, actually around $ 23 million below an estimate from 1907. The lower cost than expected, together with the fact that the project was carried out without any major scandals or corruption episodes, made the construction of the Panama Canal a great success for American engineering. It was of course accidents involved during the construction, but fairly low numbers compared to when the French lead the project, with approximately 5.500 deaths, both accidents and diseases, compared to over 20.000 deaths.

The construction was finished in 1914, with the first ever ocean-going vessel transiting the Canal on the 7th of January 1914. The Americans planed an official opening celebration for the opening of the Canal in August 1914, but due to the World War 1 the opening celebration was never carried out. After its completion, the Canal has gained an important role in world shipping and is today handling transits of more than 14.000 vessels every year, which represents approximately 5 % of the world trade today (ACP, n.d. b).

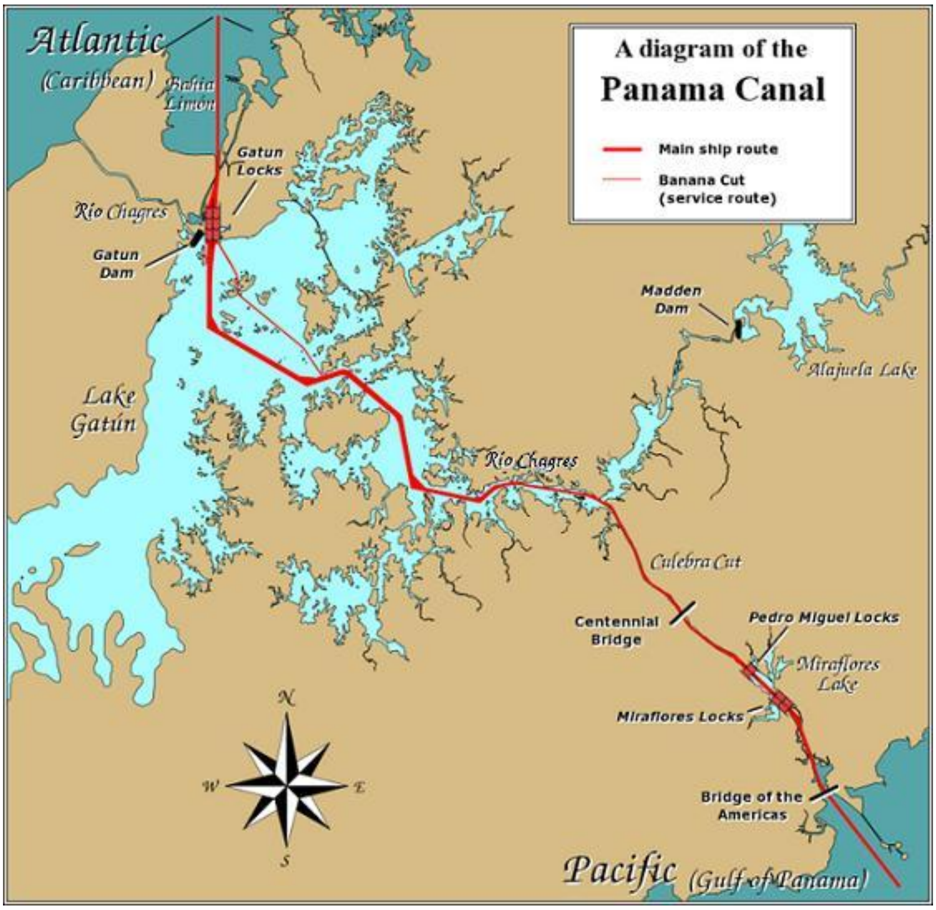


**Figure 3.1: A Diagram of the Panama Canal**
Source: Wikipedia. (2006, 12 26). Panama Canal Map. Retrieved 04 16, 2008, from Wikipedia, Panama Canal: http://en.wikipedia.org/wiki/Image:Panama-Canal-rough-diagram-quick.jpg

### *3.2 Location and Dimensions of the Panama Canal*

The Canal itself is laid out across one of the narrowest saddles of the isthmus of Central America. It has a total length close to 80 kilometers and can be seen in Figure 3.1 entering from the Atlantic Ocean in North stretching through Panama to the Pacific Ocean in South. Entering from the Atlantic Ocean, an entry channel takes you to the first set of locks, the Gatun Locks, lifting you up 26 meters above sea level and letting you into the Gatun Lake. After crossing the Gatun Lake you enters the Chagres River (Rio Chagres on the map), leading to the Gaillard Cut, originally Culebra Cut, but named Gaillard Cut to honor the

American army engineer Major David Du Bose Gaillard, who was in charge of the construction of this part of the Canal (ACP, n.d. b). The Gaillard Cut takes you to the second and third sets of locks, the Pedro Miguel Locks followed by the Miraflores Locks, bringing you down to sea level again so you can enter the Pacific Ocean.

Each of the three lock sets are named after the cities nearby their location. The dimensions of the lock chambers are 33.34 meters wide, 304.8 meter long and with a depth varying between the different Locks, with the 12.55 meters deep chambers in the Pedro Miguel Lock as the one with the lowest depth (ACP, n.d. b). This makes the Pedro Miguel Lock the lock putting restrictions on how deep the vessels that transit the Canal can go in tropical fresh water, which are set to be 12 meter. Other restrictions related to the vessels dimensions are that they are not more than 32.3 meter in beam (wide) or 294.1 meter long (depending on type of vessel). These dimensions represent the size of a vessel classified as a Panamax, which are the biggest vessel-type that can operate trough the Canal today.

### *3.3 Managing the Canal*

The Canal was when it first opened in 1914 administrated by the United States, and it was kept under United States administration until it was officially returned to the Republic of Panama the 31st of December 1999. The return of the Canal to the Republic of Panama had been discussed in many years and already on 7th of September 1977, the United State Government and the Panamanian Government signed the Panama Canal Treaty, agreeing upon a future transfer of the Canal back to the Republic of Panama. The treaty also included an agreement guaranteeing that the Canal should remain open, safe, neutral and accessible to vessels from all nations (ACP, n.d. a). This agreement is the basic of the policies the Panamanian Government uses as Canal policies today. On the 27th of December 1997 the ACP, the Panama Canal Authority, as we know it today was established. Today the ACP, with its chairman Dani Kuzniecky, is the organization establishing policies for operations, improvements and modernizations of the Canal (ACP, 2008a). The ACP has after acquiring the administration of the Canal, turned the operations into a well-functioning business unit acting as a driving force for development and growth in the Republic of Panama. In the fiscal year of 2005 the contribution from the Panama Canal to the National Treasury of Panama was on $489 million, and the estimates are that this amount will increase in the future, reaching close to 4 billion in 2025 (ACP, 2006b). Together with delivering positive economic results, the ACP has also made it important for the Panama Canal to be a safe and reliable provider of services to the maritime business. This can be seen from the new safety record set by the Panama Canal, consisting of only 10 maritime accidents in 2007 out of 14.721 transits, this is a reduction from 29 accidents in the first year ACP operated the Canal in 2000 (ACP, 2008f).

# 4. Alternative Routes

This chapter looks at the alternative routes shipping and transport companies can chose instead of using the Panama Canal. It covers the different options available as all-water-routes today, and give a basic understanding of the main competition from land transport across the North America. It also gives a short look on the future and outlines some possible alternatives that might be offered as alternatives to the Panama Canal. In the end it gives a more in-depth study on the costs related to the different all-water alternatives in comparison to the Panama Canal.


**Figure 4.1: Panama Canal versus the Strait of Magellan Alternative**
Source: Rodrigue, J.-P., Comtois, C., & Slack, B. (2006). The Geography of Transport Systems. New York: Routledge.

## *4.1 All-Water Alternatives*

The most obvious alternative to a transit through the Panama Canal is a route, as seen on Figure 4.1, around South America and the Cape Horn, or through the Magellan Strait, located between Chile and Argentina in South America. This route is at present the only available ocean route that offers an alternative to the Panama Canal regarding sea-transportation from West Coast to East Coast of the North America and back. However this alternative increases the distance between East and West by at least 13.000 kilometers, depending on which ports are served.

Other all-water routes that can be used as alternatives to the Panama Canal are the routes around the Cape of Good Hope south in Africa and the route through the Suez Canal, both of which present alternative routes between Asia and America. The Suez Canal is considered the main competitor to the Panama Canal when considering different routes between Asia and the U.S. East Coast. When calculating the distances between New York and Hong Kong, using the distance calculator from the WorldShippingRegister (2008), the two alternatives differ only with 386 nautical miles (approximately 715 km). With the Panama Canal as the shortest option equal to 11.207 nautical miles (20.755 km). When looking at other Asian ports it is clear that the Suez Canal offer shorter sailing distances between ports in South and Southeast Asia and the U.S. East Coast, while the Panama Canal is shortest route between Northeast Asian ports and the U.S. East Coast.

In addition to the differences in distances between the two Canal alternatives, there is a major factor that are of importance and this factor is in favor of the Suez alternative. The factor here is the size restrictions that affect the size of the ships that are able to pass through the Canal, here the Panama Canal impose a restriction that do not offer vessels larger than a Panamax vessel to use their alternative, while the Suez Canal handles post-Panamax vessels. ACP (2006b) explains these size restrictions by looking at transportation costs for two weekly containership services, one through the Panama Canal and the other through the Suez Canal, both between Northeast Asia and the U.S. East Coast. They show that with Panamax vessels, which are able to carry 4.800 TEU, operating in both routes, the Panama alternative offers a 23% saving in total transportation cost per container (round trip) compared to the Suez alternative. It is important to notice that in the case explained, the Suez alternative has a longer sailing time and therefore also needs more vessels to operate the service. However since the Suez Canal has the possibility to transit post-Panamax vessels, the advantage that the Panama Canal has over the Suez Canal is reduced to a marginal 14% when using post-Panamax vessel with the ability to carry 6.000 TEU through the Suez alternative.

### *4.2 Land-based Alternatives*

The main land-based alternative to the Panama Canal is the U.S. intermodal system, which is a land extension of the Northeast Asia – U.S. West Coast service. This service provides an alternative to the Panama- and the Suez- Canal service for the container-transportation between Northeast Asia and the U.S. East Coast. The main advantages of the intermodal system compared to the Panama Canal is explained to be that the intermodal system can make use of post-Panamax vessels for the sea-transport between Asia and the U.S. West Coast, with the ability to carry more than 10.000 TEU (McGowan, 2005), and that the intermodal system offer the ability to deliver a container from Asia to Chicago 9 days faster compared to any of the all-water alternatives. These advantages are important factors when explaining why the intermodal system in 2004 handled 61% of the Northeast Asia – U.S. East Coast container trade, compared to 38% through the Panama Canal and 1% through the Suez Canal (ACP, 2006b). However it is important to know that this has been a declining trend for the intermodal system from 1999, and similar growth for the Panama Canal (ACP, 2006b). These trends may be explained by a continually reduction of transit times for the Panama Canal, due to repairs and improvements of the Canal.

The intermodal system do not consists of one integrated operating system, but relies on several operators, such as port operators, railroad companies and trucking companies. This lack of one integrated unit makes the intermodal system more unreliable concerning service and also a more costly alternative than the all-water alternatives (ACP, 2006b). Another factor that is important for the intermodal system is the restriction that U.S. West Coast ports may put on the service. In 2003 the two biggest ports in U.S., looking at the number of handled TEU's, Los Angeles and Long Beach, are both located on the West Coast (McGowan, 2005). These two ports were in 2003 handling approximately 1/3 of all container import/export to and from the U.S. It is therefore easy to see that the infrastructure both on these two ports, but also on the intermodal system providing the inland transportation from these ports to the hinterland, needs to be extremely well functioning. The high demand towards the infrastructure may impose a maximum limit for units handled by the ports and lower the efficiency on the intermodal system. These limits are likely to be reached in the future, restricting the amount of containers that can be handled through this route (McGowan, 2005).

### *4.3 Possible Alternatives for the Future*

The ACP (2006b) outlines different potential alternatives which might be invested in to meet the rising demand for goods transported between the Pacific- and the Atlantic- Ocean. Out of these an intermodal connection between ports on the Pacific side of Mexico and Canada and the rail and road system in the U.S., together with an intermodal system across the Central America Isthmus, are the ones ACP sees as the most likely to be carried out. ACP (2006b) explains that a potential intermodal system connecting the Mexican and Canadian

Pacific-ports to the existing intermodal system in U.S. could be beneficiary, since it represents the natural expansion of the consisting intermodal system in the U.S. However they further explain that it will require huge investments and will also have to deal with the coordination of different transport system and cross-border problems.

The other intermodal alternative ACP (2006b) outlines is one crossing the Central American Isthmus, this alternative will have to operate a port on the Pacific side, connected with railroads and roads to a port on the Atlantic side, and then require ships on each side to transport the containers to and from East Coast U.S. and Northeast Asia. By ACP (2006b) this option is seen as a more unreliable, costly and time consuming alternative then the alternative already offered by the Panama Canal. Other studies are documented by Luxner (2007), and reports that the alternative with an intermodal connection across the Central America Isthmus is a valid alternative. He reports that work already is in progress on constructing a port on El-Salvador's Pacific coast, which is going to be connected with two Atlantic ports, one in Guatemala and one in Honduras, via a superhighway. However Luxner (2007) outlines that this alternative will be more a supplement to the Panama Canal than an alternative.

Other alternatives that are discussed which are deemed less possible, includes a route through the Arctic, north of Canada, and a new Central American Canal through Nicaragua along a route explored and even favoured before the Panama Canal was started on in the 19th century. The Arctic alternative is an option which has gained interests due to the global concerns about ice melting in the Arctic, and specific analysis about such alternative has been carried out. Analysis that the ACP (2006b) refers to concludes that such an alternative will at least not be feasible in the nearest 50 years. The other alternative with a construction of a new Canal through the Nicaraguan-route explored before the Panama Canal route, is not a very credible alternative either, due to the large investment required, the fact that Nicaragua is along the poorest countries in Central America and that the project have received many critics both home and abroad (Luxner, 2007).

### *4.4 Costs related to the different All-Water Alternatives*

The comparison of costs in the shipping business requires some standard categories to compare, such categories or classifications, internationally accepted, are hard to find, but Stopford (1997) have outlined five different cost categories all important to the shipping industry:

- Operating Costs: the daily costs of operating the vessel.
- Periodic Maintenance Costs: larger maintenance costs, often related with dry-docking of the vessel.
- Voyage Costs: variable costs related to each voyage, such as port charges, canal dues and fuel costs.
- Capital Costs: costs related to the financing of the vessels.
- Cargo Handling Costs: costs related to loading, stowing and discharging cargo.

The five categories from Stopford (1997) have different affects on the total costs and are used differently, for a comparison of costs related to a decision about route choices, the voyage costs is the main category. The other cost categories can also in special occasions influence decisions, but further in this chapter these categories are kept out of the picture.

To make a comparison easy to work with which give conclusions that make sense, some assumptions needs to me made. The two first assumptions are related to the age and the size of the vessels, which both have major impacts on the operating costs of the vessel. Stopford (1997) outlines that the age-cost relationship relates to the fact that new ships use less fuel, need less maintenance and keeps higher speed, all of which includes lower costs. However at the same time the new ships have higher value, influencing the capital costs and gives higher total costs. The size-cost relationship is explained by Stopford (1997) as the economics of scale related to vessel size; this is a well accepted argument in the shipping business, and Stopford (1997) shows that an increase in vessel size from 30.000 dwt to 150.000 dwt cut the costs per dwt per annum by approximately 2/3. Due to these facts, an assumption is made that the alternative routes used in the comparison are served by identical vessels.

Other assumptions to make are related to the operating speed of the vessel, this again relates to the fuel consumption and the revenues the vessel generates. The operating speed will, when increased, give a shorter travel time which generates higher revenues since more goods are delivered. But at the same time an increase in speed will lead to higher fuel consumption which gives higher costs. These two conflicting patterns are well illustrated in Table 4.1 below, reproduced from Stopford (1997).

| | | Fuel cost saving from slowing down at….. | | Revenue loss by slowing down at….. | |
|---|---|---|---|---|---|
| Speed (Knots) | Fuel Consumption per annum tons | Fuel oil $200/ton $'000 | Fuel oil $100/ton $'000 | Low freight rate $'000 | High freight rate $'000 |
| 14 | 10.176 | --- | --- | --- | --- |
| 13 | 8.184 | 398 | 199 | 224 | 448 |
| 12 | 6.546 | 726 | 363 | 455 | 910 |
| 11 | 5.156 | 1.004 | 502 | 692 | 1.384 |

**Table 4.1: The effect on speed on operating cash flow**
Source: Stopford, M. (1997). Maritime Economics (2 ed.). London and New York: Routledge.

In the table the conflict a ship operator face when he needs to decide which speed the vessel should use is easily seen. It is illustrated with two different fuel costs and also two different freight rates, which in different combinations give different solutions for the optimal speed. Two different cases could be to consider slowing down from 14 to 11 knots with high fuel costs and high freight rates or high fuel costs and low freight rates. The first case would lead to a saving in fuel costs of $ 1.004.000, however at the same time reduced revenue by $ 1.384.000. In total this makes it a bad option for our first case to slow down. The second case have a higher saving from the fuel reduction then the loss of revenue, which makes slowing down profitable with a saving of $ 312.000.

Out of these combinations the importance that the operating speed has on the costs of operating a vessel is seen, and it is easy to understand that different speed could give different solutions, therefore a standard speed of 14 knots is chosen for the following calculations. The fuel prices and the freight rates are dynamic and changing all the time, they therefore need to be carefully monitored and updated for every calculation. The fuel prices also differ from where in the world the fuel is sold based on a demand/supply relation. In the following calculations prices are for IFO 380 and MDO, two standard types of bunker oils, for sale in Houston on the 22nd of April 2008 (BunkerWorld, 2008). A similar pattern for freight rates can be found, where the rates differ from segment to segment, vessel type to vessel type and between different routes. In the calculations done here an average, estimated by RS.Platou (2008b), of the daily freight rates for trip-charters for Panamax Bulk carriers from the beginning of 2008 until week 16 are used.

With these assumptions clarified a Voyage Cash Flow (VCF), based on the outline from Stopford (1997), is performed. In Table 4.2 a full layout of a Voyage Cash Flow for a trip from Los Angeles, on the West Coast of U.S., to Rotterdam, on the Atlantic-coast of the Netherlands, with a Panamax bulk carrier using the Panama Canal to shorten the distance is presented. This example is based on an example from Stopford (1997), but with some modifications and updates, these updates will be further presented in the explanation given about each of the VCF's six sections.

- Section 1, Vessel Information: This is basic information about the vessel, what type of vessel, size, and given operating speed with fuel consumption. Section one also contains the bunker prices which are relevant for the given voyage. These are, based on the information given above, set to $ 504 per ton for main bunkers and $ 1.035 per ton for auxiliary bunkers.
- Section 2, Voyage Information: This is the specific details about the voyage, the loading and unloading port with the distance between them, total days in port for the whole voyage, this number include one extra day, if the voyage goes through the Panama or the Suez Canal. How much cargo is onboard and the freight rate for the given voyage. With the voyage distance and the operating speed from section one, the days at sea are calculated and presented together with total values for the other given information. It is important to know that in this example only a one-way trip between two ports are used for simplicity, but in a real world it is common to have voyages

with many legs, where all the legs are presented with relevant info under this section and also a total voyage sum. The freight rate used here are based on the $/day rates estimated by RS.Platou (2008b), but recalculated to be presented in $/ton. This recalculation is done by calculating the total voyage freight rate from the daily rate multiplied with the shortest possible time for the voyage, and divided by cargo transported. The reason for the recalculation is to easier present the cost differences between the alternative routes.

- Section 3, Days on voyage calculation: This section clarifies the different times used on the voyage. Calculated from the sailing distance, the operating speed, which is given a 5 % error margin due to bad weather conditions etc. and the days used in ports and for Canal transits.
- Section 4, Voyage cash flow: Is a straight forward Cash Flow with income from the voyage on top and the different costs below. It is important to notice that the post Canal dues in section 4.3 is covered separately in section 5. The post 4.5 is left empty due to the fact that operating costs does not have a direct impact on which route alternative that is favorable, since they incur whatever trade the ship is engaged in. The net voyage cash flow presented here is therefore equal to the voyage net earnings.
- Section 5, Panama Canal Dues: This is an extra section compared to the layout in Stopford (1997), and is presented to give a better understanding of the impact the Panama Canal has on the choice of route. The section present the basic cargo tariff that represent the correct segment of the vessel , the bulk cargo segment, and the relevant tariffs valid on the 1st of March 2008. It also includes a Transit Reservation System fee, which implies, in different extent, for all vessels transiting the canal.

**Voyage Cash Flow Analysis for a Los Angeles - Rotterdam trip, through the Panama Canal:**

| 1 | SHIP INFORMATION | | | | | |
|---|---|---|---|---|---|---|
| | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | |
| | | | | *Knots* | *Main* | *Auxiliary* |
| | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | |
| | | | Laden | 14,0 | 33 | 1 |
| | | | Ballast | 14,0 | 31 | 1 |
| | | | In Port | - | 3 | 2 |
| | | | Bunker price $ / ton | | 504 | 1035 |

| 2 | VOYAGE INFORMATION | | | | | |
|---|---|---|---|---|---|---|
| | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* |
| Leg 1 | Los Angeles - Rotterdam | 7.752 | 24,3 | 10 | 62.500 | 33,31 |
| | Total: | **7.752** | **24,3** | 10 | 62.500 | **2.082.171** |

| | | | |
|---|---|---|---|
| 3 | DAYS ON VOYAGE CALCULATIONS | | |
| 3,1 | Charter party speed | 14,0 | (Average for trip) |
| 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| 3,3 | Actual average speed | 13,3 | |
| 3,4 | Voyage distance | 7.752 | (From section 2 above) |
| 3,5 | Loaded days at sea | 24,3 | (tot distance / actual avg speed) |
| 3,6 | Port time & canal transit time | 10 | (From section 2 above) |
| 3,7 | TOTAL DAYS | **34,3** | |
| | | | |
| 4 | VOYAGE CASHFLOW | | |
| 4,1 | Freight Earnings $ | 2.082.171 | (From section 2 above) |
| 4,2 | Less broker's commision | 41.643 | (At 2 per cent) |
| 4,3 | Less voyage costs | | |
| | Bunker oil for main engine | 419.040 | (At consumption in section 1) |
| | Diesel oil for auxiliaries | 45.836 | (At consumption in section 1) |
| | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | Canal dues | 229.200 | (From Total Canal Dues, section 6) |
| | TOTAL | 994.076 | |
| 4,4 | Net earnings $ | 1.046.452 | |
| | *memo; daily earnings* | *30.522* | |
| 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| 4,6 | Net voyage cashflow | **1.046.452** | |
| 4,7 | Contribution to capital ($/day) | 30.522 | |
| | | | |
| 5 | PANAMA CANAL DUES | | |
| 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | For the first 10.000 tons | 32.000 | (Tariff = $3,20 * 10.000 ton) |
| | For the next 10.000 tons | 31.300 | (Tariff = $3,13 * 10.000 ton) |
| | For the remaining tons | 130.900 | (Tariff = $3,08 * 42.500 ton) |
| | Total Cargo Fee | 194.200 | |
| | | | |
| 5,2 | Transit Reservation System Fee: | 35.000 | |
| | | | |
| | Total Panama Canal Dues: | 229.200 | |

**Table 4.2: Voyage Cash Flow Analysis**

Notes/Sources:

Sec 1: Bunker: Main = IFO 380
Bunker: Auxiliary = MDO (Marine Diesel Oil)
Bunker prices from Houston 22. April 2008.
Source: BunkerWorld. (2008). BunkerWorld. Retrieved 04 22, 2008, from BunkerWorld, Fuel Prices, Houston: http://www.bunkerworld.com/markets/prices/us/hou/

Sec 2: Distances are calculated with SEA DISTANCES - VOYAGE CALCULATOR
Source: WorldShippingRegister. (2008). Sea Distances - Voyage Calculator. Retrieved 04 21, 2008, from World Shipping Register, Sea Distances: http://www.e-ships.net/dist.htm
Freight rate per day = $60.730, this is the 2008 average until week 16 (22nd of April) for Panamax Bulk Carriers operating on a trip charter.
Freight rate in $/ton is given by ($60.730 * 34,3 days) / 62.500 ton = 33,31 $/ton. Where 34,3 is the shortest estimated time on this voyage.
Source: RS.Platou (2008). Trip charter rates for Bulk - Week 16. Retrieved 04 22, 2008, from RS Platou Oslo, Dry Cargo, Weekly Freight Rates: http://www.platou.com/Shipbrokers/DryCargo/WeeklyFreightRates

Sec 3: Port time & canal transit time uses a transit time of the Panama Canal equal to 1 day.

Sec 4: Port Costs are set to be $ 300.000, this is only an approximation, but this example is used to look at the differences between sailings through the Panama Canal or not, therefore the Port Costs are not of a high importance and will not influence this decision directly.

Sec 5: Specific cargo tariff is from ACP official web page, updated March 1, 2008
Source: ACP (2008). Tolls. Retrieved 04 23, 2008, from Panama Canal Authority, Maritime Operations, Marine Tariff, Item no 1010.0000: http://www.pancanal.com/eng/maritime/tariff/1010-0000.fp.swf
The Transit reservation fee is from ACP official web page, updated March 1, 2008. And it is assumed that the vessel is categorized in the largest vessel group.
Source: ACP (2008). Transit Reservation System. Retrieved 04 23, 2008, from Panama Canal Authority, Maritime Operations, Marine Tariff, Item no. 1050.0000: http://www.pancanal.com/eng/maritime/tariff/1050-0000.fp.swf
Other minor fees due to special requests may occur when transiting the Canal.

Layout and other information:
Source: Stopford, M. (1997). Maritime Economics (2 ed.). London and New York: Routledge.

The Voyage Cash Flow gives a net voyage cash flow equal to $10.460.452, and a daily contribution to capital equal to $30.522, an amount that reflects the fairly high freight rate used in the calculations, similar to what seen in the dry-bulk segment this year. To look at how this Net Voyage Cash Flow compares to an alternative route not using the Panama Canal, a similar analysis is done for a voyage from Los Angeles to Rotterdam using the Strait of Magellan south in South America instead of the Panama Canal. Calculations are also made for a route between Los Angeles and New York with the same alternatives as above, through the Panama Canal or around South America. In addition two routes from Shanghai are calculated, one going to New York and one going to Rotterdam, with the Suez Canal as an alternative to the Panama Canal. The full Voyage Cash Flow analysis for all these routes can be found in Appendix I, but the main findings are presented in Table 4.3 on the next page.

In Table 4.3 we see the distances that represent the two alternatives for each route. The Panama Canal is, as documented earlier in this chapter, representing the shortest alternative distance from the Pacific Ocean to the Atlantic Ocean by 5.500-8.000 nautical miles (10.000-15.000 km) shorter than a route through the Strait of Magellan, depending on the route and the ports served. This reduction in distance affect the total travel days and the net voyage cash flow to favor the Panama Canal compared to the alternative route through the Strait of Magellan in route one and two. When looking behind the cost variables for the two alternatives it is clear that the extra cost of transiting the Panama Canal is more than offset by the higher fuel costs that accrues on the longer journey around South America. In our calculations operating costs are left out, however operating costs, which is calculated on a annually basis and often divided into a daily rate that is subtracted from the voyage net earnings, would have made the Panama Canal even more favorable. Another cost variable that can be argued to be of importance is the storage costs of the cargo while in transport, the longer time the voyage takes the higher would the storage costs be, which again favors the Panama Canal alternative. It can further be argued that a cargo owner is willing to pay a higher freight rate to secure a faster delivery of the goods, and in that way avoid higher storage costs etc., which would give the vessel operator on the Panama Canal alternative a higher freight earning and an even better result than it already provides. It is worth notice that the Panama Canal is more favored on shorter routes, like the Los Angeles – New York route, than on longer routes, such as Los Angeles – Rotterdam, which is due to the bigger impact the Canal has on sailing distances and travel days saved on a shorter journey than it has on a longer one. For the two routes from Shanghai, to New York and Rotterdam, the differences in distance between the two alternatives are smaller, which makes the travel days spent on each voyage and the relevant net voyage cash flow’s also more alike.

## Comparison of different Alternatives

| | | |
|---|---|---|
| Cargo (ton) | 62500 | |
| Freight Rate per day: | 60730 | |
| Freight Rate $/ton Route 1: | 33,31 | (Calculated with: (Freight Rate per day * Total days on shortest route alternative) / total cargo) |
| Freight Rate $/ton Route 2: | 24,70 | |
| Fright Rate $/ton Route 3: | 41,93 | |
| Freight Rate $/ton Route 4: | 41,76 | |
| Speed (knots): | 14 | |
| Speed less 5% see margin: | 13,3 | |
| Days in Port | 9 | |
| Canal Transit | 1 | (not for the Strait of Magellan alt.) |

| | | Distances in Km. | | |
|---|---|---|---|---|
| **Route Nr:** | **Route Name:** | **Panama Canal** | **Strait of Magellan** | **Suez Canal** |
| Route 1 | Los Angeles - Rotterdam | **7.752** | 13.281 | |
| Route 2 | Los Angeles - New York | **4.923** | 12.781 | |
| Route 3 | Shanghai - New York | **10.582** | | 12.370 |
| Route 4 | Shanghai - Rotterdam | 13.411 | | **10.525** |

| | | Total Days *(w 14 knots & 9 days in port + 1 day for Canal transit)* | | |
|---|---|---|---|---|
| **Route Nr:** | **Route Name:** | **Panama Canal** | **Strait of Magellan** | **Suez Canal** |
| Route 1 | Los Angeles - Rotterdam | **34,3** | 50,6 | |
| Route 2 | Los Angeles - New York | **25,4** | 49,0 | |
| Route 3 | Shanghai - New York | **43,2** | | 48,8 |
| Route 4 | Shanghai - Rotterdam | 52,0 | | **43,0** |

| | | Net Voyage Cash Flow | | |
|---|---|---|---|---|
| **Route Nr:** | **Route Name:** | **Panama Canal** | **Strait of Magellan** | **Suez Canal** |
| Route 1 | Los Angeles - Rotterdam | **1.046.452** | 973.217 | |
| Route 2 | Los Angeles - New York | **675.559** | 473.418 | |
| Route 3 | Shanghai - New York | **1.417.477** | | 1.278.451 |
| Route 4 | Shanghai - Rotterdam | 1.250.270 | | **1.369.940** |

**Table 4.3: Comparison of different Alternative Routes**
Notes: Based on calculations in Appendix I

On the route Shanghai – New York the Panama Canal represent the shortest distance and are therefore favored when it comes to travel time. In our example, the Panama Canal is also favored when looking at net voyage cash flow, but we have made one important assumption that does not give the full picture, that is the usage of similar vessels on both alternatives. This assumption is based on the restrictions on vessel size for the transit of the Panama Canal, for the Suez alternative this restriction is not valid and therefore gives a wrong picture. If we changed the vessel and the cargo capacity on the Suez alternative, this would influence the freight earnings and the different costs and might have turned the Suez alternative into a better option for the route between Shanghai and New York.

The last route, between Shanghai and Rotterdam, is already from our calculations in favor of the Suez alternative, based on the shorter distance that give a shorter travel time and a higher net voyage cash flow. And if we look at this route without the assumption discussed in the previous paragraph, it will turn out even more in favor of the Suez alternative. However this example has several assumptions that might influence which alternative representing the best solution, it is therefore not possible to conclude that the Suez alternative always is the best option for a route between Shanghai and Rotterdam. To show this, an example where the assumption about common fuel prices and same operating speed are not valid can be used. If the fuel price for the Panama alternative is 25% cheaper, this will probably make the operator run his vessel with a higher operating speed and by this generate higher revenue and make the Panama alternative the best option, as long as the Suez alternative is kept as before. This example shows that it is many variables influencing the solution of an optimal route, and that it is not always enough to consider the sailing distance.

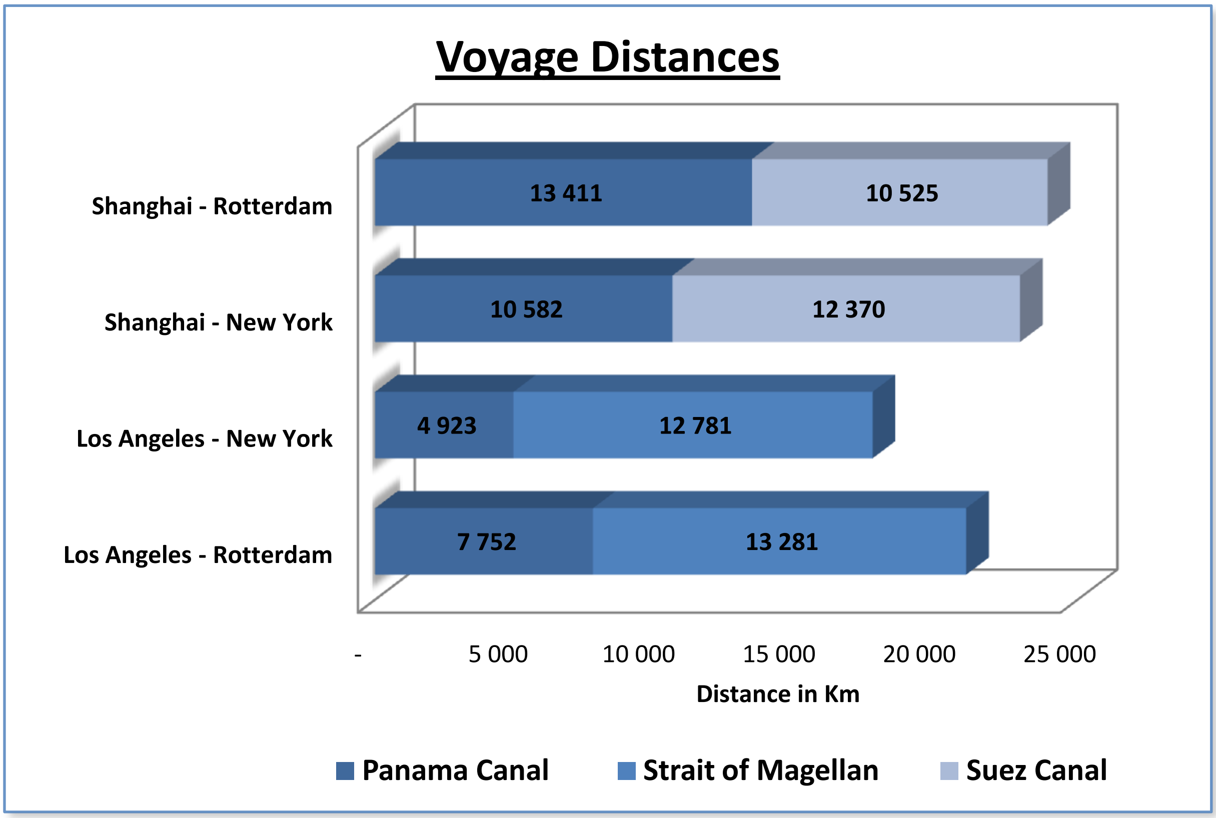


**Figure 4.2: Voyage Distances**
Note: Based on distances from World Shipping register.
Source: WorldShippingRegister. (2008). Sea Distances - Voyage Calculator. Retrieved 04 21, 2008, from World Shipping Register, Sea Distances: http://www.e-ships.net/dist.htm

With the assumptions for the calculations done here valid, the voyage distances are of great importance for the costs related to the voyage and as Figure 4.2 shows, the Panama Canal clearly has an advantage towards the alternative routes via the Strait of Magellan. On the routes from the Northeast Asia it is a smaller difference between the alternatives, which are to use the Suez Canal or the Panama Canal. The ACP (2006b) focus on the routes between Northeast Asia and the East Coast U.S./Europe, together with the routes between West Coast U.S. and East Coast U.S./Europe as the most important once for the Panama Canal, and in all this routes our calculations have supported the Panama Canal as the best alternative. But as mention before, making the calculations with fewer assumptions will change the picture, and here the size assumption is of great importance, since this assumption clearly changes the picture in favour of the Panama Canal. This is one of the main reasons for the ACP's decision for an expansion of the Canal, a topic covered in a later chapter.

# 5. Expansion Plan for the Panama Canal

Already in the 1930's an expansion of the Panama Canal became a topic of discussion and in 1939 the United States initiated a project to implement a new set of locks which would allow larger vessels to transit the Canal. At this time the possibility to make the Canal available for the large American war-ships was a main factor for the interest in increasing the Canal, but also the growing size of commercial vessels was an argument. This project ended in 1942, due to the Second World War, without any enlargement of the Canal. In the following chapter it will be give an outline of the expansion plan, which was confirmed through a referendum in the Republic of Panama the 22nd of October 2006, and is in work today. In the end of this chapter the objectives which ACP sees as their main reasons for an expansion of the Canal are presented.

## *5.1 The Expansion Plan*

After the failure of the enlargement project carried out before the Second World War, different minor and major works have been done to the Panama Canal to maintain, increase and optimize the capacity of the Canal during the history of the Canal. It has been works such as dredging the canals, introducing night transits, widening the Gaillard Cut and updating the locomotives used to handle the vessels when entering the locks among other capacity increasing projects. In the 1980's a study was carried out by Panama, Japan and the United States, which concluded that an enlargement of the Canals locks-system was the best way to increase the Canals capacity. This study was supported by ACP, when they carried out an in depth study, the 2005-2025 Master Plan, about the Canals future outlook and looked at how to optimize the Canals position in the maritime world. This studies have made the basic for the full expansion plan carried out by ACP; the Proposal for the Expansion of the Panama Canal, Third Set of Locks Project, of April 24, 2006.

The ACP (2006b) outlines the expansion project of the Canal, which aims at doubling the capacity of today's Canal with introducing one new lock line, existing of two new locks and their own entrance canals, which will come as a supplement till today's existing solution and not as a replacement. The ACP (2006b) consists of three integrated sub-projects, first the construction of two new locks, one at the Atlantic side and on the Pacific side of the Canal, second, excavation of new entrance canals from the Atlantic- and the Pacific- Ocean to the new locks together with widening of existing ones, and third a deepening of the navigation canals and increase of the Gatun Lakes maximum operating level.

### *5.2 The New Locks*

The project of building two new locks, could be seen as the main project of the expansion, since the major capacity problem for the Panama Canal is that the existing locks do not allow vessel lager in size than a Panamax to transit the Canal, that is: less than 304.8 meter long, 32.3 meter wide and 12.55 meter deep, which is the existing lock chambers dimensions. With the introduction of the new locks, supplementing the ones already existing, the Panama Canal will be able to offer one transit lane where the lock-chambers have a dimension of 427 meter long, 55 meter wide and 18.3 meter deep and will be able to handle vessels of a post-Panamax size.

The two new locks will both consist of three lock chambers each, that is, the lock operating on the Atlantic side will consist of three lock chambers which lifts the vessels from sea level to the level of Gatun Lake and on the Pacific side a similar lock do the same job. The operations of the new locks will be similar to the ones already existing and only uses gravity and water basins to fill and empty the lock chambers. Beside the difference in dimension from the existing lock lanes, the new lock's will be built with a different gate system than the old ones, this is a rolling gate system, which ACP (2006b) states are the common system for lock's of this size. It will also be introduced tugboats, which will help the vessels when entering/exiting the lock-chambers, which is different from today's operations which uses locomotives.

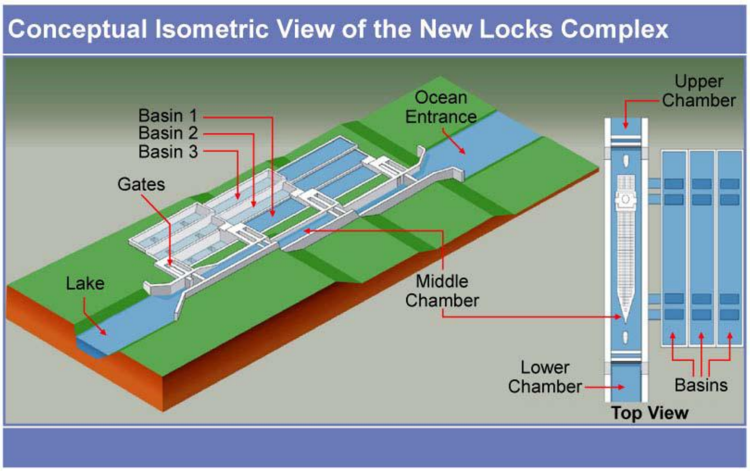


**Figure 5.1: The New Locks Complex**
Source: ACP (2006). *Proposal for the Expansion of the Panama Canal.* Retrieved 04 23, 2008, from Panama Canal Authority, Expansion Program,: http://www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf

### *5.3 New Entrance Canals*

The location of the new lock-line is close to the existing ones, but it will require new entrance channels from the Atlantic- and the Pacific- Ocean and also a channel connecting the new Pacific lock with the existing channel through the Gaillard Cut. The new lock located on the Atlantic side will be accessed from the existing entrance at the Atlantic Ocean followed by a 3.2 kilometre long access channel located east of today's access channel. On the Pacific side two new access channels are required, a 1.8 kilometre long channel from the new lock to the existing entrance at the Pacific Ocean and another 6.2 kilometre long channel connecting the new lock with the existing channel through the Gaillard Cut. The new entrance channels will at least have a dimension allowing post-Pannamax vessels to navigate these channels in a single direction at any time, in the Gatun Lake the widening and dredging work of the existing navigation channel will allow post-Pannamax vessels to meet or overtake each other. And with the widening and deepening of the Canal entrances, both on the Atlantic- and the Pacific- Ocean side, post-Panamax vessels will be allowed to navigate these channels and meet with vessels of Panamax sizes.

### *5.4 Gatun Lakes Maximum Operating Level*

The third sub-project consists of increasing the maximum operating level of the Gatun Lake. With an increased operating level the Gatun Lake will have a larger usable water reserve which is needed to handle the extra demand for water by the two new locks. The ACP (2006b) declare that ACP plan to increase the operating level by 4.5 meter, which together with the deepening and widening of the navigation channel, will increase the usable water reserves of the Gatun Lake by 625 million litres. This will make the operations of the new locks possible, or more specific, make it possible to operate approximately 1100 additional lockages compared to today's operations, without affecting the water supply to human use.

### *5.5 Expansion Plan Schedule*

The full expansion plan, which is estimated to have a total cost of $ 5.250 million, is scheduled by the ACP to be finalised in 2014 (ACP, 2006b). The ACP has a separate schedule for the different sub-projects which makes it possible to operate the existing Canal under normal conditions during the whole construction period. The schedule which was planned in the ACP (2006b) operates with a construction start of the locks in 2008, the ACP (2008e) report that the project is following the planned schedules with some of the sub-projects actually being ahead of the scheduled plan at this date, 31st of March 2008.

### *5.6 The 4 Objectives of the Canal Expansion*

The ACP clarify through the ACP (2006b) that the expansion of the Panama Canal is based on different in depth studies, about topics such as the market outlook, environmental effects caused by an expansion, financial situation for the canal itself and for the Republic of Panama. From the studies ACP have formed four objectives which act as a base for the expansion project, these four objectives are as follow:

- *To achieve long-term sustainability and growth for the Canal's contribution to Panamanian society through the payments it makes to the National Treasure.*
- *Maintain the Canal's competitiveness as well as the value added by Panama's maritime route to the national economy.*
- *Increase the Canal's capacity to capture the growing tonnage demand with the appropriate levels of service for each market segment.*
- *Make the Canal more productive, safe and efficient.*

*Source:* (ACP, 2006b)

The first objectives can be seen in relation with ACP's estimates for the future contribution of the Canal, in 2005 this contribution was on $489 million, and estimates for the contribution in 2015, the first year of operations of the expanded canal, which is published in the ACP (2006b), are tripled the numbers from 2005. And by 2025 the contribution is estimated to have increased by more than eight times the contribution of 2005, which clearly support the objectives of a long-term sustainability and growth of the Canal's contribution. The second and third objectives relates to how attractive the Panama Canal is for different trade routes compared the competition the Canal faces from other alternatives.

This is covered more in depth in the chapter Alternative Routes, where a calculation show the drawback the Canal have today, with restriction on vessel sizes, compared to the alternative routes. The third objectives also relates to the outlook of the different market segments which the Panama Canal are of interest to, which are covered more in details in Part 1 of this paper. The fourth objective is connected to the ACP official corporate mission who highlights the importance of offering an efficient and competitive transit of the Canal, with the highest safety standards (ACP, n.d. c).

# 6. The Panama Canal Transit Reservation System

The Panama Canal is every year used by more than 14.000 vessels, carrying an enormous amount of goods through the two sets of lock lanes which forms the entrance to the almost 80 kilometer long water way connecting the Atlantic with the Pacific Ocean. The administration of these transits is managed by the Authority of the Panama Canal, ACP, with detailed schedule plans to take advantage of the Canals maximum capacity. This chapter covers a detailed outline of how the ACP manages the operations of the Canal and also a short overview of the different fees and costs related to the usage of the Canal.

## *6.1 Today's operation of the Canal*

After the Panamanian Government got back the control of the Canal, the 31$^{st}$ of December 1999, they have changed the operations from a non-profit operation, which was the policy under the American rule, to a market oriented policy focusing more on customer satisfaction and profitability. This market oriented operations are lead by the Authority the Panama Canal, ACP, an agency operating on behalf of the Panamanian Government. The ACP is managing the transits of the Canal by offering their customers three different options for approaching the transit of the Canal. The different options are to use the Transit Reservation System to book a transit in advance, use a regular transit without a pre-booked time, or use the transit booking slot auction system to bid on the wanted slot. The Transit booking slot auction system was launched as an extra service by the ACP in 2006 to better serve smaller customers of the Canal, which had problem booking the transit they wanted because of a Customer Ranking, the ACP uses, that favors larger customers.

## *6.2 Transit Reservation System*

The Transit Reservation System, TRS, operates with a time horizon over a year; booking starts 365 days prior to the date the customer wants the transit of the Canal. The available transit slots that ACP has allocated to the TRS are divided into three booking periods varying in time prior to the transit. Each of the three periods has allocated some of the available transit slots for the specific date. The three time periods are as follow:

Period 1 from 365 to 22 days prior to the requested transit date

Period 2 from 21 to 4 days prior to the requested transit date

Period 3 from 3 to 2 days prior to the requested transit date

The number of available slots ACP has allocated to the different periods is, from the 1st of February 2008, nine for the first period, five for the second and eleven for the third. Making a total of 25 slots for each single day, this is an increase by two slots compared to what usually has been the amount ACP allocates to the Transit Reservation System when the Canal operates under normal conditions. The increase of two slots to the TRS that found place in early 2008, ACP explains as a response to the growing demand for pre-booked slots and a step toward simplifying the option of making changes to already reserved slots. The 25 slots are again divided into two different vessel groups with respect to the size of the vessel. The two vessel groups are named Supers and Regulars, representing vessels equal to or greater than 91ft/27.74m in beam/width for Supers and under 91ft/27.74m in beam/width for Regulars. The separation between Supers and Regulars is also used to divide the slots available to the three periods in the Transit Reservation System. A summary of the available slots for Supers and Regulars for each period can be found in table 6.1 below. Both the new slots that were made available to the TRS in February 2008 were allocated to the first booking period for Supers, increasing this period's available slots from five to seven.

| | 1st Booking Period | 2nd Booking Period | 3rd Booking Period | |
|---|---|---|---|---|
| VESSEL | 365-22 days prior to transit | 21-4 days prior to transit | 3-2 days prior to transit | Total: |
| Supers: 91ft/27.74m in beam and over | 7 | 3 | 7 | 17 |
| Regulars: under 91ft/27.74m in beam | 2 | 2 | 4 | 8 |
| Total: | 9 | 5 | 11 | 25 |

**Table 6.1: Slot Allocations in the Transit Reservation System**

Source: ACP (2008). Panama Canal Transit Reservation System. Retrieved 01 16, 2008, from Panama Canal Authority, Maritime Operations, Customer Information, Notices to Shipping 07-2008: http://www.pancanal.com/eng/maritime/notices/2008/n07-2008.pdf

A booking rule, or an extra booking period, that could have been added to the table above is the exclusive right given to passenger vessels to book three of the seven slots available in the first booking period. This exclusive right is available between October 1st and May 31st and gives commercial passenger vessels an exclusive right to book their transits in the time period between 547 and 335 days prior to the transit. After 335 days prior to the transit date, that is, 30 days into the first booking period, there is no more differentiation between commercial passenger vessels and other types of vessels. For the three exclusively reserved slots, the size of the passenger vessel will decide which of the vessel size groups, Supers or Regulars, the slots will be taken from.

Slots that are not reserved when the time period they are allocated to ends are automatically transferred to the following booking period. Sometimes it happens that ACP has to change the number of allocated slots for a given date, due to reduction in the Canals capacity. Such reductions have different levels with respect to how much the capacity is reduced, and for each reduction level the number of transit slots distributed through the Transit Reservation System is reduced. The number of reduced slots varies and it is decided by the ACP from which of the size groups, Supers or Regulars, the reduction are taken from.

Other restrictions influencing the Transit Reservation System are the direction of the transit and the full-daylight-hour option. The direction restriction relates to the Canal's capacity and how many vessels it is possible to transit in the same direction per day. Under normal conditions it allows no more than ten Supers and five Regulars to transit in the southbound direction, from the Atlantic to the Pacific Ocean. In the northbound direction the restrictions are nine Supers and five Regulars. The full-daylight-hour option also relates to the Canals capacity to handle vessels, a full-daylight-hour transit is, as the name indicate, a transit of the Canal during daylight, and reasons for such requests relates to navigation difficulties for the vessels. The limits are set to no more than seven Supers in the southbound direction and six in the northbound direction, and with an extra restriction on total ten Supers using the full-daylight-hour transit every day. For Regulars, the restrictions for full-daylight-hour transits are on two vessels in total, the lower number here reflects that this is a more typical problem for vessels classified as Supers, and the need for more full-daylight-hour transits for Regulars are not needed.

To be allowed into the Transit Reservation System there are different requirements for the vessel, the agent operating the vessel and for the process of requesting a transit. For the vessel the requirements relates to technical and safety standards. Requirements toward the operator have to do with the financial responsibilities of the vessel, that is, costs related to transit and booking fees. The process of requesting a transit must follow ACP specific rules, involving the usage of the Request for Transit Booking form and the submission of this to the ACP through the electronic data collection system (EDCS), by mail, fax or personal deliveries. The form, which can be found in Appendix II, require the operator to fill in some basic information, such as the name of the vessel, transit date, direction, size and special remarks. The Form further consists of a part where the ACP gives their response to the request with information regarding the transit, such as the booking fee.

For the submission of a Request for Transit Booking form there is specific regulations for when these forms can be submitted. The time starts from the first day of a new period at 0900 AM, but during the first half hour it is only possible to submit requests and not get them processed. This means that the requests submitted during the first ½ hour, will at 0930 am, when the processing starts, be treated as they were submitted at the same time and then ranked after ACP Customer Ranking. The reason for this is to give customers with a high ranking at the ACP Customer Ranking an advantage in getting the slots they want. The customer ranking is calculated as a weighted average of the number of transits and the total amount of tolls paid during the last 12 months, with 60% of the weight representing the number of transits and the remaining 40% representing the total amount in tolls paid. Table 6.2 shows the customer ranking for January 2008 with the huge container operator Maersk Line on top, with a weight of 1.40, which is 350 times less than the weight Talleres Industriales, S.A. has, the customer on the bottom of the customer ranking.

| No. | Company | Code | Weight |
|---|---|---|---|
| 1. | MAERSK LINE | MAERSK | 1.40 |
| 2. | NIPPON YUSEN KAISHA (NYK LINE) | NIYUKA | 2.20 |
| 3. | EVERGREEN MARINE | EVERGR | 2.80 |
| 4. | KAWASAKI KISEN (K LINE) | KKLINE | 6.20 |
| ------------- | ------------------------------------------------ | ---------------------------- | --------------- |
| 559. | FRASER YACHTS WORLDWIDE | FRASER | 488.60 |
| 560. | TALLERES INDUSTRIALES, S.A. | TALIND | 493.40 |

**Table 6.2: Customer Ranking - Period January 2008**

Source: ACP (2008). Customer Ranking Januar 08. Retrieved 01 16, 2008, from Panama Canal Authority, Maritime Operations, More Information, Transit Booking: http://www.pancanal.com/eng/maritime/transit/index.html

### *6.3 Regular Transit*

This is a transit of the Canal that has not been pre-booked through the Transit Reservation System. It could be called a "first-come-first-served" system, where the customer has to wait in line to get transit through the Canal when it is their turn. This is not a totally correct description of how a Regular Transit of the Panama Canal works, since it is actually the ACP that determines the order of the vessels transiting the canal each day. The transit schedule is determined by different factors, with the arrival time in the Canal waters, which would be the "first-come-first-served" principle, only as one of the factors considered. Another factor is the already scheduled transits for the given day and how the different Regular transits fit into this schedule, this clearly depends on type of vessel and the open time windows in the scheduled plan. Figure 6.1 show the daily forecasted demand for transits of the Panama Canal for January 2008, and how this is expected to be divided between the three different alternatives for transit requests. It shows that the total numbers of regular transits each day, Supers and Regulars together, accounts for approximately half of the capacity of the Canal. The figure also shows that the regular transit is more common for vessels of Regular size, reflecting the lower number of slots available for regular sized vessels in the transit reservation system.

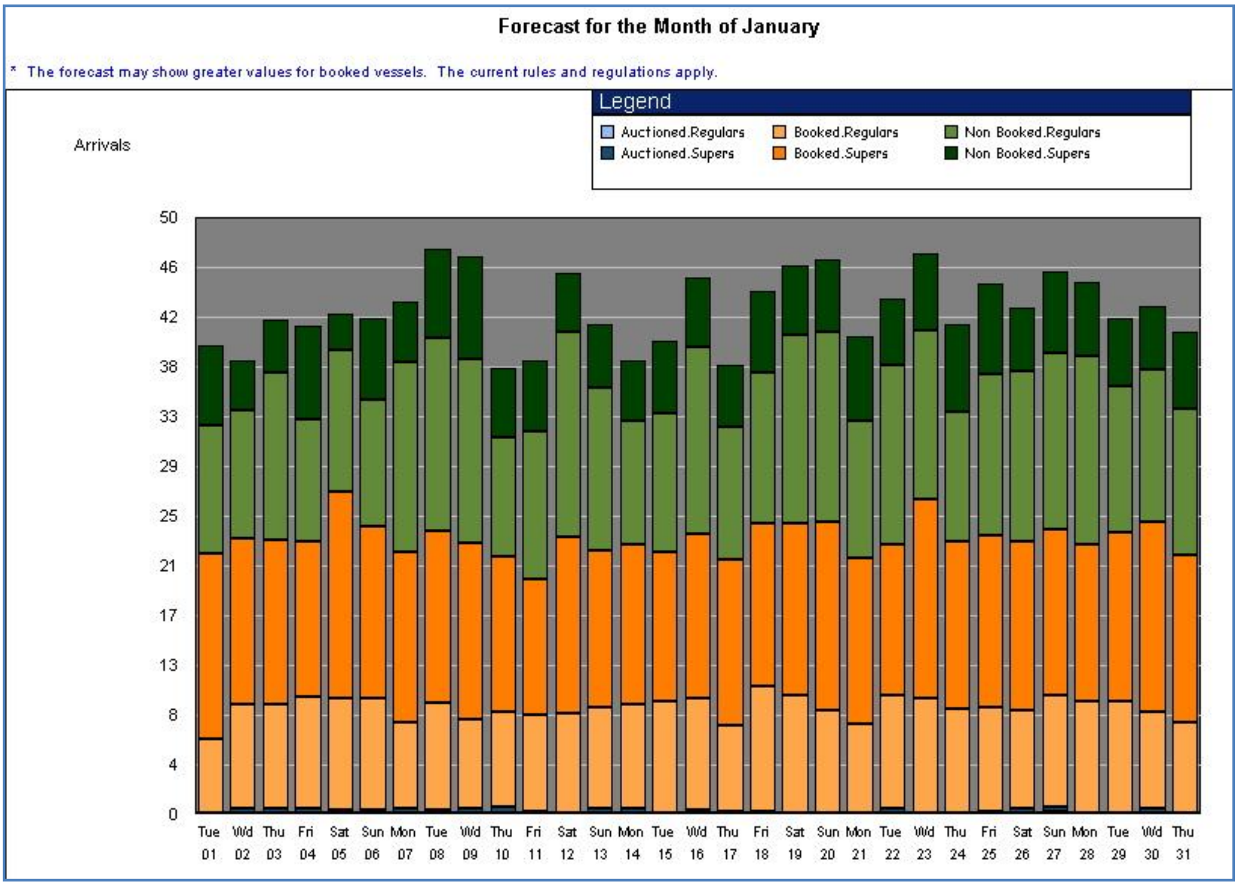


**Figure 6.1: Type of Transit of the Panama Canal Forecast January 2008**

Note: Statistical information projected by auto-regression. Every month is based on similar months from the last two years, and the trend of the most recent two months.

Source: ACP (2007). Forecast for the Month of January, All Vessels. Retrieved 01 16, 2008, from Panama Canal Authority, Maritime Operations, Vessel's ETA & Transit Booking, Arrival Information: http://www.pancanal.com/eng/maritime/jit/all/all-01-DB001.HTM

## *6.4 Transit Booking Slot Auction*

The transit booking slot auction was first implemented after a 60 days test-period in 2006, in order to make it easier for lower ranked customers in the customer ranking system to secure transits. It had been a problem for the customers who had low rankings to secure the transit slots they wanted, since higher ranked customers was prioritized, and the lower ranked customers was left with no other option then to wait and use the regular transit, based on the "first-come-first-serve" principle. In Figure 6.1 the numbers of auctioned slots are showed, on the bottom of the graph, but it is clear that it is very few customers that use this method to book their transit through the Canal. In Part III of this paper it is argued that a growing demand for the transit booking slot auction could be expected, based on a growing total demand for Canal transits and that the Canal's maximum operating level will be reached.

There are different regulation rules for how the slot auction works. First of all, the slot auction is available only during the 3rd period of the Transit Reservation System, 3-2 days prior to the transit, when all the available slots for this period are allocated. Further, there are specific time regulations for when, in the 3rd period, the auction can open and when it can close. The outline of the auction itself is based on a standard auction model, where the bidder is starting the auction by placing a starting bid higher or equal to the base price for the auction. Then the bids increase over time until the auction ends, and the customer with the highest bid is the winner of the auction. For further details about standard auctions, see the auction theory chapter. The base price, which is a minimum price ACP requires for the slot auctioned away, is set by the ACP for each single auction with respect to the vessel size, Supers or Regulars, and the condition of the Canal, that is, the total capacity for transits on that specific date. Under normal conditions the base price for Supers are set to be US $25.000 and for Regulars US $10.000. With lower conditions, which mean lower capacity, the base prices rises.

The winner of the slot auction will be the vessel or customer that has the highest bid when the auction period is over. The winner is offered the slot for a price equal the winning bid, with the same rights as other reserved slots, that is a right to request same day transit due to late arrival, a swap of vessel with a not pre-booked vessel or a substitution with another pre-booked vessel. The only exception that the winner of the auction does not get is the option of changing the transit date, due to the requirements that such request is received no later than 60 days prior to the transit, and therefore not possible for slots booked through an auction. The different rights offered to the auction winner are related with different fees, the request for a same day transfer is charged 200% of the winning bid, for the swap and the substitution the fee charged will be the higher of the two booking fees applicable to the vessels involved. For a cancellation of a transit booked through an auction a fee equal to 90% of the winning bid are charged, and then the slot is offered to the vessel that failed to secure the slot during the tie-breaker competition.

The auction process is carried out through the Panama Canal Web Auction System, administrated by the ACP. To get access to the system and be able to take part in the online auctions, the customers need to register their personal and company information. When the information is registered and accepted, the customers are able to enter the Web Auction System, navigate through the ongoing auctions and place their bid on the auction for the slot they require. It is important to notice that when the customers place their bid, they are legally responsible for this, and if their bid turns out to be the winning bid they are legally obliged to purchase the transit slot, and have also accepted the terms and conditions set by ACP regarding a transit of the Panama Canal.

Before placing their bid, the customer has access to different information about the ongoing auction. The most important information is the starting bids for the auctions, equal to the base prices mentioned above when the conditions are normal, the next acceptable bid and the time left of the auction. In the auction process each customer enter his or hers secret maximum value of the slot, and the program automatically simulates the bidding rounds where the customers increases each other's bid by US $100 up to their maximum value. This process is called proxy bidding and is designed to make it easier for the customers to use the auction, it also guarantee the lowest possible winning price for the customer, since it only increases each customers bid by US $100 more than the existing highest bid and not uses the customers maximum value of the slot. The proxy bidding process goes on to all the customer reaches their maximum value and, if there is not entered any new and higher bids before the time set available for the auction is over, the customer with the highest bid is announced the winner.

The bidding process of every auction is continually updated to the customers by e-mails, including information about successfully placed bids, unsuccessfully bids, when you are outbid and no longer have the highest bid in the auction, and the time remaining of the auction. When the auction ends the customer with the winning bid is notified by e-mail with general auction information and the amount of the winning bid. The e-mail will also include a request that the booking request form, as seen in Appendix II, is submitted through normal procedures. As an extra service the Web Auction System offers its customers the opportunity to save their auction history with detailed information about the auctions the customers have taken part in for later use.

### *6.5 Costs of transits through the Canal*

The costs the vessels have when transiting the Panama Canal are related to the different costs of the operations of the Canal. Each vessel is therefore charged with an individual fee, based on the services it requires. The different services ACP provides for its customers and charge fees for includes among others a tugboat service, a canal and lock pilot service and a locomotive service, to help the vessels maneuver in the lock chambers. These services are charged with different fees based on the vessels requirements toward each service. In complement to the fees for the optional services the ACP charge a Canal toll and a Transit Reservation fee to all its customers, based on vessel and cargo type.

The policy of charging a toll for the transits of the Panama Canal goes back to the opening of the Canal in 1914, but the fees charged and the policy behind have changed during the time. The major change can be found after year 2000, when the Panamanian government got back the control of the Canal from the Americans, and turned the Canal into a market oriented organization, focusing on customer attention, reliability and profitability. This new focus was a change from the break-even model the American had used and has proved very successfully, turning both efficiency of the Canal and revenue generated by the Canal to new levels.

The toll system ACP uses today is named the Panama Canal Universal Measurement System (PC/UMS) and was introduced in October 1994. This is a toll system based on the International Convention on tonnage Measurement of Ships from 1969 used by the International Maritime Organization. In short, this measurement system is based on a mathematical formula multiplying the total volume of the ship with an appropriate rate, depending on type of cargo the vessel carries and whether the vessel is laden or in ballast. The introduction of different rates related to different cargo types is one of the major changes ACP has done to their measurement system. This change descend from the introduced of price differentiation by size of vessel ACP introduced in 2002-2003, and have lead to a market segmentation, with different tariffs for each segment. The segments ACP operates with, and continually revises the tariffs for, are the eight segments outlined about in Part 1 of this paper; General Cargo, Refrigerated Cargo, Dry Bulk, Tanker, Container Vessel, Vehicle Carrier, Passenger Vessel, and Others.

In complement to the individual rates for the different segments ACP implemented a special ad-measurement system for full container vessels and vessels with container-carrying capacity on-deck between 2005 and 2007. The reason for this extra measurement for the container segment was based on a desire to offer this segment, which is of very high importance to the Canal, a measurement system more in conformity with the rest of the container industries international standards. The new ad-measurement calculates the fees charged for container vessels by multiplying a given rate per TEU with the number of containers carried. Today the rate per container with cargo is US $63 and for the once in ballast US $50.40 (ACP, 2008h).

# 7. Auction Theory

This chapter contains essential auction theory with an outline of the four basic auction methods, before looking more in-depth at the Transit Booking Slot Auction that ACP uses. It gives an understanding of the strategy ACP's customers in the Transit Booking Slot Auction choose to use. And it argues how ACP best should frame the Transit Booking Slot Auction based on general auction theory and the underlying characteristics of the transit of the Panama Canal and its customers preferences.

## *7.1 The four basic Auction Methods*

The most basic assumption behind auction theories is that the seller wants to sell an object/service, but does not know the customers value of this object/service. An auction is then appropriate, since it offers the object/service to the customers by asking how much they are willing to pay for it. The customer who values the object/service highest will be the one winning the auction and gets the right to buy the object/service. With this basic assumption established, Klemperer (2004) outlines the auction theory with four main auction methods that are accepted as the theoretical background for most research about auctions. These four auction methods are recognized by different characteristics:

Method 1: The seller or auctioneer is starting with announcing a low selling price, followed by the bidders announcing their interest, the seller is successively raising the price until only one of the bidders remain interested in the object. The last remaining bidder is the winner of the auction and wins the right to buy the object to a price equal the last announced price. This method could also be arranged by letting the bidders call out the price they are willing to pay for the object themselves, followed by other bidders raising the bid, until the price reaches the level where no bidder are willing to increase his or hers bid. In auction theory this auction method is known as the open, oral or English auction.

Method 2: This method works in the exact opposite way than method one. The seller, or the auctioneer, first announces a very high price for the object and then lower the price continually until the first bidder announces his or her interest to pay the called out price for the object. The bidder who first announces his/her interest is the winner of the auction, and wins the right to buy the object to a price equal to the called out price. In theory this auction form is known as a Dutch auction, descending from the flower auctions in the Netherlands where this auction form is commonly used.

Method 3: This method is characterized with each bidder submitting a single individual bid that is kept secret from the other bidders. When the ending time for the auction is reached, all the bids are opened and the bidder who submitted the highest bid is announced as the winner of the auction. The winner wins the right to the object for a price equal the submitted bid. This auction method is commonly named a first-price sealed-bid auction by economists.

Method 4: The last of the four basic auction methods are very similar to method 3, the first-price sealed-bid auction, but with one important difference. It works in the same way, with each bidder submitting a single secret bid before the closing time for the auction. The winner of the auction is announced to be the bidder who submitted the highest bid, but the important difference from the first-price sealed-bid auction is seen in the price the winner has to pay for the object. Here the winner only pays a price equal to the second highest bid, which has led to this method being named a second-price sealed-bid auction. This method is also sometimes referred to as a Vickery auction, after William Vickery, a well known author of papers about auction theories.

### *7.2 The choice of Auction method by the Panama Canal Authority*

The auction method the Panama Canal Authority is using as their transit booking slot auction, described in the previous chapter, is characterized by similar characteristics as Klemperer (2004) uses for the first of the four auction methods, the so called English auction. The transit booking slot auction works as the English auction, where the auctioneers, here the ACP, publish a base price which set the starting point for the auction, before the customers call out their bids in a successively raising order, or more correct, electronically submit their bids. At the closing time for the auction the bidder holding the highest bid is announced the winner of the auction and wins the right to the transit slot for a price equal the winning bid.

The transit booking slot auction is further characterized as a private-value auction, that is by Klemperer (2004) described as one of two types of auctions, where the other is named common-value auction. The private-value auction is an auction of an object/service that has different value for the different bidders, that is, each customer has their individual value of the object up for auction. For the transit auction this is explained by looking at the different customers' willingness to pay for the transit, which is related to the customers' vessel, the types of goods and the time schedule etc. that the vessel operates under and will therefore be different for each customer. Another important aspect of the private-value auction is that the individual valuation of the object is only known by the bidder himself and kept secret to the other bidders. For a common-value auction the object auctioned away is an object with a common value additional to the bidders individual value, this could be objects that have a selling value for the buyer on a later stage.

The next important aspect related to the auction method is the number of items auctioned away. The common assumption in auction theories is that an auction consists of one item offered to the bidders in one auction, but this is not always the case. It could be auctions consisting of several rounds with several similar objects up for sale, called multi-unit auctions (Klemperer, 2004). The transit booking slot auction could simplified be said to be a single unit auction, consisting of one item offered in one auction, but this is only partly correct. The transit booking slot auction only consists of one transit in each auction, which is consistent with a single unit auction, but it is sometimes possible to buy a very similar transit through the next auction. This possibility depends on how many slots ACP has allocated to the transit slot auction for the given day, when it is two or more slots allocated to the auction for one day, it could be described as a multi-unit auction with sequential auctions of homogenous objects. This conflicting problem could be solved by making a justified assumption that none of the bidders are interesting in more than one of the objects, which make sense when each bidder operates one vessel and therefore only needs one transit.

With this assumption valid, Weber (1983) and Klemperer (2004), report that individual bidders are not influenced by other bidders when deciding their bidding strategy, due to the revenue equivalence theorem [1]. Following this rule the transit booking slot auction can be described as a single unit auction.

Risk-aversion versus risk-neutral bidders is another important aspect in auction theory. This relates to how the participants in the auction look at the risk of losing the auction. Participants who are risk-averse see a loss as worse than a higher cost of winning, while a risk-neutral player value the cost of winning to the same value as a loss. For the transit booking slot auction the aspect of risk aversion versus risk neutral bidders is not a problem, since it is an auction method similar to an English auction, where the winner of the auction only pay an amount slightly above the second highest bid to beat the bidder with the second highest valuation of the object (Klemperer 2004). The optimal strategy for players in a second-price auction, same as the transit booking slot auction, is to bid up to his/her actual value of the object, irrespectively of risk aversion/neutrality. For other auction methods the strategies are different, in a Dutch auction, also called a first-price auction, risk-averse players tend to bid more aggressive due to the fear of losing which will be worse than the higher cost of winning.

### *7.3 Analysis of the ACP's transit booking slot auction, from the customers view*

The customers taking part in an auction can use different bidding strategies that give different outcomes of the auction, in the following paragraphs an analysis of the different strategies the players in the transit booking slot auction can use are studied. The analysis is based on the aspects outlined above, together with theory from Klemperer (2004) and lecture notes from Sunde (2006). Assumptions are made, following the arguments in the above paragraphs, that the transit booking slot auction is a private-value auction, consisting of a single item in an auction with risk-neutral players.

[1]The revenue equivalence theorem states that in a private-value auction consisting of *k* identical objects, where each risk-neutral bidder only want one of the *k* available objects, any auction method, where the object always goes to the bidder with the highest value of the object and the bidder with the lowest value has an expected revenue equal to zero, will give the seller the same expected revenue and all the bidders with value *v* of the object making the same expected bids.

The players in the transit booking slot auction has three different bidding strategies they can chose to follow, these are:

1. The bidder resigns from the auction before it ends, and before the price has reached his or her value of the transit.
2. The bidder keeps on bidding on the transit, still when the price has passed his/her value of the transit.
3. The bidder is in the auction as long as the highest price is under his/her value of the transit, if this is not enough to win the auction, the bidder resign from the auction when the price exceed his/her value of the transit.

Out of these three strategies it is clearly strategy three that is the optimal one. With strategy one, the auction player could lose an auction that is won to a prize lower than the players own value of the transit. With strategy two, the player could end up as the winner of the auction with a prize to pay for the transit higher than his/her own value of the transit. In both cases the player are clearly not using an optimal strategy, which would be to follow the third strategy, where the player only win the auction to a prize equal or lower to his/her value of the transit.

We simplify by assuming that there is only two players interested in the transit, which will always be the case late in the auction, both players are using strategy three and rises their bids just above the highest standing bid until their value is reached. Figure 7.1 below illustrates this auction process, here $B_1$ and $B_2$ represent the two players bidding strategies and $V_1$ and $V_2$ the player's individual value of the transit. Player one starts out with a low first bid, just above or equal to the base price, player two raises with a small increase, followed by a further increase by player one and so on. This bidding game goes on until player two reaches his value $V_2$ of the transit, then player one raises the bid once more with a slight increase. Player two stops when the price slightly surpasses his value, and player one is announced the winner of the auction to a price P, slightly above $V_2$, ($P \approx V_2$).

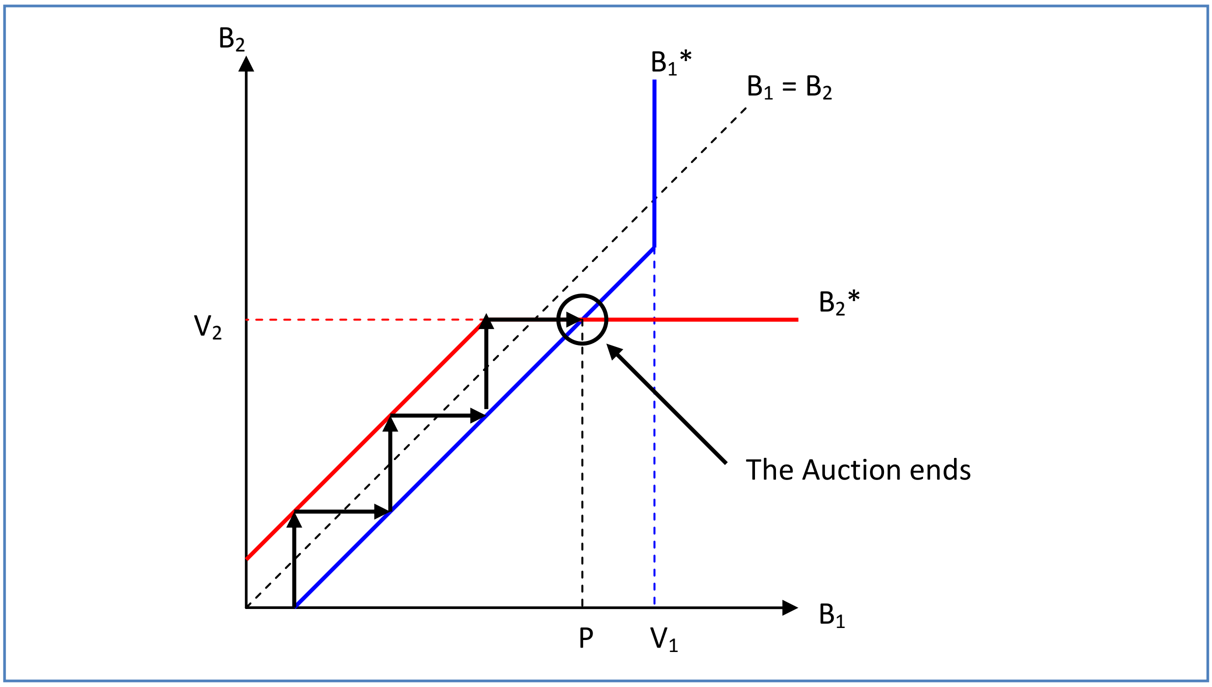


**Figure 7.1: Optimal Bidding Strategy**

Notes: The distance between the bidding curves is increased in the figure to illustrate the dynamic of the auction better, this could led to an wrong impression that the ending price P, is more than slightly above V2.

Source: Sunde, Ø. (January 2006). Privatverdiauksjoner av enkeltobjekter, forelesningsnotat 2 i SØK610. Molde: Molde University College.

This analysis and figure 7.1 shows that when using an English auction method, as the ACP does in their transit booking slot auction, the player who value the object/transit highest will be the winner of the auction. The winner will get the object/transit to a price equal player two's valuation of the object/transit, which explains the name second-price auction used for English auctions.

### *7.4 The transit booking slot auction, from the sellers, ACP's, view*

When looking at the different auction methods from a seller's point of view the main goal is clearly to maximize the expected profit for the seller. For the transit booking slot auction this assumption will clearly be valid, but it is also important to know the reason behind the introduction of the slot auction. The slot auction was launched as an extra service toward customers with lower ranking in the ACP customer ranking database that had raised their concern about the difficulties of securing transit slots through the transit booking slot system. Therefore it is important not only to look at the revenue aspect when considering which auction method that gives the best outcome for ACP.

The four basic auction methods introduced earlier, all give the same expected revenue to the seller as long as the revenue equivalence theorem holds (Klemperer, 2004). The revenue equivalence theorem is based on three key assumptions; all players involved in the auction are risk-neutral, that is they all try to maximize their expected revenue, the value of the object is fully individual and not influenced by the other players valuation of the object, and third the private values are drawn from a common distribution, that is the bidders expectations are equally strong. When these three assumptions holds all the four basic auction methods will offer the object to the player who has the highest value of the object and the expected revenue for the player with the lowest value of the object will be equal to zero. And it will give the same expected revenue to the seller independently of the basic auction method chosen.

The revenue equivalence theorem is important in the studies of auction theories, but the simplification it builds upon are not always a correct way to see it, it is therefore important to look at how the different auction methods react when one of the assumptions behind the revenue equivalence theorem does not hold. This is studied in details under, with a special look at how the transit booking slot auction are influenced, but first one aspect that clearly influence the expected revenue for the seller in a positive way is covered.

### *7.4.1 Number of auction players*

In lecture notes from Sunde (2006) it is shown that when the revenue equivalence theorem holds and all the four auction methods have equal expectations for the revenue, the expected revenue will be equal to:

$$E(P) = \frac{n-1}{n+1} V^{\max}$$

Here n represent the number of players involved in the auction, $V^{max}$ the highest value of the object among the auction players and E(P) the expected price. The equation shows that the number of auction players has an important role toward the revenue expectations. The increase in the expected revenue for the seller, due to the increase in the number of auction players, is higher with a lower number of players involved in the auction, then it is when the number of auction players increases, this is clearly seen in the Figure 7.2.

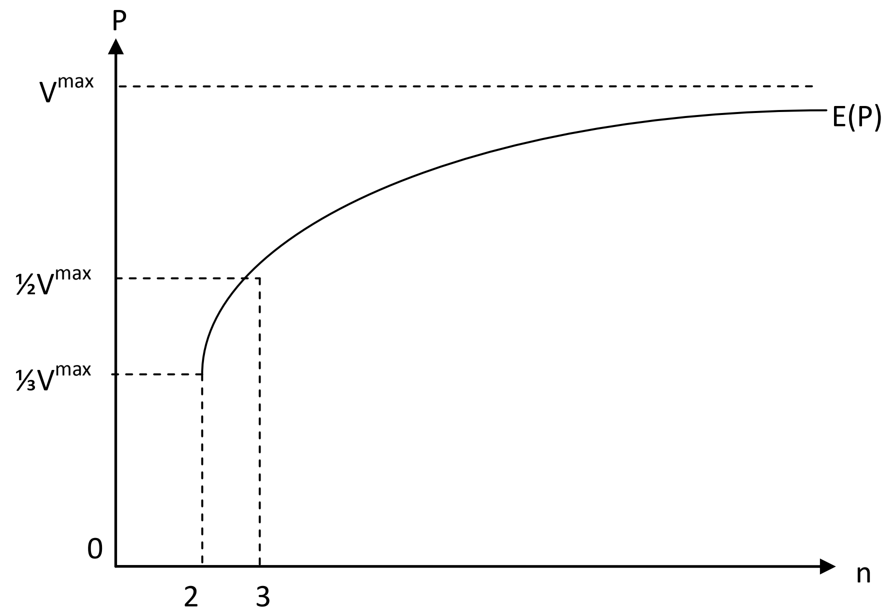


**Figure 7.2: The Number of Auction Players Effect on Expected Price for the Seller**
Source: Sunde, Ø. (2006). Privatverdiauksjoner av enkeltobjekter, forelesningsnotat 2 i SØK610. Molde: Molde University College.

The connection between the number of auction players and the increase in expected revenue for the seller is explained by that an increase in the number of players involved in the auction increases the number of players with a high valuation of the object, which leads to a more aggressive bidding strategy by the players and a higher expected price for object. Figure 7.2 also show that the marginal rise in $V^{max}$ is falling with an increase in n, this is due to the more aggressive bidding strategy the players use when it is more players involved. The aggressive strategy leads to each player bidding closer to their value of the object and when the price raises fewer players will have a $V^{max}$ above the price and therefore not be able to increase their bid.

### *7.4.2 Assumptions behind the revenue equivalence theorem do not hold*

When one of the three assumptions behind the revenue equivalence theorem does not hold, the four auction methods react differently and will not provide the same expected revenue for the seller any longer. The following paragraphs are based on Klemperer (2004) and lecture notes by Sunde (2006), and look at the different methods reaction when the different assumptions are broken.

The first assumption is about risk-neutral players, this is covered in an earlier part of this chapter with the findings that risk-averse auction players will not change their bidding strategy in an English auction and the expected revenue for the seller will remain the same as before. When considering other auctions methods, the introduction of risk-averse auction players changes the bidding strategy toward a more aggressive strategy, because they see the probability of losing as worse than the increased cost of winning, this leads to higher expected revenues for the seller. The conclusion when we have risk-averse auction players is that auction method two and three, the Dutch- and the first-price-sealed-bid auction, will generate the highest revenues for the seller.

The second assumption behind the revenue equivalence theorem is that the value of the object is fully individual and not influenced by the other player's valuation of the object. When this assumption does not hold, we have correlated values between the players, it means the object has some sort of common value and that other player's valuation of the object influence the player's bidding strategy. The other player's valuation remains secret for the others it is therefore an uncertainty related to how the common valuation is estimated by the players, which fear they estimate a higher common value than the others. This fear is often referred to as the winners curse, and makes the players use a less aggressive bidding strategy. It is therefore important for the auctioneer to make as much information as possible about the different player's valuation available to the other players, since more information leads to less fear for the winners curse. The solution here is to use auction method one, the English auction, which will give the player's full information about the others valuation and therefore a higher expected revenue to the seller. As second best choice is method four, the second-price sealed-bid auction, due to the security of only paying a price equal to the second highest bid.

The last assumption behind the revenue equivalence theorem is that all the player's private values are drawn from a common distribution, when this is not the case and the player's values are related with different probabilities, the different bidding strategies can be influenced by the player's "strength". This is not the case with English- and second-price-sealed-bid auctions which are not be influenced by asymmetric bidders, where asymmetric bidders refers to auction players with private values drawn from different distributions. For auction method two and four, the Dutch- and the first-price-sealed-bid auction, asymmetric players will make an impact on the bidding strategy. Players that know they represent a weak group will use an aggressive bidding strategy because they know they face strong competition. On the other side, players that know they belong to a strong group will use a less aggressive strategy. These two tactics works in the opposite direction of each other and it is therefore impossible to say whether the Dutch- and the first-price-sealed-bid auction will give a higher or lower expected revenue for the seller compared to the English- and second-price-sealed-bid auction.

Table 7.1 summarizes how the different auction methods react when the different assumptions behind the revenue equivalence theorem are broken and ranks them according to which gives the highest expected revenue for the seller. The table shows that there is not one of the methods that clearly dominate the others, but each situation has to be studied individually.

| | Risk-averse players | Correlated values | Asymmetric players |
|---|---|---|---|
| Method 1: English Auction | 2 | 1 | ? |
| Method 2: Dutch Auction | 1 | 3 | ? |
| Method 3: First -price sealed-bid auction | 1 | 3 | ? |
| Method 4: Second -price sealed-bid auction | 2 | 2 | ? |

**Table 7.1: Ranking of Auction Methods**

Note: 1 = best ranking, 3 = lowest ranking.

Source: Sunde, Ø. (2006). Privatverdiauksjoner av enkeltobjekter, forelesningsnotat 2 i SØK610. Molde: Molde University College.
Klemperer, P. (2004). Auctions: Theory and Practice. Princeton and Oxford: Princeton University Press.

When we look at the transit booking slot auction and consider the three different scenarios it is not clear which auction method the ACP should chose based on their criteria's, that is both to maximize revenue and to offer the lower ranked customers an extra possibility to secure the slots they want. The scenario with risk-averse players favor method two and four, that is not consistent with ACP's choice of an English auction model, but then it is important to evaluate if the players involved in the transit booking slot auction are of the risk-averse or the risk-neutral type. This question is difficult to give a clear answer to and will probably differ between the different customers using the transit booking slot auction. One argument is that the customers using the transit booking slot auction have not been able to secure a transit through the transit reservation system and are therefore very eager to secure the slot through the auction, which could be seen as being risk-averse, the fear of losing is worse than the higher cost of winning. Using this argument a first-price auction is clearly favored, but it could also be argued that the customers see the cost of winning in comparison with the cost of waiting or using alternative routes, and value this equally and could therefore be characterized as risk-neutral.

Scenario two, with correlated values, ranks the English auction method on top and supports the ACP choice of method. Considering this scenario with respect to whether or not you can find correlated values between the players involved in the transit booking slot auction is another way to look at it. It is hard to see any common value from a transit of the Panama Canal since the customers cannot sell a slot they have bought to other customers, the value of this service depends more on the individual customer's preferences, or alternative costs related to waiting or the use of other routes. This makes the scenario with correlated values less important for the ACP, when they decide which auction method to use.

The last scenario does not come up with a clear ranking for which method to choose in a general way, and it is equally hard to rank the methods with respect to the transit booking slot auction. For the transit booking slot auction it is clearly asymmetric players represented and it could be argued that this was one of the reasons for why ACP introduced the auction, since the high ranked customers in the ACP customer ranking was favored too much in the transit reservation system. With respect to the customers using the transit booking slot auction it is not clear which will be arranged in the "strong" group and which in the "weak" group, since this is influenced by each individual vessels operations and will probably change the customer's preferences for each time. In a general manner Maskin and Riley (2000) show that "strong" buyers prefer the second-price auction, that is either the English- or the second-price-sealed-bid auction, whereas "weak" buyers prefer the first-price auction, the Dutch- or the first-price-sealed-bid auction. This can be explained by looking at a second-price auction, which always ends up with the player valuing the object highest as the winner, which means the "strong" buyer. Whereas in a first-price auction the "weak" player might beat the "stronger" competitor, due to an aggressive bidding strategy and an equivalent less aggressive strategy for the "strong" player.

The question for scenario three becomes how to arrange the customers, if you group the high ranked customers in the ACP customer ranking as the "strong" group and the low ranked as the "weak" group, it would favor a first-price auction when taking into consideration that ACP introduced the auction as an extra service to the lower ranked customers. At the same time the expected aggressive bidding strategy from the "weak" group could work toward higher expected revenue for the ACP. It is clearly a question about whether this way of arranging "weak" and "strong" customers are correct, to say that the lower ranked customers in the ACP customer ranking are weaker player's might be wrong. These customers are actually the ones that most often are expected to use the transit booking slot auction and could therefore be expected to have higher private-values, which indicate that they should be the "strong" group. If this is the case, the ACP should chose a second-price auction, favoring the "strong" customers, such choice is also supported by auction theory in general, which says that second-price auctions not influence the players bidding strategy and will always have the player with the highest valuation of the object as the winner.

It is clearly a difficult decision to choose the auction method that best match ACP's requirements for the transit booking slot auction. Both a second-price auction, which they use now, and a first-price auction method, could be argued to be the best choice. It is also other aspects influencing how an auction should be set up and (Klemperer, 2004) discuss different aspects the seller should consider in supplement to the choice of auction method. These include the question about entry costs/reservation prices, discriminations of strong bidders, information sharing and royalties.

### *7.4.3 Other aspects to consider*

The question about royalties is not relevant for the transit booking slot auction and the information sharing is not very relevant either, since we have concluded that the transit through the Panama Canal does not have a common value for the customers, which would have made information sharing much more important. The discrimination of strong bidders is an aspect that could have been relevant for the ACP, due to the concern for lower ranked customers. However as argued above it is very hard to distinguish between "strong" and “weak” customers, it is therefore not clear if such discrimination strategy would be in line with ACP’s requirements for the auction.

The aspect that really is important for the transit booking slot auction is the entry cost/reservation price. An entry cost could be seen as a price just to enter the auction, this would only work toward fewer players in the auction, and as discussed earlier in this chapter, the higher number of auction players you have the higher is the expected revenue for the seller, so a price for entering the auction is not a good aspect to add to the auction process. When looking at the entry cost as a reservation price, or as a base price, which the ACP operates with, it is another case. A reservation price will make sure the seller does not lose money on selling the service/object to a lower price than the sellers own valuation of the object, or costs of providing the service. Klemperer (2004) discusses what the right reservation price is, and concludes that a reservation price should be equal to the sellers value of the object/service. Is the reservation price higher the seller risk that the object is not sold and if it is lower, he risk selling the object for less than he values it. In the transit booking slot auction the reservation price should therefore be set equal to the actual cost of transiting the vessel through the Canal.

# Part III

## 8. Concluding Remarks

### *8.1 The Panama Canal's position in World Seaborne Trade*

The Panama Canal has during its 94 years long life established itself as a major service provider for the maritime sector, offering all the different segments in the shipping world an alternative route between the Pacific Ocean and the Atlantic Ocean. For the fiscal year of 2007 the total number of vessels transiting the Panama Canal are reported to be 14.721 vessels, paying $ 1.183.929.208 in tolls to ACP and carrying 312.651.466 PCUMS tons of cargo (ACP, 2007h). These huge numbers indicate the important position the Panama Canal has got as a service provider for the maritime sector and makes it clear that the ACP is offering a well-known and popular service that the customers are willing to pay for to use.

The services offered by the Panama Canal is clearly of more value to some routes and segments than to others, and as reported and illustrated earlier in this paper, see Part I and Figure 1.3, the trade route between Asia and East Coast North America is undoubtedly the route that contribute the most to the total number of transits, tolls paid and volumes of cargo transported through the Canal. In the same way the paper has recognized the container segment as the most important segment with respect to number of transits, tolls paid and cargo transported, ahead of the dry bulk segment.

The future outlook for both these two segments are predicted to follow the developments in the world economy, (RS.Platou, 2008a) predicts that the container segment in 2008 will see a growth in the demand for ships on 12-13%, indicating a further increase in total goods transported as containerized goods. The prediction for the dry bulk market is indicating further growth on 5-6% from the very strong year seen in this segment in 2007 (RS.Platou, 2008a). These estimates for the coming year support the ACP's predictions about a growing demand for their services. The ACP predicts that the annual increase of PCUMS tonnage transiting the Panama Canal on average will be on 3% for the next 20 years, if the Canal is capable of handling the growing volume (ACP, 2006b).

The two major concerns for the ACP when estimating future demand for their services relates to the maximum capacity for transits handled by the Panama Canal today and the trend with growing vessel sizes seen in the shipping world today. The capacity constraint is calculated to be met between the years 2009 and 2012 and will make the Canal unable to meet further demand growths and reduce its competitiveness toward the alternative routes. The trend of larger vessel sizes is the other major concern for the Canal, and as described earlier in this paper, this relates to the dimensions of the Canal's lock chambers and act as a physical constraint making the Canal unable to serve the vessels that their customers prefer to use.

The trend of growing vessel sizes are clearly seen both in the container segment and in the dry bulk segment. RS.Platou (2008a) indicates that new vessels entering the market next year are mainly from the larger vessel groups, classified as post-Panamax vessels or greater, with a capacity to carry more than 8000 TEU for the container vessels. The trend of growing vessel sizes can be seen in the demand for Panama Canal transits, which for the last 15 years have seen the percentage of large vessels [1] transiting the Canal increasing from 23% out of the total number of vessels transiting in 1990 to 45% in 2005 (ACP, 2006b). And this trend is only expected to keep on indicating a serious problem for the Panama Canal.

The concern related to the capacity constraint of the Panama Canal is closely linked with the trend of growing vessel sizes. The larger vessels needs more time for transiting the Canal and therefore decrease the maximum level of vessels that can transit through the Canal every day. This together with predicted growth in almost all the market segments using the Canal makes the Canal meet its maximum level sometime between 2009 and 2012.

[1] Large vessel is here set to be equal or greater to 30.5 meter in beam/width.

### *8.2 The Importance of an Expansion*

The ACP's solution toward its challenges with a growing demand for its services and the trend of growing vessel sizes has been, as described in Part II, to expand the Panama Canal. The expansion process has, after its acceptance in a national referendum on 22$^{nd}$ of October 2006, started and is expected to double the Canals capacity when finalised in 2014. Based on the different arguments in this paper, five main points are stated in support to the decision of expanding the Panama Canal.

Meet the capacity challenge

> To be able to meet the growing demand for transits through the Panama Canal the solution to build an extra lock line in supplement to the existing two is a decision increasing the number of vessels able to transiting the Canal every day. And with the expected growth in PCUMS tonnage transiting the Canal from the 2005 level of 279 million PCUMS, which is equal to 85% of the maximum volume the Canal can handle without an expansion, to 508 million PCUMS in 2025, with an expansion, it is clearly a potential market for the expansion.

Meet the growing trend in vessel sizes

> The container segment is pointed out to be the main segment for the Canal and with the growing trend in vessel sizes seen in this market it is an important issue to meet these customers preferences and requirements. Out of the predicted PCUMS tonnage transported through the Canal in 2025, ACP (2006b) report that more than half of it will origin from the container segment. The introduction of a lock line with locks able to handle the modern post-Panamax container vessels is therefore highly needed.

Keep the Canal a favoured alternative for the Asia – East Coast North America route

> In the calculations under Part II in this paper it is shown that the Panama Canal offers a competitive route alternative in the trade between Asia and East Coast North America. However without an expansion of the Panama Canal to meet the requirements from the new post-Panamax vessels, the two main alternatives, the Suez Canal and the intermodal system through the U.S., will capture big shares from

the Panama Canal. The ACP (2006b) has calculated that from 2004 level, where the US intermodal system accounted for 61%, the Panama Canal for 38% and the Suez Canal 1%, of the containers transported between Asia and East Coast US, without an expansion of the Panama Canal this will change to 64% for the intermodal system, 23% for the Panama Canal and 12% for the Suez Canal. While an expansion will give the Panama Canal a further advantage leading to a market share of 49% in 2025.

Capture new markets

With an expansion of the Panama Canal the Canal will be able to handle larger vessels, such as Suezmax vessels with a size of 130.000 – 140.000 dwt., and will therefore open new possibilities for markets which have not seen the Panama Canal as an alternative before. This includes coal transportation from the US and Colombia to East Asia, oil from Venezuela to East Asia, natural gas from Peru to the US East Coast and post-Panamax cruise ships (ACP, 2006b). The possibility of capturing new markets clearly gives support to the expansion.

The Canals impact on the Panamanian economy

The ACP has turned the operations of the Panama Canal into a well-functioning business unit after they took over the administration of the Canal, generating huge incomes for the Panamanian Government every year. In 2005 this amount was on $489 million and with the expansion of the Canal planned so it does not affect the daily operations of the Canal, the amount is estimated to increase every year due to a growing demand and an annual increase of the Canal tolls, reaching close to 4 billion in 2025 (ACP, 2006b). It is also an important factor supporting the expansion plan from ACP that this is a so called self-financeable project, that is, a project that does not require any Governmental financial support, which means the Panamanian economy will not be affected by the huge investments required to implement the project.

### *8.3 How to deal with the capacity problem before 2014*

The capacity problem for the Panama Canal is estimated to occur sometime between 2009 and 2012, and it will then still remain 2-5 years of the expansion project before the Canal is able to handle the estimated demand again. During these 2 to 5 years, when the Canal is predicted to handle a demand equal or greater than its maximum capacity, special attention toward the transit booking system is required.

The transit reservation system outlined in detail under Part II of this paper show the three different possibilities for how to secure a transit of the Canal, that is, to use the reservation system, wait in line or use the transit booking slot auction. And as pointed out under Part II, the option of using the transit booking slot auction is today only used to a very limited amount. However the statistics over customers that have requested a transit of the Canal, but not succeeded, have risen from 1% in 2000 to 18% in 2005 out of the total transits (ACP, 2006b), this clearly indicates that the transit booking slot auction might become more popular in the near future.

The transit booking slot auction offer ACP an option to deal with the rising demand for its services, by allocating more slots to the auction than it does today the ACP will offer its customers an option to buy a transit slot to a price equal to the customers own value of the slot. The basic principle of an auction is to allocate an object to the buyer that has the highest value of it, and in the same time generate the highest possible income for the seller, which indicates that ACP can allocate the slots to the customers with the highest value of it and increase their incomes. In Figure 6.1 in Part II it is shown that the usage of the transit booking slot auction is today very limited and that most of the Canals customers are either using the transit reservation system or just a regular transit, which is to wait in line, to get their transit. This pattern can be expected to change due to an increased waiting time for all the customers that do not have a pre-booked slot, in 2005 the waiting time for customers with a pre-booked slot was approximately 16 hours, while for the ones using a regular transit it was close to 30 hours (ACP, 2006b), indicating that it is much time to save on having a pre-booked slot.

The long waiting time related to the regular transits can, with the rising demand, be expected to increase further, and ACP might be interested in allocate even more of the total available slots to the transit reservation system and the transit booking slot auction to plan the transits better and in that way manage to maximise the operations. With this argument we could expect an increased demand for the slot auction, and as argued in Part II, the higher the number of auction players is, the higher is the expected revenue for the seller, indicating an increase in income for ACP. For the customers more slots allocated through the slot auction will make it easier to secure a pre-booked slot, which clearly will be favourable due to the longer waiting time for regular transits.

One of the reasons behind the introduction of the slot auction was that lower ranked customers was not able to secure the slots they wanted through the transit reservation system, this reason gives support to an increase of slots allocated through an auction instead of only offering pre-book slots through the TRS. With the slot auction the customers own value of the slot will be of importance, without the customer ranking influencing the decision, it might increase the transit price, but, as argued in Part II, the optimal strategy in an auction is to stay in the auction as long as the price is below your value of the object, and leave the auction when the price increases over your value. When using this strategy, the slot should be expected to be offered to the customer that value it highest, which most probably will be the customer that have the highest costs on waiting or using an alternative route.

The ACP's decision about forming the transit booking slot auction based on an English auction method, as outlined in Part II, can with regard to the future where the slot auction get a more important role in the allocation of slots, be argued both to be a correct and a not correct decision. As argued in Part II the different auction methods are favoured with respect to different assumptions, this makes the assumptions about the auction players important when choosing auction method. When assuming the customers are risk-neutral, that is, they see the cost of transiting through the Canal in relation to wait in line or to use an alternative route the English method is the best choice. Further the discussion show that the question about asymmetric players is difficult, due to the grouping of strong and weak players, and that the question about correlated values are not valid with regard to the transit booking slot auction.

It could therefore be argued that the English method is the correct one, since it offers all the players all the information available through the open bidding rounds and allocates the slot to the player with the highest value, to a price equal the second highest valuation. With the price equal the second highest valuation, it could be said that ACP favours its customers, instead of maximizing its revenue, by offering the slot to a lower price than the customer actually valuing it to. This can be seen as a nice way to distribute a scarce service, which the slots are expected to be when the maximum capacity is reached. The fact that ACP is sharing information about other customer's valuation in an open bidding auction is also a way to secure that all the players will be in the auction until their value of the transit is reached, so it can be said to be a win-win situation for the customers, which maximizes their chances to secure the transit, and ACP, which maximizes their auction income. The information sharing might also lead to a better understanding from the customers and make it a more favourable environment in the years operating on maximum capacity.

# References:

ACP (2008a). *Board of Directors*. Retrieved 04 16, 2008, from Panama Canal Authority, About ACP, General Information: http://www.pancanal.com/eng/general/boardpca.html

ACP (2008b). *Changes to the Panama Canal Transit Reservation (Booking) System.* Retrieved 01 16, 2008, from Panama Canal Authority, Maritime Operations, Customer Information, Advisories to Shipping, A-02-2008: http://www.pancanal.com/common/maritime/advisories/2008/a-02-2008.pdf

ACP (2008c). *Customer Ranking Januar 08.* Retrieved 01 16, 2008, from Panama Canal Authority, Maritime Operations, More Information, Transit Booking: http://www.pancanal.com/eng/maritime/transit/index.html

ACP (2008d). *Panama Canal Transit Reservation System.* Retrieved 01 16, 2008, from Panama Canal Authority, Maritime Operations, Customer Information, Notices to Shipping 07-2008: http://www.pancanal.com/eng/maritime/notices/2008/n07-2008.pdf

ACP (2008e). *Project Progress Report.* Retrieved 05 14, 2008, from ACP Expansion Program, Reports: http://www.pancanal.com/eng/expansion/informes-de-avance/avance.html

ACP (2008f). *Safety Record*. Retrieved 04 16, 2008, from Panama Canal Authority, About ACP, General Information: http://www.pancanal.com/eng/general/record-de-seguridad.html

ACP (2008g). *Tolls Assessment.* Retrieved 11 10, 2007, from Panama Canal Authority, Maritime Operations, More Information: http://www.pancanal.com/eng/maritime/tolls.html

ACP (2008h). *Tolls.* Retrieved 04 23, 2008, from Panama Canal Authority, Maritime Operations, Marine Tariff, Item no 1010.0000: http://www.pancanal.com/eng/maritime/tariff/1010-0000.fp.swf

ACP (2008j). *Transit Reservation System.* Retrieved 04 23, 2008, from Panama Canal Authority, Maritime Operations, Marine Tariff, Item no. 1050.0000: http://www.pancanal.com/eng/maritime/tariff/1050-0000.fp.swf

ACP (2007a). *Commodity Movement, by Country of Origin and Destination (Atlantic to Pacific).* Retrieved 05 16, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table08.pdf

ACP (2007b). *Commodity Movement, by Country of Origin and Destination (Pacific to Atlantic).* Retrieved 05 16, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table09.pdf

ACP (2007c). *Commodity Movement, over Principal Trade Routes (Atlantic to Pacific).* Retrieved 05 20, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table10.pdf

ACP (2007d). *Commodity Movement, over Principal Trade Routes (Pacific to Atlantic).* Retrieved 05 20, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table11.pdf

ACP (2007e). *Forcast for the Month of January, All Vessels.* Retrieved 01 16, 2008, from Panama Canal Authority, Maritime Operations, Vessel's ETA & Transit Booking, Arrival Information: http://www.pancanal.com/eng/maritime/jit/all/all-01-DB001.HTM

ACP (2007f). *Panama Canal Tolls.* Retrieved 11 10, 2007, from About ACP, General Information: http://www.pancanal.com/eng/general/peajes-en-el-canal.html

ACP (2007g). *Principal Commodities Shipped through the Panama Canal.* Retrieved 05 21, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table07.pdf

ACP (2007h). *Traffic -- Fiscal Years 2005 - 2007.* Retrieved 06 05, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/reports/table01.pdf

ACP (2007i). *Traffic by Market Segment.* Retrieved 04 26, 2008, from Panama Canal Authority, Maritime Operations, Transit Statistics 2007: http://www.pancanal.com/eng/maritime/statisti.html

ACP (2006a). *Panama Canal Web Auction System.* Retrieved 01 17, 2008, from Panama Canal Authority, Maritime Operations, Information Systems, Auction System, User's Guide: http://www.pancanal.com/eng/maritime/auction/user-guide.pdf

ACP (2006b). *Proposal for the Expansion of the Panama Canal.* Retrieved 04 23, 2008, from Panama Canal Authority, Expansion Program,: http://www.pancanal.com/eng/plan/documentos/propuesta/acp-expansion-proposal.pdf

ACP (2001a). *Read our Story*. Retrieved 04 16, 2008, from Panama Canal Authority, About ACP, Canal History: http://www.pancanal.com/eng/acp/index.html

ACP (n.d. a). *Historic Milestones*. Retrieved 04 17, 2008, from Panama Canal Authority, About ACP, Canal History: http://www.pancanal.com/eng/ctransition/milestones.html

ACP (n.d. b). *This is the Canal*. Retrieved 16 04, 2008, from Panama Canal Authority, About ACP, General Information: http://www.pancanal.com/eng/general/asi-es-el-canal.html

ACP (n.d. c). *Vision, Mission and Values.* Retrieved 05 15, 2008, from Panama Canal Authority, General Information: http://www.pancanal.com/eng/general/vision-mision.html

Brooks, M. R. (2002). International Trade in Manufactured Goods. In C. T. Grammenos (Ed.), *The Handbok of Maritime Economics and Business* (pp. 90-104). London: Lloyds of London Press.

BunkerWorld. (2008). *BunkerWorld*. Retrieved 04 22, 2008, from BunkerWorld, Fuel Prices, Houston: http://www.bunkerworld.com/markets/prices/us/hou/

Fleming, D. K. (2002). Patterns of International Ocean Trade. In C. T. Grammenos (Ed.), *The Handbook of Maritime Economics and Business* (pp. 63-89). London: Lloyds of London Press.

Klemperer, P. (2004). *Auctions: Theory and Practice.* Princeton and Oxford: Princeton University Press.

Kumar, & Hoffman. (2002). Globalisation: The Maritime Nexus. In C. T. Grammenos (Ed.), *The Handbook of Maritime Economics and Business* (pp. 35-62). London: Lloyds of London Press.

Luxner, L. (2007, March). Canal Alternatives. *LatinFinance* , 1.

Maskin, E., & Riley, J. (2000). Asymmetric auctions. *The Review of Economic Studies, 67* , 413-438.

McGowan, M. (2005). The Impact of Shifting Container Cargo Flows on Regional Demand for U.S. Warehouse Space. *Journal of Real Estate Portfolio Management , 11* (2), 167-185.

RS.Platou (2008a). *The Platou Report 2008.* Retrieved 05 20, 2008, from RS Platou Oslo, Market Information:

http://www.platou.no/loadfileservlet/loadfiledb?id=1205311719484PUBLISHER&key=1205499801725

RS.Platou (2008b). *Trip charter rates for Bulk - Week 16*. Retrieved 04 22, 2008, from RS Platou Oslo, Dry Cargo, Weekly Freight Rates: http://www.platou.com/Shipbrokers/DryCargo/WeeklyFreightRates

Stopford, M. (1997). *Maritime Economics* (2 ed.). London and New York: Routledge.

Sunde, Ø. (January 2006). *Privatverdiauksjoner av enkeltobjekter, forelesningsnotat 2 i SØK610.* Molde: Molde University College.

Weber, R. J. (1983). Multi-Object Auctions. In R. Engelbrecht-Wiggans, M. Shubik, & R. Stark, *Auctions, Bidding, and Contracting* (pp. 165-191). New York: New York University Press.

WorldShippingRegister. (2008). *Sea Distances - Voyage Calculator*. Retrieved 04 21, 2008, from World Shipping Register, Sea Distances: http://www.e-ships.net/dist.htm

WTO (2007a). *Table 1.2.* Retrieved 04 26, 2008, from WTO, Resources, Trade Statistics, International Trade Statistics 2007, World trade developments in 2006; Trade by region; Table 1.4 Intra- and inter-regional merchandise trade, 2006: http://www.wto.org/english/res_e/statis_e/its2007_e/its07_world_trade_dev_e.htm

WTO (2007b). *Table 1.4.* Retrieved 05 16, 2008, from WTO, Resources, Trade Statistics, International Trade Statistics 2007, World trade developments in 2006; Trade by region; Table 1.4 Intra- and inter-regional merchandise trade, 2006: http://www.wto.org/english/res_e/statis_e/its2007_e/its07_world_trade_dev_e.htm

WTO (2007c). *World Trade Developments in 2006.* Retrieved 04 26, 2008, from WTO, Resources, Trade Statistics, International Trade Statistics, 2007: http://www.wto.org/english/res_e/statis_e/its2007_e/its07_toc_e.htm

# APPENDIX I

## Voyage Cash Flow Analysis for a Los Angeles - Rotterdam trip, through the Panama Canal:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | SHIP INFORMATION | | | | | | |
| | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | | |
| | | | | *Knots* | *Main* | *Auxiliary* | |
| | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | Laden | 14,0 | 33 | 1 | |
| | | | Ballast | 14,0 | 31 | 1 | |
| | | | In Port | - | 3 | 2 | |
| | | | Bunker price $ / ton | | 504 | 1035 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | VOYAGE INFORMATION | | | | | | |
| | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | Los Angeles - Rotterdam | 7.752 | 24,3 | 10 | 62.500 | 33,31 | |
| | Total: | **7.752** | **24,3** | 10 | 62.500 | **2.082.171** | |

| | | | |
|---|---|---|---|
| 3 | DAYS ON VOYAGE CALCULATIONS | | |
| 3,1 | Charter party speed | 14,0 | (Average for trip) |
| 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| 3,3 | Actual average speed | 13,3 | |
| 3,4 | Voyage distance | 7.752 | (From section 2 above) |
| 3,5 | Loaded days at sea | 24,3 | (tot distance / actual avg speed) |
| 3,6 | Port time & canal transit time | 10 | (From section 2 above) |
| 3,7 | TOTAL DAYS | **34,3** | |
| | | | |
| 4 | VOYAGE CASHFLOW | | |
| 4,1 | Freight Earnings $ | 2.082.171 | (From section 2 above) |
| 4,2 | Less broker's commision | 41.643 | (At 2 per cent) |
| 4,3 | Less voyage costs | | |
| | Bunker oil for main engine | 419.040 | (At consumption in section 1) |
| | Diesel oil for auxiliaries | 45.836 | (At consumption in section 1) |
| | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | Canal dues | 229.200 | (From Total Canal Dues, section 6) |
| | TOTAL | 994.076 | |
| 4,4 | Net earnings $ | 1.046.452 | |
| | *memo; daily earnings* | *30.522* | |
| 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| 4,6 | Net voyage cashflow | **1.046.452** | |
| 4,7 | Contribution to capital ($/day) | 30.522 | |
| | | | |
| 5 | PANAMA CANAL DUES | | |
| 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | For the first 10.000 tons | 32.000 | (Tariff = $3,20 * 10.000 ton) |
| | For the next 10.000 tons | 31.300 | (Tariff = $3,13 * 10.000 ton) |
| | For the remaining tons | 130.900 | (Tariff = $3,08 * 42.500 ton) |
| | Total Cargo Fee | 194.200 | |
| | | | |
| 5,2 | Transit Reservation System Fee: | 35.000 | |
| | | | |
| | Total Panama Canal Dues: | 229.200 | |

## Voyage Cash Flow Analysis for a Los Angeles - Rotterdam trip, using the Strait of Magellan

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | SHIP INFORMATION | | | | | | |
| | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | | |
| | | | | *Knots* | *Main* | *Auxiliary* | |
| | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | Laden | 14,0 | 33 | 1 | |
| | | | Ballast | 14,0 | 31 | 1 | |
| | | | In Port | - | 3 | 2 | |
| | | | Bunker price $ / ton | | 504 | 1035 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | VOYAGE INFORMATION | | | | | | |
| | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | Los Angeles - Rotterdam | 13.281 | 41,6 | 9 | 62.500 | 33,31 | |
| | Total: | **13.281** | **41,6** | 9 | 62.500 | **2.082.171** | |

| | | | |
|---|---|---|---|
| 3 | DAYS ON VOYAGE CALCULATIONS | | |
| 3,1 | Charter party speed | 14,0 | (Average for trip) |
| 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| 3,3 | Actual average speed | 13,3 | |
| 3,4 | Voyage distance | 13.281 | (From section 2 above) |
| 3,5 | Loaded days at sea | 41,6 | (tot distance / actual avg speed) |
| 3,6 | Port time & canal transit time | 9 | (From section 2 above) |
| 3,7 | TOTAL DAYS | **50,6** | |
| | | | |
| 4 | VOYAGE CASHFLOW | | |
| 4,1 | Freight Earnings $ | 2.082.171 | (From section 2 above) |
| 4,2 | Less broker's commision | 41.643 | (At 2 per cent) |
| 4,3 | Less voyage costs | | |
| | Bunker oil for main engine | 705.618 | (At consumption in section 1) |
| | Diesel oil for auxiliaries | 61.693 | (At consumption in section 1) |
| | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | Canal dues | - | (From Total Canal Dues, section 6) |
| | TOTAL | 1.067.311 | |
| 4,4 | Net earnings $ | 973.217 | |
| | *memo; daily earnings* | *19.231* | |
| 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| 4,6 | Net voyage cashflow | **973.217** | |
| 4,7 | Contribution to capital ($/day) | 19.231 | |
| | | | |
| 5 | PANAMA CANAL DUES | | |
| 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | For the first 10.000 tons | | (Tariff = $3,20 * 10.000 ton) |
| | For the next 10.000 tons | | (Tariff = $3,13 * 10.000 ton) |
| | For the remaining tons | | (Tariff = $3,08 * 42.500 ton) |
| | Total Cargo Fee | - | |
| 5,2 | Transit Reservation System Fee: | | |
| | Total Panama Canal Dues: | - | |

**Voyage Cash Flow Analysis for a Los Angeles - New York trip, through the Panama Canal:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | SHIP INFORMATION | | | | | | |
| | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | | |
| | | | | *Knots* | *Main* | *Auxiliary* | |
| | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | Laden | 14,0 | 33 | 1 | |
| | | | Ballast | 14,0 | 31 | 1 | |
| | | | In Port | - | 3 | 2 | |
| | | | Bunker price $ / ton | | 504 | 1035 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | VOYAGE INFORMATION | | | | | | |
| | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | Los Angeles - New York | 4.923 | 15,4 | 10 | 62.500 | 24,70 | |
| | Total: | **4.923** | **15,4** | 10 | 62.500 | **1.543.935** | |

| | | | |
|---|---|---|---|
| 3 | DAYS ON VOYAGE CALCULATIONS | | |
| 3,1 | Charter party speed | 14,0 | (Average for trip) |
| 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| 3,3 | Actual average speed | 13,3 | |
| 3,4 | Voyage distance | 4.923 | (From section 2 above) |
| 3,5 | Loaded days at sea | 15,4 | (tot distance / actual avg speed) |
| 3,6 | Port time & canal transit time | 10 | (From section 2 above) |
| 3,7 | TOTAL DAYS | **25,4** | |

| | | | |
|---|---|---|---|
| 4 | VOYAGE CASHFLOW | | |
| 4,1 | Freight Earnings $ | 1.543.935 | (From section 2 above) |
| 4,2 | Less broker's commision | 30.879 | (At 2 per cent) |
| 4,3 | Less voyage costs | | |
| | Bunker oil for main engine | 271.634 | (At consumption in section 1) |
| | Diesel oil for auxiliaries | 36.663 | (At consumption in section 1) |
| | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | Canal dues | 229.200 | (From Total Canal Dues, section 6) |
| | TOTAL | 837.497 | |
| 4,4 | Net earnings $ | 675.559 | |
| | *memo; daily earnings* | *26.573* | |
| 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| 4,6 | Net voyage cashflow | **675.559** | |
| 4,7 | Contribution to capital ($/day) | 26.573 | |

| | | | |
|---|---|---|---|
| 5 | PANAMA CANAL DUES | | |
| 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | For the first 10.000 tons | 32.000 | (Tariff = $3,20 * 10.000 ton) |
| | For the next 10.000 tons | 31.300 | (Tariff = $3,13 * 10.000 ton) |
| | For the remaining tons | 130.900 | (Tariff = $3,08 * 42.500 ton) |
| | Total Cargo Fee | 194.200 | |
| 5,2 | Transit Reservation System Fee: | 35.000 | |
| | Total Panama Canal Dues: | 229.200 | |

## Voyage Cash Flow Analysis for a Los Angeles - New York trip, using the Strait of Magellan

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | SHIP INFORMATION | | | | | | |
| | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | | |
| | | | | *Knots* | *Main* | *Auxiliary* | |
| | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | Laden | 14,0 | 33 | 1 | |
| | | | Ballast | 14,0 | 31 | 1 | |
| | | | In Port | - | 3 | 2 | |
| | | | Bunker price $ / ton | | 504 | 1035 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | VOYAGE INFORMATION | | | | | | |
| | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | Los Angeles - New York | 12.781 | 40,0 | 9 | 62.500 | 24,70 | |
| | Total: | **12.781** | **40,0** | 9 | 62.500 | **1.543.935** | |

| | | | |
|---|---|---|---|
| 3 | DAYS ON VOYAGE CALCULATIONS | | |
| 3,1 | Charter party speed | 14,0 | (Average for trip) |
| 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| 3,3 | Actual average speed | 13,3 | |
| 3,4 | Voyage distance | 12.781 | (From section 2 above) |
| 3,5 | Loaded days at sea | 40,0 | (tot distance / actual avg speed) |
| 3,6 | Port time & canal transit time | 9 | (From section 2 above) |
| 3,7 | TOTAL DAYS | **49,0** | |

| | | | |
|---|---|---|---|
| 4 | VOYAGE CASHFLOW | | |
| 4,1 | Freight Earnings $ | 1.543.935 | (From section 2 above) |
| 4,2 | Less broker's commision | 30.879 | (At 2 per cent) |
| 4,3 | Less voyage costs | | |
| | Bunker oil for main engine | 679.565 | (At consumption in section 1) |
| | Diesel oil for auxiliaries | 60.072 | (At consumption in section 1) |
| | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | Canal dues | - | (From Total Canal Dues, section 6) |
| | TOTAL | 1.039.638 | |
| 4,4 | Net earnings $ | 473.418 | |
| | *memo; daily earnings* | *9.654* | |
| 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| 4,6 | Net voyage cashflow | **473.418** | |
| 4,7 | Contribution to capital ($/day) | 9.654 | |

| | | | |
|---|---|---|---|
| 5 | PANAMA CANAL DUES | | |
| 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | For the first 10.000 tons | | (Tariff = $3,20 * 10.000 ton) |
| | For the next 10.000 tons | | (Tariff = $3,13 * 10.000 ton) |
| | For the remaining tons | | (Tariff = $3,08 * 42.500 ton) |
| | Total Cargo Fee | - | |
| 5,2 | Transit Reservation System Fee: | | |
| | Total Panama Canal Dues: | - | |

**Voyage Cash Flow Analysis for a Shanghai - New York trip, through the Panama Canal:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | SHIP INFORMATION | | | | | | |
| | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | | |
| | | | | *Knots* | *Main* | *Auxiliary* | |
| | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | Laden | 14,0 | 33 | 1 | |
| | | | Ballast | 14,0 | 31 | 1 | |
| | | | In Port | - | 3 | 2 | |
| | | | Bunker price $ / ton | | 504 | 1035 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | VOYAGE INFORMATION | | | | | | |
| | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | Shanghai - New York | 10.582 | 33,2 | 10 | 62.500 | 41,93 | |
| | Total: | **10.582** | **33,2** | 10 | 62.500 | **2.620.598** | |

| | | | |
|---|---|---|---|
| 3 | DAYS ON VOYAGE CALCULATIONS | | |
| 3,1 | Charter party speed | 14,0 | (Average for trip) |
| 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| 3,3 | Actual average speed | 13,3 | |
| 3,4 | Voyage distance | 10.582 | (From section 2 above) |
| 3,5 | Loaded days at sea | 33,2 | (tot distance / actual avg speed) |
| 3,6 | Port time & canal transit time | 10 | (From section 2 above) |
| 3,7 | TOTAL DAYS | **43,2** | |
| | | | |
| 4 | VOYAGE CASHFLOW | | |
| 4,1 | Freight Earnings $ | 2.620.598 | (From section 2 above) |
| 4,2 | Less broker's commision | 52.412 | (At 2 per cent) |
| 4,3 | Less voyage costs | | |
| | Bunker oil for main engine | 566.498 | (At consumption in section 1) |
| | Diesel oil for auxiliaries | 55.012 | (At consumption in section 1) |
| | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | Canal dues | 229.200 | (From Total Canal Dues, section 6) |
| | TOTAL | 1.150.710 | |
| 4,4 | Net earnings $ | 1.417.477 | |
| | *memo; daily earnings* | *32.849* | |
| 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| 4,6 | Net voyage cashflow | **1.417.477** | |
| 4,7 | Contribution to capital ($/day) | 32.849 | |
| | | | |
| 5 | PANAMA CANAL DUES | | |
| 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | For the first 10.000 tons | 32.000 | (Tariff = $3,20 * 10.000 ton) |
| | For the next 10.000 tons | 31.300 | (Tariff = $3,13 * 10.000 ton) |
| | For the remaining tons | 130.900 | (Tariff = $3,08 * 42.500 ton) |
| | Total Cargo Fee | 194.200 | |
| 5,2 | Transit Reservation System Fee: | 35.000 | |
| | Total Panama Canal Dues: | 229.200 | |

## Voyage Cash Flow Analysis for a Shanghai - New York trip, through the Suez Canal:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | | SHIP INFORMATION | | | | | | |
| | | *Ship type* | *dwt* | *Speed* | | | *Bunkers (tons / day)* | |
| | | | | | *Knots* | | *Main* | *Auxiliary* |
| | | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | | Laden | 14,0 | | 33 | 1 |
| | | | | Ballast | 14,0 | | 31 | 1 |
| | | | | In Port | - | | 3 | 2 |
| | | | | Bunker price $ / ton | | | 504 | 1035 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | | VOYAGE INFORMATION | | | | | | |
| | | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | | Shanghai - New York | 12.370 | 38,8 | 10 | 62.500 | 41,93 | |
| | | Total: | **12.370** | **38,8** | 10 | 62.500 | **2.620.598** | |

| | | | | |
|---|---|---|---|---|
| 3 | | DAYS ON VOYAGE CALCULATIONS | | |
| | 3,1 | Charter party speed | 14,0 | (Average for trip) |
| | 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| | 3,3 | Actual average speed | 13,3 | |
| | 3,4 | Voyage distance | 12.370 | (From section 2 above) |
| | 3,5 | Loaded days at sea | 38,8 | (tot distance / actual avg speed) |
| | 3,6 | Port time & canal transit time | 10 | (From section 2 above) |
| | 3,7 | TOTAL DAYS | **48,8** | |
| 4 | | VOYAGE CASHFLOW | | |
| | 4,1 | Freight Earnings $ | 2.620.598 | (From section 2 above) |
| | 4,2 | Less broker's commision | 52.412 | (At 2 per cent) |
| | 4,3 | Less voyage costs | | |
| | | Bunker oil for main engine | 659.662 | (At consumption in section 1) |
| | | Diesel oil for auxiliaries | 60.809 | (At consumption in section 1) |
| | | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | | Canal dues | 269.264 | (From Total Canal Dues, section 6) |
| | | TOTAL | 1.289.735 | |
| | 4,4 | Net earnings $ | 1.278.451 | |
| | | *memo; daily earnings* | *26.223* | |
| | 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| | 4,6 | Net voyage cashflow | **1.278.451** | |
| | 4,7 | Contribution to capital ($/day) | 26.223 | |
| 5 | | SUEZ CANAL DUES | | |
| | 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | | For the first 5.000 tons | 38.250 | (Tariff = SDR 7,65 * 5.000 ton) |
| | | For the next 5.000 tons | 26.000 | (Tariff = SDR 5,20 * 5.000 ton) |
| | | For the next 10.000 tons | 44.000 | (Tariff = SDR 4,40 * 10.000 ton) |
| | | For the next 20.000 tons | 28.000 | (Tariff = SDR 1,40 * 20.000 ton) |
| | | For the next 30.000 tons | 29.250 | (Tariff = SDR 1,30 * 30.000 ton) |
| | | Total Cargo Fee | 165.500 | |
| | 5,2 | Exchange Rate, SDR 1 = US $: | 1,62697 | |
| | | Total Suez Canal Dues in $: | 269.264 | |

## Voyage Cash Flow Analysis for a Shanghai - Rotterdam trip, through the Panama Canal:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | SHIP INFORMATION | | | | | | |
| | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | | |
| | | | | *Knots* | *Main* | *Auxiliary* | |
| | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | Laden | 14,0 | 33 | 1 | |
| | | | Ballast | 14,0 | 31 | 1 | |
| | | | In Port | - | 3 | 2 | |
| | | | Bunker price $ / ton | | 504 | 1035 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | VOYAGE INFORMATION | | | | | | |
| | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | Shanghai - Rotterdam | 13.411 | 42,0 | 10 | 62.500 | 41,76 | |
| | Total: | **13.411** | **42,0** | 10 | 62.500 | **2.609.754** | |

| | | | |
|---|---|---|---|
| 3 | DAYS ON VOYAGE CALCULATIONS | | |
| 3,1 | Charter party speed | 14,0 | (Average for trip) |
| 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| 3,3 | Actual average speed | 13,3 | |
| 3,4 | Voyage distance | 13.411 | (From section 2 above) |
| 3,5 | Loaded days at sea | 42,0 | (tot distance / actual avg speed) |
| 3,6 | Port time & canal transit time | 10 | (From section 2 above) |
| 3,7 | TOTAL DAYS | **52,0** | |
| 4 | VOYAGE CASHFLOW | | |
| 4,1 | Freight Earnings $ | 2.609.754 | (From section 2 above) |
| 4,2 | Less broker's commision | 52.195 | (At 2 per cent) |
| 4,3 | Less voyage costs | | |
| | Bunker oil for main engine | 713.904 | (At consumption in section 1) |
| | Diesel oil for auxiliaries | 64.185 | (At consumption in section 1) |
| | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | Canal dues | 229.200 | (From Total Canal Dues, section 6) |
| | TOTAL | 1.307.289 | |
| 4,4 | Net earnings $ | 1.250.270 | |
| | *memo; daily earnings* | *24.037* | |
| 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| 4,6 | Net voyage cashflow | **1.250.270** | |
| 4,7 | Contribution to capital ($/day) | 24.037 | |
| 5 | PANAMA CANAL DUES | | |
| 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | For the first 10.000 tons | 32.000 | (Tariff = $3,20 * 10.000 ton) |
| | For the next 10.000 tons | 31.300 | (Tariff = $3,13 * 10.000 ton) |
| | For the remaining tons | 130.900 | (Tariff = $3,08 * 42.500 ton) |
| | Total Cargo Fee | 194.200 | |
| 5,2 | Transit Reservation System Fee: | 35.000 | |
| | Total Panama Canal Dues: | 229.200 | |

**Voyage Cash Flow Analysis for a Shanghai - Rotterdam trip, through the Suez Canal:**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | | SHIP INFORMATION | | | | | | |
| | | *Ship type* | *dwt* | *Speed* | | *Bunkers (tons / day)* | | |
| | | | | | *Knots* | *Main* | *Auxiliary* | |
| | | *Panamax Bulk Carrier* | 66.000 | Design | 15,0 | | | |
| | | | | Laden | 14,0 | 33 | 1 | |
| | | | | Ballast | 14,0 | 31 | 1 | |
| | | | | In Port | - | 3 | 2 | |
| | | | | Bunker price $ / ton | | 504 | 1035 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | | VOYAGE INFORMATION | | | | | | |
| | | *Route* | *Distance* | *Days at sea* | *Days in port* | *Cargo* | *Freight $/ton* | |
| Leg 1 | | Shanghai - Rotterdam | 10.525 | 33,0 | 10 | 62.500 | 41,76 | |
| | | Total: | **10.525** | **33,0** | 10 | 62.500 | **2.609.754** | |

| | | | | |
|---|---|---|---|---|
| 3 | | DAYS ON VOYAGE CALCULATIONS | | |
| | 3,1 | Charter party speed | 14,0 | (Average for trip) |
| | 3,2 | Less sea margin | 5% | (Allowance for weather etc.) |
| | 3,3 | Actual average speed | 13,3 | |
| | 3,4 | Voyage distance | 10.525 | (From section 2 above) |
| | 3,5 | Loaded days at sea | 33,0 | (tot distance / actual avg speed) |
| | 3,6 | Port time & canal transit time | 10 | (From section 2 above) |
| | 3,7 | TOTAL DAYS | **43,0** | |
| 4 | | VOYAGE CASHFLOW | | |
| | 4,1 | Freight Earnings $ | 2.609.754 | (From section 2 above) |
| | 4,2 | Less broker's commision | 52.195 | (At 2 per cent) |
| | 4,3 | Less voyage costs | | |
| | | Bunker oil for main engine | 563.528 | (At consumption in section 1) |
| | | Diesel oil for auxiliaries | 54.827 | (At consumption in section 1) |
| | | Port costs | 300.000 | (Cost of port calls, an approximation) |
| | | Canal dues | 269.264 | (From Total Canal Dues, section 6) |
| | | TOTAL | 1.187.619 | |
| | 4,4 | Net earnings $ | 1.369.940 | |
| | | *memo; daily earnings* | *31.879* | |
| | 4,5 | Less operating costs | - | (daily operating cost * total days ) |
| | 4,6 | Net voyage cashflow | **1.369.940** | |
| | 4,7 | Contribution to capital ($/day) | 31.879 | |
| 5 | | SUEZ CANAL DUES | | |
| | 5,1 | Specific Cargo Tariff for the Dry Bulk Segment: | | |
| | | For the first 5.000 tons | 38.250 | (Tariff = SDR 7,65 * 5.000 ton) |
| | | For the next 5.000 tons | 26.000 | (Tariff = SDR 5,20 * 5.000 ton) |
| | | For the next 10.000 tons | 44.000 | (Tariff = SDR 4,40 * 10.000 ton) |
| | | For the next 20.000 tons | 28.000 | (Tariff = SDR 1,40 * 20.000 ton) |
| | | For the next 30.000 tons | 29.250 | (Tariff = SDR 1,30 * 30.000 ton) |
| | | Total Cargo Fee | 165.500 | |
| | 5,2 | Exchange Rate, SDR 1 = US $: | 1,62697 | |
| | | Total Suez Canal Dues in $: | 269.264 | |

Notes/Sources:

Sec 1: Bunker: Main = IFO 380
Bunker: Auxiliary = MDO (Marine Diesel Oil)
Bunker prices from Houston 22. April 2008.
Source: BunkerWorld. (2008). BunkerWorld. Retrieved 04 22, 2008, from BunkerWorld, Fuel Prices, Houston: http://www.bunkerworld.com/markets/prices/us/hou/

Sec 2: Distances are calculated with SEA DISTANCES - VOYAGE CALCULATOR
Source: WorldShippingRegister. (2008). Sea Distances - Voyage Calculator. Retrieved 04 21, 2008, from World Shipping Register, Sea Distances: http://www.e-ships.net/dist.htm
Freight rate per day = $60.730, this is the 2008 average until week 16 (22nd of April) for Panamax Bulk Carriers operating on a trip charter.
Freight rate in $/ton is given by ($60.730 * 34,3 days) / 62.500 ton = 33,31 $/ton. Where 34,3 is the shortest estimated time on this voyage.
Source: RS.Platou (2008). Trip charter rates for Bulk - Week 16. Retrieved 04 22, 2008, from RS Platou Oslo, Dry Cargo, Weekly Freight Rates: http://www.platou.com/Shipbrokers/DryCargo/WeeklyFreightRates

Sec 3: Port time & canal transit time uses a transit time of the Panama Canal equal to 1 day.

Sec 4: Port Costs are set to be $ 300.000, this is only an approximation, but this example is used to look at the differences between sailings through the Panama Canal or not, therefore the Port Costs are not of a high importance and will not influence this decision directly.

Sec 5: Specific cargo tariff is from ACP official web page, updated March 1, 2008
Source: ACP (2008). Tolls. Retrieved 04 23, 2008, from Panama Canal Authority, Maritime Operations, Marine Tariff, Item no 1010.0000: http://www.pancanal.com/eng/maritime/tariff/1010-0000.fp.swf
The Transit reservation fee is from ACP official web page, updated March 1, 2008. And it is assumed that the vessel is categorized in the largest vessel group.
Source: ACP (2008). Transit Reservation System. Retrieved 04 23, 2008, from Panama Canal Authority, Maritime Operations, Marine Tariff, Item no. 1050.0000: http://www.pancanal.com/eng/maritime/tariff/1050-0000.fp.swf
Other minor fees due to special requests may occur when transiting the Canal.

Layout and other information:
Source: Stopford, M. (1997). Maritime Economics (2 ed.). London and New York: Routledge.

# APPENDIX II

ACP 4623
Rev. 1-2004

## AUTORIDAD DEL CANAL DE PANAMÁ

**REQUEST FOR TRANSIT BOOKING**

(Complete on typewriter or legibly printed)

**SECTION A.** *(To be completed by Vessel Agent)*

| 1. Vessel Name | 2. S.I.N. | 3. Vessel Agent | 4. Customer Code |
|---|---|---|---|
| | | | |

5. Transit Booking *(Check one box and show month, day and year)*
☐ North
☐ South  Date _ _ _ _ _ _ _ _ _ _

6. Vessel Beam
☐ Under 91'
☐ 91' or over

7. If beam is 80' or over but under 91' state draft

8. Vessel is carrying
☐ Dangerous Cargo  If box is checked, dangerous cargo information must be declared to ETA Clerk.

9. Initial Transit
☐ Yes
☐ No

10. Integrated tug and barge? If yes, please state name and S.I.N. of joint unit.
☐ Yes  Name: _ _ _ _ _ _ _ _ _ _
☐ No  S.I.N. _ _ _ _ _ _ _ _ _ _

11. Remarks

**STAMP DATE AND TIME REQUEST RECEIVED**

12. Does the vessel have any other characteristic e.g., protrusions, unusual configuration, etc., which under Panama Canal regulations would require that it transit under restriction, e.g., clear-cut, daylight in the cut, full daylight transit, etc.?
☐ Yes  If Yes, describe:
☐ No

13. I certify that, to the best of my knowledge and belief, the above information is true and correct and that my principal has authorized me to book the named vessel for transit. In consideration of the named vessel being booked for transit, my principal agrees to pay the prescribed fees and to comply with the provisions of the Vessel Transit Reservation System contained in the Autoridad del Canal de Panamá Canal Water Navigation Regulations, articles 12 to 25.

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Autorized Vessel Agency Representative´s Name

_ _ _ _ _ _ _ _ _ _ _ _
Signature

**SECTION B.** *(To be completed by the Autoridad del Canal de Panamá)*

| **TRANSIT BOOKING** | | **TRANSIT BOOKING CONDITION** | **TRANSIT BOOKING REQUEST** | **REQUIRED ARRIVAL TIME** |
|---|---|---|---|---|
| ☐ First Period<br>☐ Second Period<br>☐ Third Period | | ☐ First Condition<br>☐ Second Condition<br>☐ Third Condition | ☐ APPROVED<br>☐ REJECTED | ☐ 0200<br>☐ 1400<br>☐ Commercial Passenger Vessel (exempted from arrival time requirement) |
| Restriction | HML | PC/UMS Tons | Booking Fee<br><br>$ | |

Rejection reason/comments:

Approved by: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
(Autoridad del Canal de Panamá Representative)

**SECTION C.** *(To be completed by Vessel Agent and the Autoridad del Canal de Panamá)*

☐ Request for same-day transit (lost reservation due to late arrival)

_ _ _ _ _ _ _ _ _ _ Vessel Agent  _ _ _ _ _ Date

☐ Approved
☐ Disapproved

_ _ _ _ _ _ _ _ _ _ Autoridad del Canal de Panamá Representative  _ _ _ _ _ Date

☐ Request for daylight transit

_ _ _ _ _ _ _ _ _ _ Vessel Agent  _ _ _ _ _ Date

☐ Approved
☐ Disapproved

☐ 120 or more days in advance
☐ less than 120 days in advance

_ _ _ _ _ _ _ _ _ _ Autoridad del Canal de Panamá Representative  _ _ _ _ _ Date