Economic Feasibility of a Fast Car-Ferry Service

by

Javier Saez Ramirez

Naval Architect,
Escuela Tecnica Superior de Ingenieros Navales, Madrid, Spain, 1997

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Signature of the Author ______________________
Department of Ocean Engineering
May 1998

Certified by ______________________
Henry S. Marcus
Professor of Marine Systems
Chairman, Ocean Systems Management Program

Accepted by ______________________
J. Kim Vandiver
Professor of Ocean Engineering
Chairman, Ocean Engineering Departmental Graduate Committee

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Abstract

Since the early nineties, the introduction of new High Speed Car-Ferries has had an important effect on waterborne transportation networks. In some of the most characteristic routes around the globe, a substitution process of conventional ferries by high-speed units in a certain domain of distances is taking place.

The purpose of this research is to analyze the economic parameters that define the Fast Ferry market and to study the economic feasibility of such a service. The demand for the service, the cost structure of both the fast car-ferry and the conventional ferry as well as competitive issues characteristic of the industry will be analyzed to determine the feasibility of a high-speed service. Special attention will be paid to the possibility of substituting conventional ferries with fast car-ferries.

Thesis Supervisor: Henry S, Marcus
Professor of Marine Systems

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INTRODUCTION

Motivation for the Study

Since the early nineties, the introduction of new High Speed Car-Ferries has had an important effect on waterborne transportation networks. Prior to the present decade, the speed at sea had been restricted to a very limited number of passenger-only ferries. In some of the most characteristic routes around the globe, a substitution process of conventional ferries by high-speed units in a certain domain of distances is taking place.

Up until today, both the number of units ordered and the size of the vessels continue to grow. The market has already validated the size of the vessels initially introduced, around 400 passengers and 75 cars, sailing at around 35 knots. New orders have focused on bigger and faster units, with the biggest ones currently in operation of 1,500 pass / 375 car catamarans sailing at 40 knots, and the faster one a 450pass / 50cars sailing at 55 knots.

Such a young transportation service has not yet reached its equilibrium. Operators continue to study new proposals in relation to both routes and technical particulars. Certain operators in the market believe that these new vessels will create a revolution in the ferry market, while others remain doubtful, thinking that the profitable application of the new designs will remain confined to a few very specific routes.

The Fast Car-Ferry market has been especially developed in European routes. The deregulation of passenger transportation at sea within the UE member states scheduled to be effective in 1999 will move to a more competitive market, and operators with competitive advantages will take advantage of the situation. Within this framework, the study of the Fast Car-Ferry, its economies and its viability as a concept become important issues.

Aim and Scope

The purpose of this research is to analyze the economic parameters that define the Fast Ferry market and to study the economic feasibility of such a service. The demand for the service, the cost structure of both the fast car-ferry and the conventional ferry as well as competitive issues characteristic of the industry will be analyzed to determine the feasibility of the high-speed service. Special attention will be paid to the possibility of substituting conventional ferries with fast car-ferries.

The study will be specifically, although not exclusively, focused on vessels of over about 500 pass/100 vehicles with a minimal speed of 35 knots. The range of the routes analyzed will include trips in between 20 and 200 nautical miles. This is the range where timesaving offered by the high speed vessels can be appreciable. The study will be limited to inter-city waterborne transportation.

To the extent that information is available, a database including existing vessels and new orders, defined with technical characteristics with relevant economic influence, prices, delivery dates, operators, builders, routes, passengers carried, etc. will be developed. This database will be used as a support for the study.

Chapter 1

AN OVERVIEW OF THE INDUSTRY

This chapter provides the necessary knowledge about the Fast Ferry industry to develop the targeted goals of the study. In conjunction with Appendices 1 and 2, it will provide knowledge about the state of the art in the Fast Car-Ferry industry. We begin by briefly reviewing the history of fast ferry transportation. In the second section, the potential markets for Fast Ferry services are outlined, pointing out the main characteristics of the existing routes. The main particulars defining the vessels and specially those with economic influence are reviewed. Finally, we present an overview of the current corporate structure of the industry.

1.1 Brief History of the Fast Ferry Industry[1]

It may come as a surprise to learn that the world's first Fast Ferry, using the classical definition of a commercial vessel sailing over 25 knots, entered service on a route in southern Italy, linking Sicily with mainland Italy in August 1956. That first ferry, a 72 seat PT.20 designed by Supramar and built by Rodriquez, remained in service for almost 30 years and the same design is still operated on the route to this day.

In June 1957 the first hydrofoil designed for river routes was launched in the USSR. The total number of hydrofoil ferries produced in the former USSR is supposed to have been very large. Although available data is not very reliable, the production lines of just three designs (the Raketa, Meteor and Kometa) exceeded 1,000 vessels.

Conveniently, at the beginning of each subsequent decade since the 1950s, a new fast ferry concept has emerged. We will consider the development of the industry on a decade by decade basis:

1956-1959: Surface piercing hydrofoils

Following the introduction of its first hydrofoil in 1956, Rodriquez had a monopoly for the remainder of the decade. The company initially concentrated on production of the PT.20 but introduced the larger PT.50 in 1959.

[1] This section is primarily based on information contained in Refs. [1] to [8].

At the end of the decade, the prospective fast ferry operator had the choice of one yard, one type of vessel, two designs, a size range of 70-140 seats and a service speed of approximately 32 knots.

1960-1969: Surface Effect Ships (SES)

Air cushion vehicles (hovercraft and sidewall hovercraft, or SES vehicles) were introduced, but with limited commercial success. Supramar remained the dominant designer with the PT.20 and PT. 50 and Rodriquez had been joined as licensee by Hitachi in Japan and Westamaran in Norway. For most of the decade, surface piercing hydrofoils were the only practical option available to operators and the size range remained identical to the one offered in the fifties.

Towards the end of the decade there were two significant developments in the United Kingdom. One, the appearance of the Hovermarine 216 SES, was to have a pronounced impact on fast ferry development during the next two decades. The other was the appearance of the British Hovercraft Corporation SR.N4, and was to prove a false dawn.

At a time when the largest capacity/service speed being offered elsewhere was 140 passengers and 32 knots, this was a vessel capable of carrying 254 passengers plus 30 cars at a service speed of up to 65 knots. It is worth pointing out that two of those self-same craft, rebuilt as larger versions during the late 1970s, are still in service in the English Channel (operated by Hoverspeed, a subsidiary of SeaContainers). They carry 390 passengers and 55 cars at a service speed that results in an average crossing time of less than 30 minutes - faster that the train trip through the Channel Tunnel.

1970-1979: Asymmetric Catamarans

This was the period when passenger transport around the West Coast of Norway was changed by the appearance of the Westamaran 86. The builder was Westamaran, who having built Supramar hydrofoils under license, could see the attraction of high speed at sea, but could also see that the market was being suppressed by the relatively high cost and perceived sophistication of providing such a service.

The company's solution was to produce a catamaran that could carry 160 passengers with a reasonable ride quality for the Norwegian market. Although the service speed was approximately 7 knots lower than that of the hydrofoils, it was still faster than what had been generally available in the area previously. A few years after the Westamaran 86, a 180-seat having a service speed of around 28 knots, the Westamaran 95, appeared and started to make an impact on export markets.

While this was happening, Rodriquez had started to build its own designs, which were marginally larger and marginally faster than those proposed by Supramar. At the same time, Hovermarine was having considerable success with its HM 216, a design able to carry up to 65 passengers at a service speed of 35 knots.

By the end of the 1970s, the number of fast ferries built had doubled, and the number of designs available was seven. Fast ferries with capacities of over 200 passengers were still relatively rare.

The 1970s also proved to be the high point, in terms of commercial sales, of hovercraft. We should also mention the Boeing Marine Systems Jetfoil, a 260-seat fully submerged hydrofoil design that has a service speed of 42 knots and a ride quality that fast ferry designers continue to use as a benchmark to this day. The craft is still in license production but a design that was expected by its builder to be very well received became, like the SR.N4 hovercraft, a one-route vessel. SR.N4 is in operation only in Dover-Calais, and the Jetfoil, in Hong Kong-Macao.

1980-1989: Symmetrical Catamarans

The 1980s were the decade of commercial realism as far as the fast ferry industry was concerned. It was the decade when the builders and operators made the breakthrough. The number of countries building fast ferries doubled, symmetrical catamarans appeared, and for the first time one country, Norway, could claim to have more than one significant builder. By the end of the decade, not only were the symmetrical catamarans considerably bigger than the surface piercing hydrofoils, they were also as least as fast. A country that had not previously figured at all – Australia – entered in the scene. The number of operators in Australia was limited, basically to Barrier Reef excursions, as was its design base but in International Catamarans, it had a company that was prepared to license builders around the world. The country also had companies that were experienced in aluminum construction and by the end of the 1980s, two Australian yards were becoming dominant.

Growth in the size of fast ferries worldwide had also been substantial and by the end of the 1980s, operators had a choice going up to 449 seats - the largest then allowed by international legislation. They still had only eight basic types to choose from. By 1989 the catamaran was the most common type of vessel.

The 1980s was the decade when Hovermarine completely dominated the market for fast ferries up to 100 seats, apart from the vessels purchased by Norwegian operators, at the expense of the surface piercing hydrofoils. By now, the hydrofoil market had basically been marginalized to 150-250 seats.

Around the middle of the 1980s, there was also another important development that has proved successful: the appearance of the first wavepiercing catamaran.

1990s: Fast Car-Ferries

Since the early nineties, when the size of the vessels started to grow, several yards now looking for new markets to replace lost naval orders, entered the commercial high-speed sector. Their strategy has been to offer designs that they know and understand -

high speed monohulls. The possibility of high value contracts has also attracted yards that would have previously dismissed fast ferries as being too small to bother with.

One result of all this is that there is now a much wider geographic spread of fast ferry builders, particularly in Europe. At present, vessels are under construction in 19 countries around the world. However, most of those countries continue to be represented by just one or two yards. Approximately 85% of all the fast ferries ever built are still in existence.

The first Fast Car-Ferry suitable for commercial use transporting both passengers and cars was the "Great Britain" wave piercing catamaran, built in Australia on account of the British conglomerate SeaContainers. It was destined to the English Channel and, although it suffered some operating problems, it proved that this new mode was technically practicable and profitable.

At present, the industry is dominated by vehicle carrying ferries. The number in service and on order continues to grow, as does the size of the designs, some of which now have a limited bus and truck carrying capability. One of the most recent to appear is the Stena HSS 1500.

To take the growth at one yard, International Catamarans Australia, as an example, in 1990 the normal size of the 74m wavepiercer was 450 passengers plus 84 cars. In 1996, the standard production model was an 81m wavepiercer able to carry 700 passengers and 180 cars. But from the middle of 1997 onwards, the standard design has been an 86m wavepiercer capable of carrying 800 passengers and 200 cars.

Development of the Fast Ferry Fleet

Type	Number 1990	Number 1997	Growth %	1997 Fleet Avg age	1997 Fleet Passenger capacity	1997 Fleet Car capacity
Catamaran	311	530	70.4%	6.5	151.6	3,911
Hovercraft	45	28	-37.8%	11.5	3.4	184
Hydrofoil	368	343	-6.8%	16.9	50.4	0
Monohull	118	215	82.2%	7.4	45.5	2,091
SES	61	102	67.2%	11.4	18.2	0
Total	903	1,218	34.9%	10.1	269.1	6,186

Source: Drewry Shipping Consultants

Table 1.1.1: Development of the Fast Ferry Fleet

With the exception of two SR.N4 hovercraft, all the vehicle ferries at present in service have been built since 1990. At the end of 1995, 37 of the 85 fast ferries on order were vehicle ferries. In Table 1.1.1 we summarize the growth of the industry in the nineties.

Ponder the words of the chairman of Stena Line, an operator that currently operates several Incat wavepiercers, a HSS 900 catamaran, and three HSS 1500 catamarans:

"Our technical achievements [with the HSS] will revolutionize ferry traffic worldwide and the commercial importance of this breakthrough can be likened to the changeover in the aviation industry from propeller driven aircraft to jet engines"

1.2 Fast Ferry Markets

Waterborne transportation is something that continues to be seen by the general public as a strange or, at least, an unfamiliar transportation mode. For the rest of the transportation modes it will not be necessary to explain what their potential markets are; it is something that, for most people, is intuitively obvious.

In the introductory notes to this thesis, the length of the potential routes to be studied was limited to a range between 20 and 200 nautical miles. The reason for this restriction is that, with the level of technology presently available, the proposed distance range is the one in which a fast car-ferry can compete with other transportation modes. For longer routes, timesaving will never be comparable with those of the air mode, and if time is not a constraint, the conventional ferry seems a "good enough" alternative. Also, different regulations require providing cabins when trip time exceeds a certain number of hours. For distances under a certain limit, which we have roughly defined equal to 20 miles, the time gains, in comparison to the conventional ferry, decrease by the presence of the port and terminal timing constraints to levels at which the service does not offer any competitive advantage.

For existing routes, Appendix 2.1 serves as a valid reference to show where large fast ferries are an available mode at present. The main areas with fast ferry presence can be divided geographically as follows:

- Those surrounding U.K. (the English Channel, including routes from Belgium Holland, the Ireland- England or Scotland routes).
- Scandinavian routes, mainly connecting Denmark with the Scandinavian peninsula,
- West Mediterranean routes, either from mainland Italy to Sardinia, mainland France with Corsica or mainland Spain with the Balearic Islands, and also the Gibraltar Strait, connecting mainland Spain with Ceuta or with Morocco.
- Other routes, including Rio de la Plata (linking Argentina with Uruguay), Australia-Tasmania route, the Cook Strait in New Zealand, the British Columbia project, one route in Japan, domestic Greek routes and others in Asia.

Future potential markets, based on geographical considerations and in an important ferry tradition (i.e., routes where the distance range is appropriate and the economy of the area is perceived as being capable to support such a service), can be found in several places. To mention just some examples, within the U.S. (see Ref. [4]), Lake Michigan offers interesting possibilities as does the Hawaiian Islands. In an international context, several places on the planet offer potential for development. Some connections between U.S. and certain Caribbean destinations can also be potential routes. In Asia, Japan, Philippines and Malaysian domestic routes also offer high potential for development. In Southern Europe, expansion is now facing the eastern Mediterranean countries, especially the inter-island Greek network.

A categorization of the markets attending to the trip purpose will allow us to distinguish between the two most important segments of this market. To the present, fast car-ferries have been introduced in routes serving recreational destinations and in routes serving non-recreational destinations with high passenger flow rates round the year. The analysis of the different routes in service shows that, from a distance viewpoint, recreational destinations tend to be longer links.

However, the most important fact that clearly distinguishes these two routes is the seasonality of the demand. In the case of non-recreational routes, although with clear peak periods and therefore important seasonal effects over the demand, vessels are capable to operate round the year. In the case of recreational routes, the ships are not profitable out of the summer season. In this second case, the operators need to relocate the vessel in the winter season. The strategies to relocate the vessels in the off-summer periods will be discussed later on in this study.

The competing modes in a given route are also an important parameter to look at. Among the existing routes, the most extensive competition is found in the English Channel. In this route, we find all potential competitors. Airplanes, joining Paris and Brussels with London; the fixed link, provided by Eurotunnel, offering direct high-speed trains to link London with Paris and Brussels and Shuttle trains to transport freight vehicles and passengers between Dover and Calais, the conventional ferry operators and the fast ferry operators. In most of the cases the fixed link is not an available mode, although fixed links are expected to join, in the near future, Denmark with the Scandinavian Peninsula and Argentina with Uruguay.

The existence of a fixed link is in practice synonymous with a non-recreational and short route. That is the case of the all the (three) existing or projected major links. Nevertheless, the most common situation that we find is a fast ferry competing with a conventional ferry.

Seasonality can also be due to weather or sea-state conditions. This would be in direct relation with a parameter that must be analyzed from both the viewpoint of the vessel and the route: the level of reliability of the service. By reliability we mean the ability of the ship to sail at the targeted speed in rough seas (without causing seasickness to the majority of the passengers, or deteriorating the vehicles). Prior to the introduction of a Fast Car-Ferry in a given route, it is necessary to perform a statistical analysis of the sea state along the operational season. With these data, the operator will be able to statistically infer the expected number of days that the service will not be operational, and the number of days that it will be operated at lower speeds. A Reliability coefficient for a given route summarizing this information will be used. In the following section of this chapter we will analyze the problem from the vessel's design perspective.

All the route examples outlined a few paragraphs above share some common characteristics, apart from the fact that they are in a certain distance range. First, previous to the introduction of a fast ferry, there was a conventional ferry operating in the route. In most of the routes the conventional ferry continues to operate, although capacity has been reduced. From this viewpoint, the fast ferry is somehow implicated in a substitution process of conventional units. Second, all of the routes are located in areas where the average household income is enough to support the extra-cost associated with the timesaving offered by the service. The routes are located in well-developed economies. Third, the introduction of the fast service has expanded the number of passengers and cars carried. It is not clear to what extent this fact relates to the introduction of the new mode or if it has just been the consequence of introducing the new service at a time in which demand for transportation is suffering strong growth.

The previous discussion and the information contained in Appendix 2 help to gain knowledge about the routes where Fast Car-Ferries are potential competitors. We have reviewed the different parameters that can characterize a route, including trip purpose, domestic or international route, distance, seasonality, and competing modes.

For the purposes of this study, we now suggest to breakdown the routes in the following categories:

- Short Non-Recreational Route: operating throughout the whole year, competing with a conventional ferry offering seats, a fix link (in some cases) and indirectly with air transportation services. The best example for this category may be the Dover-Calais route.

- Long Non-Recreational Route: operating throughout the whole year in longer routes, competing with a conventional ferry, offering seats and in some cases also cabins, and indirectly with airplane services. Two very different examples of this category are the routes between Montevideo and Buenos Aires and the one between Hook of Holland and Harwich.

- Recreational Route: operating only in the peak season, the vessel must be relocated or shifted to another service in the off season. They operate in a distance range longer on average than the non-recreational routes. They are in competition with the airplane and the conventional ferry, offering both seats and cabins. Examples of recreational routes include the links between the Mediterranean islands Mallorca, Corsica and Sardinia and the mainland of their respective countries, Spain, France and Italy.

The distance range chosen, between 20 and 200 miles, shows approximate figures just for guidance. It will be difficult for all the existing routes to fit in the rigid frame of a given range of distances. In any case, to define the upper limit of the long route, considerations about comfort and time on board for passengers, regulations imposing the disposition of cabins for trips over certain travel time, and relative timesaving to other modes have been taken into account. To define the minimal distance of the short route, relative timesaving with respect to conventional ferries has been the most important issue taken into consideration.

The proposed classification intends to distinguish routes looking to the core of their economics. Regarding the demand on the route, the main distinction is recreational versus non-recreational markets. Regarding costs, the main distinction is long versus short routes.

1.3. Fast Ferry Characteristics

This section intends to overview fast ferry's technical characteristics and discusses those with economic influence. We begin by choosing the most representative issues and afterwards we discuss in depth different available alternatives and their consequences. The main particulars of most of the ships currently operating or on order are included in Appendix 1.

To characterize a specific vessel we have chosen to take into account the following features [10]:

- Basic available designs
- Construction material
- Geometrical particulars
- Transportation Capacity
- Performance
- Construction time
- Crew

Other important characteristics of the ships, such as price, financial conditions, and in general the cost structure will be studied in Chapter 4.

Design Types

At present there are three basic available designs on the market (Figure 1.3.1): Conventional Catamarans, Wave Piercing Catamarans and Monohulls. In short, it is generally accepted that catamarans constitute the best choice for calm seas, while single-hull units are supposed to offer major flexibility to service requirements, granting better performance on rough seas. This difference is more difficult to detect as vessels grow in size.

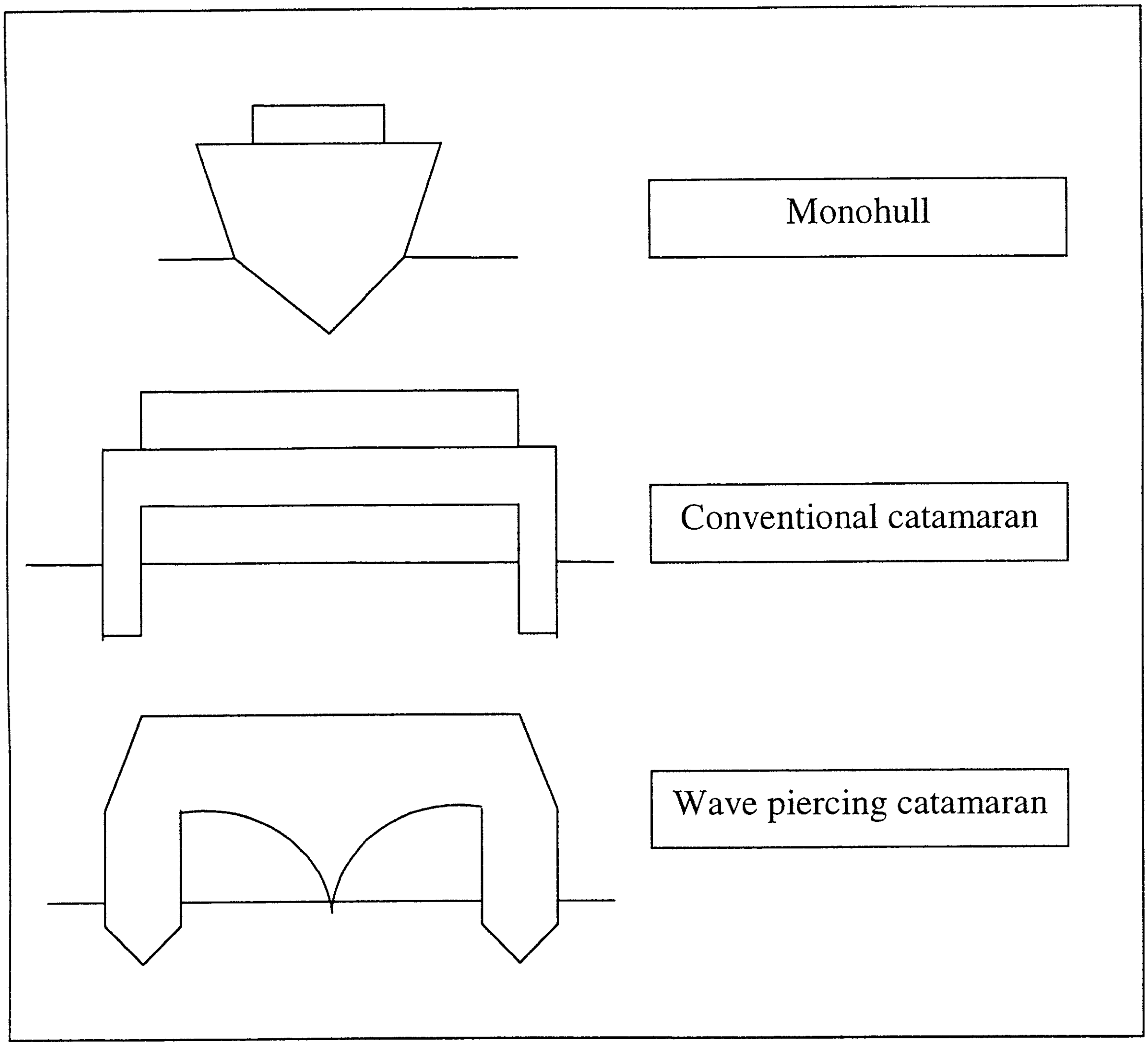


Figure 1.3.1: Fast Car-Ferry Typology

In reference to the typology of the builders, simplifying the matter, we can say that monohulls are offered especially but not exclusively, by shipyards with strong military construction tradition, while wavepiercer catamarans are exclusive of the Australian builder InCat (International Catamarans). Conventional catamarans are built in several different shipyards, especially in Australia and Scandinavian countries.

Although the type chosen has not a direct economic effect, it will have a direct relation with the route to which the vessel is optimized and the reliability of the service in relation with its sea-keeping properties. It will also be related to the type of terminal most suitable. If no investment at all is to be made in the terminal, monohulls are the most appropriate option. Catamarans will provide the operator with bigger beams thus giving them greater flexibility to decide the configuration of the public spaces.

The reported prices for existing units tend to show higher values for catamarans. In any case, this information has to be carefully examined, since the importance of subsidies in the shipbuilding industry (especially in the case of naval constructors) can distort the real investments made by the owners. In EU countries OECD conditions are assumed to be mandatory, which is not necessarily the case in Australia.

Construction material

Two basic options are available for fast ferries: aluminum alloys and high tensile steel. Combinations of these basic options are also possible; the most common is a high tensile steel hull with an aluminum superstructure. For certain parts on the superstructure composite materials can also be used. Although certain hulls have been built of high tensile steel, the most common solution chosen is aluminum.

The motivation for the use of this material is the reduction in weight, which is in the order of 30%. Performance in fast ferries is strongly dependent on displacement, and the reductions provided by the use of this material are a key factor.

On the other hand, aluminum imposes certain added difficulties. First, aluminum loses its structural properties at temperatures under those that are reached in a fire, and it becomes necessary to double the structure in certain areas of the vessel for security reasons. Second, the number of units fully built in aluminum, of the size of the average fast car-ferry, is very limited, and the expense in structural design calculations in order to fulfill the class requirements can be burdensome.

Geometrical particulars

The main particulars to be reviewed include Length Over All (Loa), Maximum Beam (B), Molded Draft (T), Gross Registered Tons (GRT), Displacement and Deadweight Tons (DWT).

Physical size related parameters, combined with the type of design chosen, provide a better understanding of the product we are dealing with. Physical dimensions can also be important to study the interaction with the terminals.

In the case of monohulls, the L/B ratio is not especially high. Most of the units have a ratio around 6.5. The vessel's small block coefficients are obtained combining V hulls with small drafts. Thus, the key issue is to minimize the draft. Most of the units (including catamarans) are reporting drafts of less than 3 meters. Also, DWT will be adjusted as much as possible. For that reason, endurance is considered a key parameter when defining the specification of the vessel.

The other major implication of the need of a draft as small as possible is the limitation imposed on the propulsion. Waterjets perform like propellers inside nozzles, providing higher power for a given diameter than conventional propellers. This becomes an important advantage when draft is a major constraint.

Vessels are light with most of the hull out of the water. This creates in them the need for extra-maneuvering power, since it can prove very difficult to approach the terminal at low speeds and high winds. Waterjets also help to overcome this inconvenience.

Transportation Capacity

To define the transportation capacity we need to know the number of passengers and cars for which the ship is licensed and the dead weight capacity. With the exception of the HSS 1500 Stena design, none of the units currently in service is prepared to carry freight. The two MDV 3000 Jupiter units currently under construction in Fincantieri will add to this list.

The first generation of fast car-ferries was one of vessels around 450 passengers and 80 vehicles. But, following the development of the industry in the nineties, the average size of the units on order has been continuously growing. A stable size for these vessels might be around half of the capacity of a competing conventional ferry.

An important reference when studying the fast ferry fleet is the ratio of passengers-to-cars. The first units that entered into service in the early nineties (Incat 74) had a ratio around 5.5. That was also the case with the first monohulls, Aquastrada and Mestral. The most recent units seem to be closer to a ratio of 4. Conventional ferries use to have figures in between 3 and 4, although in this case a certain percentage of car space is devoted to freight transportation. It seems that fast ferry designs have reached a ratio that is consistent with the market needs.

Another group of fast car-ferries, characterized by much higher speeds (over 50 Knots) and higher ratios (around 9), has been introduced recently. This is the case of the designs developed by Advanced Multihull Designs. This particular type of catamaran is especially designed to maximized its speed is calm waters.

Performance

This heading includes Service Speed (at a percentage of the MCR and for a given displacement and sea state), sea-keeping properties (ride quality) and issues related to the propulsion plant (power output, type of engines, propulsion method and consumption).

The service speed must be clearly defined, at a realistic MCR percentage and for a given displacement and sea state. Usual terms to define service speed are 90% of the MCR, the expected load factor in the route and a sea state characterized by waves of 1.5 m of significant height. It would be necessary to reduce the nominal speed to take into account an operational margin that will sustain a reliable schedule in case of any inconveniences. Maximum allowed speeds in restricted waters must be taken into consideration when calculating total navigational times for the routes.

Seakeeping properties of the vessels are assured by the stabilizing systems on board. The most common arrangement includes a T-foil in the forepart of the hull, lateral fins placed in a "strategic" position (usually about 2/3 from the aft part of the ship) and two flaps at the aft of the vessel. The performance measurement used is the percentage of people getting seasick in the route. Precisely, the probability that, given a certain vertical acceleration (consequence of the sea state, the interaction of the vessel with the waves and the speed) a certain percentage of the passengers will become seasick.

O'Hanlon and McCauley defined the comfort curves, or Motion Sickness Incidence (MSI) curves. These curves give the most probable percentage of seasick passengers after a given exposition time to a certain vertical acceleration and wave-ship encounter frequency.

Certain countries limit the navigational permits for fast ferries to a maximum characteristic wave height. For example, when the Stena HSS 1500 started operations in the Irish Sea, the British Authorities decided to impose a maximum limit of 2.5m significant wave height, that later was changed to 4.5m. For a given route, there is statistical information about the waves in the area that will allow the operator to estimate a certain number of cancellations per year, providing an evaluation of the minimal seakeeping properties that the vessel must comply with.

There are two alternatives to provide the necessary power to these vessels: high-speed diesel engines and gas turbines. At least three issues must be considered when defining the propulsion plant: Consumption (high in both cases, but higher for the turbine), weight per kW produced, and maximum throughput of each option. If very high speeds are required, the turbine will be the only available option. The weight per kW in the case of diesel engines is about 4.5 Kg/kW, which compares to the 14.2Kg/kW ratio of the conventional diesel engines installed in conventional ferries.

Most of the fast car-ferries currently operating are equipped with diesel engines, due to the considerable fuel savings offered by this option. Just to give an approximate idea, while the consumption in shop trials of a diesel engine is about 200gr/kW-hr, the same figure in the case of the gas turbine is about 240gr/kW-hr. A further inconvenience of the gas turbine is that its performance is very sensitive to the ambient temperature. In all the cases surveyed, the propulsion was provided with waterjets. The only differences detected are the number of waterjets and its specification.

Construction time

The time gap between contract signature and delivery date affects the timing of the payments (and prefinancing needs for the builder) and the forecasts that the operator must do when planning the investment. Construction time is shorter in the case of fast ferries as it compares to conventional ferries. While for a fast ferry it takes about 1.5 years to be built, for a comparable conventional ferry it will take between 2 and 2.5 years.

It is likely that better payment terms will be available in the case of fast ferries (say, 20% at signature and 80% at delivery) than for the conventional ferry. For the latter, the payment terms are more likely to follow the general rule in the industry (20% at signature, steel cutting, keel laying, launching, and delivery). This is due to the smaller prefinancing required for a fast ferry, which is a consequence of the shorter construction time and smaller capital requirements.

Crew

The smaller crew requirement in the case of fast ferries is considered one of the major potential advantages of this option. A fast ferry can be completely operated with as little as 12 crewmembers, while the number in a conventional unit will be much higher. This matter will be analyzed in depth in the study of the cost structure.

1.4. Corporate Structure of the Industry

In this section, the corporate structure of the fast ferry industry will be reviewed focusing on the different parties involved. First, we will characterize the operators and then we will review the builders.

Operators

The typology of the companies involved in fast ferry operations can be traced by categorizing the companies in relation to their position in the ferry business in general. There are at least three well-differentiated types of companies [2]: fast ferry specialists, major ferry companies with interests in the fast ferry segment, and regional ferry operators.

Specialized firms include firms dedicated to Fast Ferries with little or no presence in the conventional ferry market. Buquebus, the Uruguayan operator, Holyman, an Australian subsidiary of the TNT Group, and the ferry branch of SeaContainers are the best examples.

Those companies have almost no conventional ferries and are not limited to a single market or operational area. They do not back-up fast ferry operations with conventional ferries. The strategy is to take advantage of any potential route through direct operations, subsidiaries or joint ventures. The vessels are not operated in a single route; on the contrary, they are located on the market what they best suit at any time. Some of these companies are also active in the charter market, bareboat chartering the vessels to other ferry operators in their off-peak seasons.

The companies that best represent the segment of the ferry operators committed to introducing new fast units are, with very different strategies Stenaline, the ferry operator of the Stena Group, and the ferry division of the P&O Group. Those companies are the most important conventional ferry operators in Europe. From the very beginning of the fast car-ferry era, Stenaline has stated its commitment to the fast ferry concept. First, chartering units to operate them in selected routes and later on developing their own designs. The HSS program constitutes a unique approach to the Fast Ferry concept, based on units customized to fulfill the needs of the company, but also requiring extensive investments both on the ships and at the terminals. The HSS 1500 are the only operating fast car-ferries capable of handling freight, which is also a major difference with respect to the approach of the other operators.

The case of P&O is substantially different. It has been the most reluctant among the major operators to enter in the high-speed segment, and when they finally decided to enter in this market, they have chosen to charter existing vessels rather than order new ships. For two years, the company has been testing the concept in one route, between Scotland and Northern Ireland, where the Group also has control over the ports. For the 1998 summer session, they have decided to charter another ship to serve one of their U.K.- Continent routes.

These two companies have merged most of their operations in the English Channel and, interestingly, have decided not to include (with the exception of one route) fast ferries in the assets of the resulting company, P&O Stena.

Regional Ferry companies constitute the third group. An important number of them are state-owned companies. That is the case of SNCM in France, Tirrenia di Navigazione in Italy, BC Ferries in British Columbia, Tranzrail in New Zealand and Transmediterranea in Spain. Other private corporations specialized on certain areas. That is the case of the Greek Minoan Lines, the Scandinavian venture ScandLines or the Norwegian ColorLine. All these companies support their operations with a conventional ferry fleet and have introduced on certain specific routes fast ferries, in some cases to absorb seasonal demand and in other cases on a more continuous basis. In all the cases, the companies operate jointly fast and conventional tonnage, thus backing-up the fast service in the case of cancellations.

In most of the routes the number of companies competing is very restricted. There is an important number of routes that are quasi-monopolies in practice, and in most of the routes the number of operators is three or less. Since most of the fast car-ferries are operated in European routes, the scheduled deregulation of the industry in 1999 (eliminating entry barriers to domestic routes in all EU countries) can have a major impact, especially for regional operators with protected niche markets.

Ferry operators have three major sources of revenue: Passengers and private vehicle tickets, freight, and onboard sales (in international routes granted with duty free sales rights). Freight is seized by most of the conventional operators as a key element, since it produces a fairly constant stream of cargo during the whole year, as opposite to the highly seasonal passenger demand. On board expense can be the major source of revenue in routes granted with duty free rights, providing up to one third of the total revenues for some conventional ferry operators [20]. In mid-99, duty-free sales are going to be eliminated in European Union domestic routes, and will force some of the major operators to restate their revenue structure.

The ferry business is rich in cash. Reservations and delayed expense payments provide operations cash flows and companies do not need to finance operations.

Fast Ferry Builders

The type of designs offered by the shipyards is a good criterion to categorize fast ferry builders. While wavepiercing catamarans are an exclusive product of International Catamarans, the Australian yard, different shipyards build the other two basic designs, conventional catamarans and monohulls.

Monohulls are basically a product offered by European naval builders (e.g., Fincantieri in Italy, Bazan in Spain, etc) that have used this market to maintain workloads in the yards at a time when naval orders were not buoyant. Applying their expertise to the more conventional monohull high speed crafts, they have been capable to enter a market that in its origin was dominated by catamaran builders, offering extremely competitive prices and good delivery dates. Perhaps the fact that most of the monohull builders are naval yards is not totally unrelated to the price differential between monohulls and catamarans.

The country building most of the tonnage to date is Australia, a non-traditional shipbuilding country with two yards specialized in high speed: Austal and International Catamarans. Only catamarans are built in Australia, and Australian firms are very active in design and licensing to build in other countries. That is the case, for example, of the three catamarans under construction in British Columbia, Canada for BC ferries, or the B60, a 60 knot unit built in Bazan but designed by Advanced Multihulls Designs, an Australian naval architecture studio specialized in high-speed, inside the high speed market. Other shipyards in Europe, especially in Scandinavian countries (Danyard for the local operator Mols Linen, Finnyards and Westamaran for Stena, etc) also build conventional catamarans.

From the point of view of profitability, building fast crafts has proven to be a dangerous business. Two major issues have played a major role in mismatching costs and prices for the builders. First, and keeping aside the Australian builders, specialized in fast ferries and aluminum, the yards entering the market coming from traditional shipbuilding have found costly the adaptation to the new construction material (aluminum) and the precision needed in these ships, including painful guarantee periods. The introduction of new technologies has proven to be more costly than expected, as usual.

Second, in such a restricted market, the effect of the unbalance between construction capacity and demand has been evident. The decrease in prices driven by the entrance of naval shipyards in the industry has affected severely the margins of all the builders. The other effect has been an industry growing at a very high rate, possibly generating excess capacity.

Some examples can help to illustrate those situations. Westamaran went bankrupt before finishing the first HSS 900. Finyards was acquired by the Norwegian group Aker Maritime after heavy losses and important delays in the construction of the three HSS 1500. Leroux & Lotz, the French builder, merged its shipbuilding branch with Chantiers de l'Atlantique after difficult financial years coincident with the construction of two fast ferries for the SNCM. Rodriquez, the Italian builder specialized in hydrofoils and also engaged in the construction of the Aquastrada design, was supported by a "rescue package" of local investors last year. And finally, the Australian yards, that were expanding capacity in the first half of the nineties, have nowadays several vessels under construction on "builders' account" (i.e., without a defined buyer).

Chapter 2

CONSUMER DECISIONS AND FAST FERRY DEMAND

The goal of this chapter is to analyze from a qualitative viewpoint the consumer decision process when facing the choice of different alternative modes of transportation. In this chapter only transportation aspects will be analyzed, thus not taking into account onboard leisure activities or other attributes inherently associated with the ferry market.

Although the data necessary to develop a quantitative application of a demand mode split model is out of the scope of this study, the chapter presents a conceptual model of how individuals choose from a set of alternatives (including waterborne transportation) and a description of the aggregate demand. The quantitative application will be covered in the next chapter by presenting and analyzing the market shares of Fast Ferries in a group of selected routes where they compete with conventional tonnage and with a fixed link, in the case of the English Channel routes.

Fast ferries are most of the times introduced in routes where a conventional ferry was already operating. Therefore, a certain substitution effect between conventional ferries and fast car-ferries is expected. At the same time, the service can compete with air transportation in certain cases, basically when the route is directly linking two major cities.

We begin by describing the individual behavior for the choice between the different alternatives. Then, an aggregation technique based in a classification method is proposed to estimate market shares. In order to define the classification in an accurate manner, we discuss the different market segments in this particular transportation case and propose a demand segmentation criterion.

2.1 Individual Consumer Choice[2]

A plausible model for mode choice decisions should be based in a valid theory of consumer decision-making and should be possible to be adapted to transportation mode

[2] The theoretical background and the models used this section are based on Ref. [13]. The particularization to the case of a ferry service is the author's responsibility.

decisions. The classical approach to these problems makes use of the concept of individual utilities to explain the choice behavior. The basic assumption underlying the models using the utility maximization criteria is that each individual, when confronted with a set of differentiable modes, is able to compare alternatives, rank them in terms of preference and choose the option with the maximum perceived utility. This model includes a *rational* choice at each step of the decision process. How rigidly the *rational* assumption should be interpreted is a matter that has been deeply discussed in the micro-economic consumer choice literature. For the purpose of this study, the utility maximization criterion seems to be a consistent basis to develop an individual choice framework for mode choice, regardless of how rigid those assumptions are.

Other components of the classical micro-economic model of consumer choice can be used in our context, although some must be modified to take into account the particularities of the transportation demand. The most important one is the derived nature of the transportation demand: People travel to be at a particular place at a particular time. The travel by itself imposes disutilities that must be included to realize the benefits of the trip. A transportation ticket is purchased for its attributes. From this perspective, the price of a travel option is not simply its monetary cost, but also the economic equivalent of the additional disutilities imposed to the traveler by the attributes of the trip. Among others, we should include the value of travel time, proximity of the available arrival time to the desired arrival time, comfort and reliability of the service, etc.

Since the benefits of the trip are generally independent of the attributes of the different travel options, we can say that the travel choice depends on the minimization of the disutilities of traveling to the desired destination. If the disutility of the travel is higher than the expected utility of the trip purpose, the consumer will decide not to travel.

Individual decision-makers will have different choice sets and will assign different utility values to the different attributes of the different modes. Each individual will primarily define his or her choice set, which should include the available modes that are feasible to him/her, given his own constraints for that particular travel.

It is important to clearly define who is the decision-maker. For non-business trips, it seems clear that the decision-maker is the person who pays the ticket: the individual, the householder, etc. When referring to business travelers, it can be argued that the decision maker is the traveler, while the firm is the one paying. That can be true in the short term, but for the long term the firm is more likely to impose guidelines about its business travelling policy, and therefore is the real decision-maker.

Once the choice set is defined, our rational voyager is supposed to analyze the different modes, explicitly assign to each one of them a perceived disutility, and choose the mode with the lesser of the disutilities. At the time when the decision has to be made, the conceptual model to study the decision process can assume a *Simultaneous Decision Structure* or a *Secuencial Decision Structure* (see Ref. [14]).

In the first case, the consumer is supposed to consider all the modes in his or her choice set at the same time. In the second case the decision-maker might first group the different modes attending to certain criteria (usually in direct relation with trip purpose), then choose one of the groups, and finally choose the mode that minimize the travel disutilities for him or her. For example, in our case, the passenger might first decide if he wants to carry his own vehicle and then decide what mode to use. For the purpose of this study, we have decided to follow the second approach.

To develop the choice framework in our particular case study, suppose that an individual is willing to make an inter-city trip from a certain origin to a certain destination where ferry links are an alternative. The most general scenario that our passenger can find will include four alternative modes. The passenger will be able to choose between the airplane, a fixed link (a bridge or a tunnel) including both road and railroad, a conventional ferry or a fast ferry service.

If a transportation mode is going to be considered as an alternative to the ferry, the degree of substitution should be high enough. In general, there are doubts that air transportation might be included in a ferry analysis. When the ferry is linking two major cities with important traveler flows, airplanes and ferries can be in direct competition. This is the case in the route joining Argentina's Capital Buenos Aires and Montevideo in Uruguay, or in the route that has just been started between Liverpool in U.K. and Dublin in the Republic of Ireland. But for most of the existing routes the airplanes are not believed to be in direct competition with ferry services.

We assume that the consumer has determined the desired arrival time to the desired destination, all modes are available and therefore the consumer must only choose among the different options his or her preferred one.

Each mode is defined by its attributes, which contribute to determine the disutility associated with each one of the alternatives. The attributes taken into account to characterize each mode can be separated in two groups. First, mode specific binary variables, which take the value "1" if a certain condition is met, or "0" otherwise. Second, continuous variables, taking a specific value from a continuous range for each mode. Here we propose the following variables, for each mode $\underline{i}$ competing in a given route:

- Binary (0,1) variables

- Allows carrying the vehicle? (y/n).
- Mode j competing? (y/n)
- Availability of the service in the time window? (y/n)
- Alternative specific constant: Reflects the difference in the utility of alternative i from that of j, everything else equal. The variable will be equal to 1 for the alternative chosen as the base case and 0 for the others.

- Continuous variables

- Price, P_i
- On-Route Travel Time, ORT_i
- Transit time TT_i
- Door-to-Door Travel Time, DT_i
- Comfort and Amenities, S_i

$\Longrightarrow T_i$

For the purpose of this study, all the time continuous variables will be unified in a Characteristic Travel Time, Ti. This simplification includes the assumption that all times are equally valuable for the customer. Empirical results show that, especially in travel to work, consumers tend to minimize waiting time, thus placing different time values to the different stages of their trip. The Characteristic Travel Time will be specifically defined as a function of the competing modes. In the most important case for us, it will include a transit time and an on-route time, but in other situations a door-to-door time can be more relevant.

The binary variables allow us to define in a systematic way the available modes for the specific trip that the customer is planning to undertake. Whether the targeted trip includes driving or not, or it needs a specific arrival time, will allow to define the available modes for the characteristics that he or she is demanding. In the next chapter we will assume that only fast ferries and conventional ferries are competing, and that both services are available in the time window.

Among the different attributes listed there are some that can be considered to be more relevant for a particular travel than others. Historically, the most commonly used variables have been travel cost and time. Other variables like comfort and amenities can be considered second order characteristics. All of the modes offer different degrees of comfort and service amenities in the same transportation vehicle associated with different fares. Thus, it can be argued that if a customer wants to improve his or her comfort, other things equal, it is more likely that he or she will shift to a higher class rather than changing the mode.

However, it is clear that a level of comfort can be attached to each mode intuitively. We can say, for example, that a cabin in a Ferry is more comfortable than a seat in a Fast Ferry or a Ferry. And that those are more comfortable than a seat in an airplane or driving your own car, although such a statement will carry an important dose of subjectivity. The case of amenities is similar: the range of possibilities offered to the customer ranks from a snack in a plane to duty-free shopping areas, restaurants, in a conventional ferry.

In the case of passenger transportation at sea there is always another factor to take into account when talking about comfort, and that is ride quality. We are more inclined to consider that as a technical matter related to the reliability of the service. A Fast Car-Ferry will not be able to sail at full speed for sea states over a certain limit, but this is a factor that that seems to fit better in the study of a potential route rather than affect the demand. Or putting it in another way, we will assume here that ride quality is "good enough" in all the competing modes.

We have chosen to consider cost and time as the most relevant variables. The frequency of the service will allow us to determine if a certain mode is a valid alternative for the customer. The rest of the variables will be discussed later on, at the time we revise the different strategies to implement a fast ferry service. Here we just want to remark that for ferry routes, amenities are considered to be a very important issue. In fact, the percentage of revenue obtained from onboard sales is at least of the same order of magnitude as the ticket sales in international routes with duty-free shopping.

The next step is to define a utility function form for the individual utility. For a variety of reasons, the utility of any alternative is best viewed as a random variable. We now abandon the concept of a deterministic utility function, common in the classical microeconomic theory of consumer behavior, for a probabilistic utility function. Basically, that will allow us to better take into account the empirical results demonstrating that two "identical" individuals *n* and *m*, will not choose the same option. Therefore, we will assume that individual *n* chooses option *i* with a certain probability $P_n(i)$.

The random utility variables (U_i) are divided in their systematic (V_i) and random (ε_i) components. The systematic component can be interpreted as the mean of the probability distribution once a convenient referent has been defined. The form of the function chosen to specify the systematic component is the most difficult assumption to be made. An additive utility function of the attributes (y_i) linear in the parameters is most often assumed for computational convenience:

$$V_{in} = \sum \beta_{nk} \times y_{ik}$$

Where the parameters β_{nk} show the taste of the *n* decision-maker referred to the k-attribute. These are the coefficients that, in an application of a disaggregate demand model, have to be statistically inferred sampling the potential consumer populations.

The means of the random components are (or can be made) equal to zero (after choosing the adequate reference) and their scale must be defined in concordance with the one of the mean V_i. At this point, the derivation of any choice model will be the result of making some assumption about the distribution of the disturbances. If we assume the disturbances are the sum of a large number of unobserved but independent variables, the distribution of the disturbances would tend to be normal. The model resulting from this assumption is called *probit* model. To overcome the analytical inconvenience of the *probit* model, a "probitlike" model, the *logit* model, is commonly used. This model holds the theoretical consistency supported in the central limit theorem but reduce de computational burdens.

The form of the logit model, in the case of just two alternative competing modes, *i* and *j*, competing, is:

$$P_n(i) = Prob(U_{in} \geq U_{jn}) = e^{\mu Vin} / (e^{\mu Vin} + e^{\mu Vjn})$$

where μ is a positive scale parameter (V and ε must be in the same scale). We can now substitute V by the linear function in the taste parameters β_k. Therefore, we have obtained a direct relation between the probability of customer *n* choosing mode *i* and the tastes of this Mr. *n*. Customer *n* will choose the highest ranked mode (i) under his particular utility function (defined by the β_k parameters) with a Probability $P_n(i)$. The extension to more than two modes is conceptually straightforward: simply sum in the denominator to all the possible modes.

If we name C_n the choice set, then:

$$P_n(i) = Prob(U_{in} \geq U_{jn}, \forall j \neq i) = e^{\mu Vin} / (\sum_{C_n} e^{\mu Vjn})$$

An important assumption of the model, quite restrictive and in some situations difficult to defend is that the disturbances are independent and identically distributed: all the disturbances have to have identical scale parameter μ, what implies all the variances are equal.

2.2 Market Demand Segments

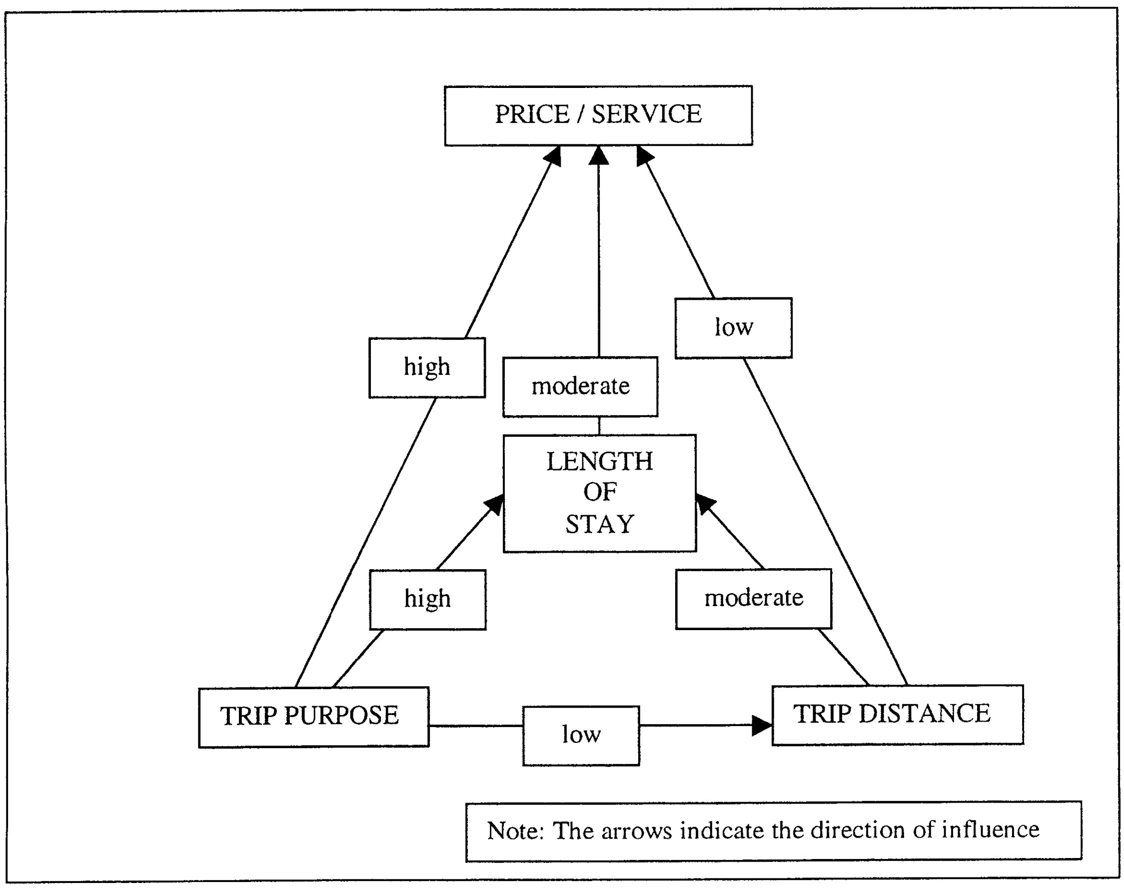
Before making a proposal for the aggregation process based in the classification method, it is necessary to divide the population following a consistent criterion. The purpose of this section is to propose a criterion to define a set of consistent segments.

Historically, the first approach to travel segmentation suggested was by trip purpose. That was the first division used by the airlines, one of the transportation inter-city modes where demand segmentation has been more deeply studied. But the results of a series of different surveys indicate that market demand segmentation in the airline transportation should not be exclusively based on trip purpose (see Ref. [12]). We believe that those results are applicable to other inter-city transportation modes.

Trip purpose, trip distance and length of stay were all examined for their influence on price versus service sensitivity. Service quality will include in a wide sense travel time, frequency, and amenities. The results are summarized in Figure 2.2.1.

Since we are using a (dis)utility function in order to measure the "value" of the trip, it seems reasonable to develop a demand segmentation model that incorporates explicitly the notions introduced with the attributes of the transportation modes. Once the first step of the choice process has been completed (i.e., travel with car or without car) the traveler can be categorized as a function of time and price sensitivity. As shown in the discussion carried out in the previous heading, the most important attributes of any mode are travel time and price. By separating time-sensitivity from price-sensitivity, we can characterize consumer groups without reference to trip purpose and therefore avoid the overlap of the trip-purpose-based categorizations. Furthermore, these consumer groups will be independent of the available transportation modes.

Given that any one trip will lie somewhere along the time-sensitivity continuum, and given that a potential traveler must fall somewhere along the price-sensitivity continuum for each trip, these two scales provide the basis for a demand segmentation model that includes all possible trip/consumer characteristics.



Source: P. Belobaba, Reference [12]

Figure 2.2.1: Price/Service relation to trip Characteristics

A consumer's location in one of these segments may differ from one trip to another. An individual can be extremely time-sensitive for, say, a business trip, while the next week the same individual becomes extremely price-sensitive for a vacation displacement.

The demand segments that this proposal includes will differentiate decision-makers between the following groups (See Figure 2.2.2 and Ref [12]):

Type 1: Time sensitive and insensitive to price
Type 2: Time sensitive and price sensitive
Type 3: Price sensitive and time insensitive
Type 4: Time insensitive and price insensitive

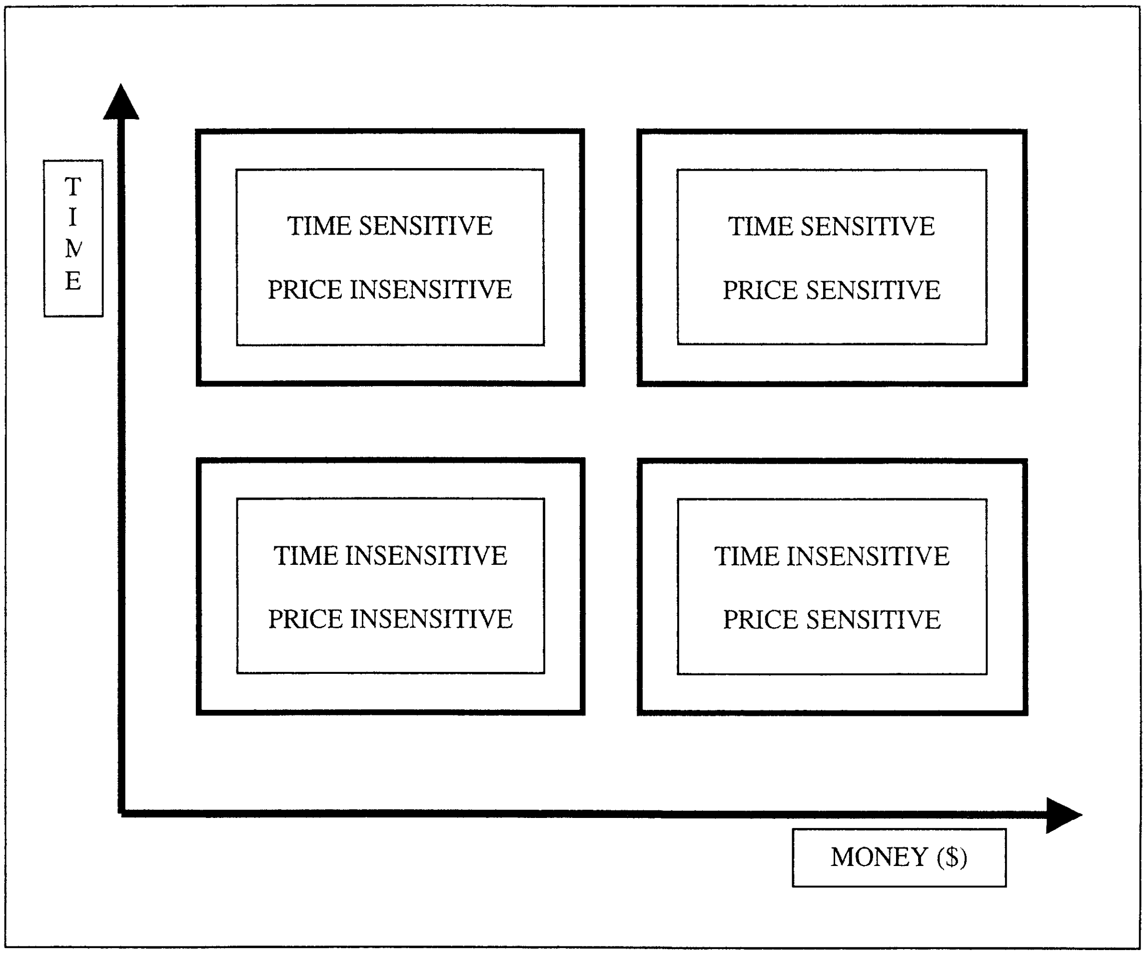


Figure 2.2.2: Demand Segmentation Conceptual Model

The most important property of such a categorization is that it relies on the same parameters that we are using to calculate the disutility of each alternative. By definition, a time-sensitive and price-insensitive traveler will give more value to trip time than to the cost of the travel. On the other hand, a time-insensitive traveler will primarily focus on the price of the ticket, accepting longer trip times. The price and time sensitive traveler is the one whose trip benefit expectations are the most modest. He is not willing to spend a lot, neither money nor time.

With this system the segmentation process is fixing a value to the taste parameters of the decision-maker: once we have decided that someone is time-sensitive and price-insensitive, we know what are his or her β parameters in relation to those of the other consumers. We can rank the preferences of the travelers, and attribute relative values to the different attributes.

The market demand segments are relevant only to the extent that differentiated transportation modes are offered to each segment. The implication of this is that no matter how well the demand is known, the firm will not be able to take advantage of it if only one product is offered to the consumers' population. The division between one segment an another is not precisely defined, and each segment still includes a wide range of consumer characteristics and trip requirements. In fact, this four-stage categorization is simply a first approach. If more accurate information were available, it would be possible to propose more and better-defined subdivisions, although from a conceptual viewpoint this categorization is exhaustive.

For demand segmentation purposes, and from the point of view of transportation firms, *type 4* consumers (if any exists) can be combined with *type 1* consumers, so that the firm will maximize its revenue. The final mode choice of the average individual of this segment will depend on factors other than price and time, such as appeal of the mode, etc.

The β parameters are measured on "utility units" per hour in the case of the time attribute and in "utility units" per $ in the case of the price attribute. Therefore, (β_t / $\beta_\$$) will be the so-called value of time (VoT), measured in $ per travel time unit (say, minute). VoT is expected to be higher for the average individual of the time-sensitive segments than for the average individual of the time-insensitive segments. Reasoning in the same manner for price, the taste parameter associated with the ticket price of the different modes will be smaller in the case of a price-insensitive consumer than in the case of a price-sensitive consumer.

So far we are defining three coherent –although imprecisely determined – consumer groups. The determination of the boundaries between each of the different groups must be based on the particular conditions on the route, including the individuals entering the route as well as the available transportation modes on that route.

The main criticism that can be made to this breakdown is whether it is possible in practice to group a consumer population according to them. The underlying question is what criteria must be followed to include a consumer in a given group. It can prove very difficult in practice to carry out such a categorization.

2.3 Aggregation across Individuals

In the first section of this chapter we have focused on the problem of predicting individual behavior. However, these results will be in practice meaningless for an investment decision. Instead, the aggregated demand for each one of the modes and, in our particular case, for the Fast Car-Ferry service is the result in which we are interested.

In other words, the final objective will be to predict the share of the population of voyagers choosing alternative *i*, W(i). If the attributes of both the route and all the individual decision-makers were known, then making the aggregate prediction would be conceptually straightforward. It would simply consist of adding the individual probabilities of choosing mode *i*. Thus, the market share of the *i*-mode would be:

$$W(i) = 1/N_T \times \Sigma P_n(i),$$

where N_T is the total number of decision-makers.

The problem is that it is virtually impossible to calculate $P_n(i)$ for all the individuals. Because of that, it is necessary to use an aggregation method (see Refs. [13] and [15]). There are different aggregation methods, which are procedures to reduce the required data and computation needed to predict aggregate usage of various alternatives. One of those is the so-called *classification* method, consisting of dividing the population in into a number N_g of "nearly homogeneous" groups and using the choice probability of the average individual within each subgroup $P_g(i)$ to predict the choice of the subgroup.

Thus, the approximation of W(i) would be:

$$W(i) \cong \Sigma (N_g/N_T \times P_g(i))$$

Under the previous heading we have analyzed and segmented consumers in our targeted transportation markets in order to accurately define these subgroups. We have concluded that a breakdown based on the time-sensitivity of the trip and the price-sensitivity of the traveler is a consistent and exhaustive categorization. The better the available information is, the bigger the number of subgroups will be. For the purpose of this study, we will limit the subgroups to the three defined in the previous section. At this point, the problem is reduced to estimate N_g and N_T.

The total size of the market, N_T, can be obtained by analyzing the targeted market and estimating a growth rate. In a second step, it will be necessary to split this figure into the different segments, thus determining each N_g. That is the same as defining the criteria for a given individual to be included in a certain segment. The criteria, in our case, must measure time-sensitiveness and price-sensitiveness, and must be in relation to the expected benefits of the trip with the purpose of the trip.

The only way to rigorously define the size of each subgroup would be to sample the travelers' population and define their sensitiveness to time and price. We can rank intuitively the size of the groups N_g as a percentage of the total travelers' population for the different types of characteristic routes defined in Chapter 1. For example, the percentage of time-sensitive travelers may be higher in a short non-recreational route than in a long recreational one. The assumptions behind this ranking are that, on average, value of time is smaller when taking a recreational trip than in a non-recreational one and that value of time, in a nominal basis, is smaller for longer trips than for short trips, other things equal.

Chapter 3

ESTIMATING FAST CAR-FERRIES MARKET SHARES

So far we have developed a general approach to the demand problem and at the same time we have tried to point out the particularities that help to describe the routes where fast car-ferry services are a transportation alternative.

In this chapter the present market situation of fast ferries will be analyzed. Using aggregate information about existing routes, we will estimate the average values of the taste parameters for price and time of the service. Because the data available is in aggregate form, it will not be possible to divide the population of travelers in the different segments defined in Section 2.3, and the results will be in aggregate form for the average consumer.

A second stage will apply the results obtained for the selected routes to the generic routes identified in Chapter 1, and analyze the implications of those results.

3.1 Existing Routes: Fast Car-Ferry Market Shares

The purpose of this section is to analyze the market shares of the different modes in some selected existing routes where fast car-ferries are in direct competition with conventional ferries and, in one case, with a fixed link. The actual market shares and the attributes of the different routes are included in Appendix 2.2. Table 3.2.2 provides the fares for selected routes.

Since there is always a consumer who can chose an indirect way to go from point A to point B, it is difficult to define without controversy the amplitude of the zone that is covered by a given link. We have chosen here to focus on the ferry by itself, thus isolating it from trips including different modes: the trip under analysis coincides with the crossing. The modes competing are also difficult to clearly define. For all the cases presented except one, the only modes considered to be directly competing are the conventional ferry and the fast ferry. In the case of the English Channel, Eurotunnel is clearly a major competitor, but it happens that for the car service, the time and price parameters are very close to the ones of the fast ferry service. Because of that, and since it is the only location where fixed links are competing with ferries, we have decided to merge it with the fast ferry service.

In none of the cases has the airplane been considered to be a direct competitor. In the routes chosen, ferries do not link major cities and, for the bulk of the passengers, the ferry is an intermediate stage in the trip: when they arrive at the port area they have to make a choice between the conventional ferry or the fast ferry. In the case of the Eurotunnel, the company offers two services: a shuttle service and the Eurostar (the high-speed train joining Paris and Brussels with London). The Eurostar passengers have been discounted to obtain a comparable figure.

Appendix 2.2 summarizes information about the routes, including the total size of the market in terms of cars and passengers, the frequency of the different services, capacity offered in seats per day and the number of passengers and cars carried by each mode. Then, the average season load factors and market shares are estimated.

The information contained in this set of data must be carefully analyzed. First, the fact that it is aggregate data restricts the use of the data to aggregate purposes. Second, the fast ferry mode is still too young to consider the figures as consolidated –static- ones. In certain cases (e.g., the Frederikshavn-Gothenburg route in 1995), the fast ferry operator was entering a monopolized market (at that time controlled exclusively by Stena and its subsidiary Lion Ferry) and obtaining an important share, but never comparable to the dominant position of the established firm. In most of the cases analyzed, the introduction of the fast ferry service has coincided with increases in demand. To what extent the increase is due to the economic situation in the area or due to the "generated" demand created by the introduction of the new fast ferry service remains unclear.

The fact that, even in the most unfavorable conditions (i.e., competing in a monopolistic situation *de facto*), high speed units obtain considerable market shares from the very beginning, show that the service is appealing and easily marketable with the actual pricing strategies.

In almost all the routes analyzed, the load factors were higher for fast ferries than for conventional ferries. Comparability across car load-factors can prove meaningless, since an unknown percentage of the lane meters of a conventional ferry are reserved for freight transportation, reducing the available space for cars. But looking to the passenger load factors, we can conclude that the asset utilization ratio is higher in the case of fast ferries.

Taking as a reference of an operational maximum the load factors achieved in the air transportation industry in the U.S., which are in between 70% to 75%[3], we can see that the figures over 50% on average are synonymous with a good operating performance for the company. With averages over half of the capacity, and since the ferry demand is extremely seasonal, the companies must be fully booking the vessels in peak-seasons.

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[3] Source: Professor P. Belobaba, MIT

An interesting information in order to define the ratio passengers-to-cars that is more convenient in a fast ferry for a given route is how the total number of passengers compares to the total number of cars transported, and how the relative load factors compare. Each route has an average ratio of passengers-to-cars, ranging from 2.9 in the case of British Columbia to 7.75 in the case of the Algeciras-Ceuta route in Spain.

The most convenient design will not have the same ratio in all the routes. In the specific case of the fast ferry, the cost of the ship is primarily related to the car-capacity of the unit, and a ratio of 4-to-1 seems to be a technological limit constraining the design of such vessels.

A load factor higher for cars than for passengers can be a sign of two situations: either the passenger capacity is over the requirements of the route, which may not be a major concern, or the car capacity is too small for the route. The second case is more likely to be true in peak periods if the average load factor is over 50%. In that case, the operator will be forced to refuse bookings because car space is lacking while there are empty seats. Another coefficient that may be used to analyze this problem is how the ratio passenger-to-car for the fast ferry compares with the ratio of the route as a whole. If the ratio is significantly higher in the case of the fast ferry, the fast-ferry operator might be losing part of his potential share.

The reasons for the lack of uniformity among the routes analyzed include, among others, the competitive situation of each particular route. It appears clear that the number of operators in the route affects market shares. The situation is different if there is only one company, operating both fast and conventional units, instead of different companies competing among them.

The strategy of the firm with the higher market share is also an important factor. Whether they replace conventional ferries with fast ferries, they continue operating conventional units or they decide to mix both services, will directly influence the resulting structure of the market.

To summarize, the structure of the different ferry markets does not respond in a simple mathematical function with time, price, and other variables. Although those variables can help to explain how the demand is distributed between the different transportation modes, the effects of the competitive environment, specific to each route, are also important in understanding the situation.

3.2 Market Shares Versus Attributes of the Modes

Using actual market shares, we will estimate the taste coefficients for time and cost of the ticket discussed in the previous chapter. The value of these estimates can be very controversial for several reasons. First, because the market situation of each of the routes is much more complicated that what the simplified model described in the previous chapter can support. Second, because, the fast ferries are such a new service, we cannot assume that the market shares are yet stabilized. The objective of the calculations presented in this section is therefore just to obtain first estimations of the average values for the taste parameters.

We will follow the method developed by Berkson (see Ref. 13) for an aggregate analysis of the problem. Based on the disaggregate model presented in Chapter 2, and labeling the shares of the ferry and the fast ferry S_{CF} and S_{FF}, we know that:

$$S_{FF} / S_{CF} = e^{\mu(\Sigma\beta y_{FF})} / e^{\mu(\Sigma\beta y_{CF})}$$

Or:

$$\mathrm{Ln}\ (S_{FF} / S_{CF}) = \mu(\beta_t(T_{FF} - T_{CF}) + \beta_\$(\$_{FF}-\$_{CF}) + \beta_d(0-1)).$$

Given the market shares on different routes, we can estimate the taste parameters β_t, $\beta_\$$ and β_d (or $\mu\beta_t$ $\mu\beta_\$$ and $\mu\beta_d$, for any given μ). β_d is the parameter that captures the mode-specific differences not associated with cost or time.

Table 3.2.1 shows the inputs for the regression. The calculation is performed for two different types of route: recreational routes and non-recreational ones. Market shares and travel times have been taken from Appendix 2.2. Prices are based on published single leg regular fares for a regular vehicle plus up to five passengers or the equivalent. The calculation has been performed for a representative tariff. Table 3.2.2 shows a list of selected fares for some representative routes.

To overcome the possible lack of comparability between fares due to the huge diversity of the areas where the ships are operating, we have redefined them. To define conventional ferry fares, the price per minute travelling has been calculated when possible, and the fares used in the regression have been redefined using a unified representative price per minute. Table 3.2.1 shows the different prices per minute used.

Once the conventional ferry fare has been redefined, the Fast Ferry fare is calculated multiplying the conventional ferry fare by the percentage that relates the *real* conventional ferry fare with the *real* Fast Ferry fare in each route, which is included in Table 3.2.2.

Market shares can be in some cases misleading. As it was pointed out in the previous section, in some routes the capacity offered by one of the modes is much higher than the offer of the other mode, to the point that the dominant mode is in an almost monopolistic situation. To overcome this, the demand has been restricted to periods where the offer is comparable between modes.

Table 3.2.3 shows the results of the regression, consisting of the numerical values of the taste coefficients β_t, $\beta_\$$ and β_d, for both the case of the recreational and the non-recreational route. Using the values of β_t, $\beta_\$$ it is possible to estimate the Value of Time for the average ferry traveler.

	Fast Car-Ferries				Conventional Ferries			
Route Type:	**Non-Recreational (round the year)**				**$/min: High**	**1.5**		
					Low	**0.9**		

Route:	*Market Share (%)*	*Time (min)*	*Price ($)*	*Dummy*	*Market Share (%)*	*Time (min)*	*Price ($)*	*Dummy*
Newhaven-Dieppe	60	165	280	0	40	285	257	1
Belfast-Stanraer, 1997	80	120	219	0	20	225	203	1
Larne-Cairnryan	70	90	162	0	30	165	149	1
Frederikshavn-Gothenburg	62	115	241	0	38	235	212	1
Wales-Ireland	58	130	248	0	42	250	225	1
Algeciras-Ceuta	57	60	140	0	43	120	108	1
Dover-Calais*	46	55	113	0	54	115	104	1

* Eurotunnel happens to have the same time-price characteristics, and has been included here

Route Type:	**Recreational (seasonal)**	**$/min: High**	**1**
		Low	**0.7**

Route:	*Market Share (%)*	*Time (min)*	*Price ($)*	*Dummy*	*Market Share (%)*	*Time (min)*	*Price ($)*	*Dummy*
Kristiansand-Hirtshals	43	180	264.6	0	57	315	220.5	1
Larvik-Skagen	36	200	352.8	0	64	420	294	1
Wellingtong-Picton	48	125	204.96	0	52	240	168	1
Nice-Corse	40	165	277.2	0	60	330	231	1
Bacelona-Palma	35	270	386.4	0	65	480	336	1

Table 3.2.1: Fast Ferry Market Share versus Time and Cost

Route	Operator	Type	Curr	Fast Ferry Low	Fast Ferry High	Conventional Ferry Low	Conventional Ferry High	Difference Low	Difference High	C. Ferry: $ per minute Low	C. Ferry: $ per minute High	Type
Dover-Calais	Various	Single	GBP	79	109	60	100	32%	9%	0.87	1.45	*
Cairnryan-Larne	P&O	Return	GBP	n/a	380	n/a	350	n/a	9%	n/a	1.75	*
Newhaven-Dieppe	Stena	Return	GBP	n/a	294	n/a	266	n/a	11%	n/a	0.95	*
Holyhead-Dun Laoghaire	Stena	Return	GBP	n/a	472	n/a	448	n/a	5%	n/a	0.9	*
Stranraer-Belfast	Stena	Return	GBP	n/a	390	n/a	360	n/a	8%	n/a	1.3	*
Fredrikshaven-Gothenbrg	Stena	Single	SEC	595	795	525	695	n/a	14%	0.59	0.79	*?
Fredrikshaven-Gothenbrg	SeaCo	Single	SEC	550	720	/	/	5%	4%			
Fishguard-Rosslare	Stena	Return	GBP	n/a	458	n/a	438	n/a	5%	n/a	1.09	*
Buenos Aires-Colonia	Buquebus	Single	US$	$230	n/a	$163	n/a	41%	n/a	0.99	n/a	*
Kristiansand-Hirtshals	Color Line	Single	NOK	2050	2380	2050	2380	0%	0%	0.88	1.02	**
Picton-Wellington	TranzRail	Single	NZ$	360	426	296	349	22%	22%	0.68	0.79	**
Barcelona-Palma	Trasmed	Single	ESP	n/a	58200	n/a	51000	n/a	14%	n/a	0.71	**
Nice-Corse	SNCM	Single	FF	n/a	n/a	1270	1886	n/a	n/a	0.78	1.16	**
Melbourne-Devonport	TT Line	Single	A$	830	$940	$699	$809	19%	16%	0.49	0.56	**
Algeciras-Ceuta	Trasmed	Single	ESP	23000	n/a	17228	n/a	34%	n/a	0.95	n/a	*

Exchange Rates:

1 GBP =	$1.6600
1 NOK=	$0.1360
1 SEK=	$0.1312
1 NZ$=	$0.5500
1ESP=	$0.0065
1 FF=	$0.17

Route Code:

* = Non recreational
** = recreational

Table 3.2.2: Selected Fares (Car +5 pass): Fast Ferries vs Conventional Ferry

Taste Parameters	Non-recreational Route	Recreational Route
Cost Variable, $\beta_\$$	-0.011427621	-0.013166324
Time Variable, β_t	-0.013399992	-0.007357702
Dummy Variable, β_d	0.30125499	0.252845868

Table 3.2.3 Estimated Values for the Taste Parameters

It can be interesting to compare these results with the usual values of time typical for commuters (trips to work and leisure as opposed to inter-city travels). These figures use to be around one half of the salary hourly wages for work trips and one fourth for other than work trips. Here we have obtained a VoT of about $70 per hour for non-recreational trips and $33.5 per hour in the case of recreational routes. Since the fare used is per car plus up to 5 passengers, it is difficult to perform a numerical calculation but, in any case, the values are higher than in the case of commuters. That can be explained due to the fact that intercity trips are much less frequent than commuter trips. The difference between recreational and non-recreational trips is also consistent with the differences between the two commuter trips mentioned (See Ref. [16] for further comparison).

3.3 Application to Generic Ferry Routes

The results obtained in the previous section will be applied to the three generic routes proposed in Chapter 1. In the previous section we distinguished only between recreational and non-recreational routes. The differences between the long non-recreational route and the short route will be captured using different fares per minute, assuming that the taste coefficients do not change significantly.

Route Type	***Modes Available***	***Cost ($/min)****	***Time (min)***
Short non-recreational	Fast Ferry	1.65	90
	Ferry	1.5	180
Long non-recreational.	Fast Ferry	1.15	210
	Ferry	1	420
Long Recreational.	Fast Ferry	0.96	210
	Ferry	0.8	420

(*) Cost per "conventional ferry minute" for both fast and conventional ferry

Table 3.3.1: Attributes for the Generic Routes

Table 3.3.1 summarizes the attributes characterizing the generic routes. The only competing mode to be considered is the conventional ferry. In the case of the long routes, we are not taking into account the possibility of cruise ferry competition (offering berths rather than seats, in overnight crossings). The frequency of the service is assumed to be high enough as to make feasible both alternatives to the voyager. The fast ferry time has been obtained dividing the ferry time by two, and in both cases it is intended to reflect the total travel time (including loading and unloading). These issues will be further discussed in the next Chapter.

The results are presented in Table 3.3.2. Using the taste parameters obtained in the previous section and the attributes shown in Table 3.3.1, we have obtained the market shares of each mode. In the non-recreational segment, and since the value of time used is the same in the case of the short and long route, the market share for the Fast Ferry mode grows as the crossing time grows. In both cases, the predicted market shares (based on the *real* market shares used in the regression, represent more than half of the market.

The results so far obtained must be understood in the frame of the assumptions made. Most of these assumptions have been already pointed out throughout the chapter, and they can be summarized saying that the simple model used cannot capture the full complexity of the real situation, and that certain major issues, specially competitive issues, are difficult to quantify.

Yet one implicit assumption that we may want to take into consideration is the use of prices. In the chapter the price has been categorized as a measurable attribute linked to each mode. We have used the concept of a representative price for each mode, but the reality is that pricing techniques in the transportation industry have reached a point, with the massive introduction of revenue management or yield management techniques, in which prices are not a measurable and fixed attribute. If those techniques are not uniformly adopted among the different modes competing in a route, the direct consequence is that the representative price for the modes will be unknown, and the analysis done in here will lose validity. For the time being, the ferry industry is not characterized by its innovative pricing techniques, and thus we can say that when isolated, this issue does not pose a major threat to the proposed analysis, although certain competitors, like Eurotunnel, seem to be using revenue management techniques.

Taste Parameters	Non Recreational	Recreational
Cost, $\beta_\$$	-0.011427621	0.013166324
Time, β_τ	-0.013399992	0.007357702
Dummy, β_d	0.30125499	-0.252845868

Short Non-recreational

	Fast Car-Ferry	*Conventional Ferry*
Time (min)	90	180
Cost ($)	297	270
Market Share (%)	**64%**	**36%**

Long non-recreational

	Fast Car-Ferry	*Conventional Ferry*
Time (min)	210	420
Cost ($)	483	420
Market Share (%)	**86%**	**14%**

Long recreational

	Fast Car-Ferry	*Conventional Ferry*
Time (min)	210	420
Cost ($)	403.2	336
Market Share (%)	**40%**	**60%**

Table 3.3.2: Generic Routes: Market Shares Estimates

Chapter 4

COST STRUCTURE OF A FERRY SERVICE

The aim of this chapter is to analyze the cost structure of the ferry industry. We will perform a cost comparison between alternatives (conventional ferry and fast car-ferry) in homogeneous terms and we will discuss the implications of the cost differential in the ferry business.

To achieve this goal, we will start defining the criterion to perform a homogeneous comparison. Then, the cost items to be studied will be reviewed, including assumptions, definitions and brief comments for each of them.

The comparison will be performed for two generic routes, consistent with the ones proposed in the demand analysis. The first task will be to specify the characteristics of these routes and to explain the reasons to select them. From the cost viewpoint, it is meaningless to differentiate between the long recreational and the long non-recreational route. Therefore, we have unified both in a single "long route". The next step is to state the numerical values to define the cost structure of both the conventional and the fast service.

Then we present the results of the comparison and a sensitivity analysis for selected parameters. The cost study ends with a discussion of the results and the possible influences of the cost differential in the decision of whether to operate a fast or a conventional ferry in a given route.

4.1 Criterion to Perform the Comparison

We will assume, for cost purposes, that the company has an estimation of the number of potential trips that they want to introduce in the targeted route. Thus, the cost comparison will be made for a given number of seats and cars per unit of time (say, a day) in a given route. The amounts of passengers and cars will be considered constant throughout the operational season, and equal to the maximum capacity if deploying only one ship on the route.

The main advantage of this approach is that we are taking into account the differences in cost associated with both different service frequency and different trip time. At the same time, these factors will influence the calculation: for example, the cost structure will not be the same for a short route than for a longer one. For that reason, we propose to focus our study in two generic –but representative- routes, which will be referred hereinafter as *short route* and *long route*. The short route is what in the demand analysis was called short non-recreational route, and the long route, represents the other two routes defined as prototypes in the previous chapters.

As we pointed out in the first chapter, for longer routes conventional ferries will offer both seats and cabins, being prepared to offer overnight trips. There is a concern about the degree of substitution between them and fast ferries. To some extent, there is an overlap between the short routes of cruise ferries and the long routes of fast ferries, an unclear range in which different operators maintain different ideas about the convenience of increasing speed. This issue has direct implications in the cost structure of both services.

A further complication to perform a homogeneous analysis is introduced by the fact that conventional ferries get part of their revenues from freight transportation (trucks), while the examples of fast ferries involved in freight transportation are reduced to the Stena HSS1500.

Aware of these sources of possible disturbances, no discount in the cost for the conventional ferry will be made, and these problems will be addressed in the discussion of the results.

4.2 Cost Structure: Main Items

The main items in the cost structure to be considered (see Ref. [17]) are explained in the following paragraphs. The main assumptions made and other costs that have been excluded from the analysis are outlined, including the reasons to exclude them.

Capital costs.

Published contract prices for newbuildings representative of the vessels chosen for the study will be used. The payment terms will in all cases assume 20% at signature and 80% upon delivery. OECD financing terms will be used as a reference: financing of 80% of the contract price at 8% annual interest rate for 8.5 years with repayments each six months.

While prices can be derived in a straightforward manner in the case of Fast Ferries, this is not the case for conventional ferries. The difficulties arrive due to the diversity of the market. Designs are customized to fit the particular needs of each route/shipowner, and comparability is thus restricted.

Two main factors have to be taken into account for the comparison. First, the operational life of the vessels will not be the same: the conventional ferry will last for as much as 30 years, while the fast ferry life may be much shorter. Second, the construction period will be longer in the case of conventional ferries. The procedure used consists basically in calculating an annuity for each option that will take into account all these factors.

Voyage Costs.

These costs will include fuel (plus other consumables) and port dues. No special traffic dues will be considered in either case.

- **Fuel**. To determine the cost of fuel and other consumables (lubes and fresh water), an estimation of tons per hour consumption times the service speed will be used. $75 is the estimation of the cost per ton of fuel oil, and $150 for Marine Diesel Oil[4].

- **Harbor dues**. In the case of ferry services, we need to distinguish between the operator who manages his own (long-term leased) terminal and the case in which the ferry operator pays harbor dues to the local port authority. In the latter, harbor dues will be estimated in connection with the net registered tonnage of the vessel and number of passengers transported. It will be assumed that the port authority is charging a fee per net registered ton in escalation: the port authority will define different segments and will charge a fixed amount per ton for each segment. The port authority will also charge a fix amount per passenger transported. Since this amount will be the same for both fast and conventional ferries, and is dependent on the number of passengers carried, it has been excluded in the comparison. In the former case, port expenses do not belong to voyage costs. They will be briefly discussed below.

  Port dues are meaningless out of an appropriate context: they are extremely dependent on regional factors. To illustrate this, we have included in Table 4.2.1 a list of port charges in the main routes between Italy, France and Corsica and Sardinia in western Mediterranean routes. Since in other operational areas the situation can be totally different, the only purpose of Table 4.2.1 is to show extreme differences in a relatively small operating area.

Operating Costs.

The main costs to be included in this category are:

- **Repairs and Maintenance**. The cost will be calculated by distributing the periodic overhauls in a per day basis. Stores are also included. The overhaul expense will be calculated as the sum of the expense attributable to engines, powering units and other machinery as well as those attributable to hull maintenance.

[4] Source: Lloyd's List, February 10, 1998. Average of EU prices.

	Nice Bastia	Nice Calvi	Livourne Bastia	Savone Bastia	Savona Ile Rousse	Livourne Golfo Aranci	Civitavecchia Golfo Aranci
Pass.	32	28	14	12	13	6	3
Children - 4 years	0	0	6	0	0	6	3
Vehicle	55	46	30	23	31	8	8

*) Each person entering or exiting Corsica must pay an extra-tax, called "taxe territoriale de transports" of 30 FF.
Source: Corsica Ferries

Table 4.2.1: Selected Port Dues Per Trip in French Francs

Engines and other elements of the propulsion plant have proved to be the most delicate items in fast car-ferries. The operational regime for the engines of both the conventional and the fast ferry will assume the following pattern:

- 5% of service hours at 100% of maximum power.
- 85% of service hours at 90% of maximum power.
- 10% of service hours at less than 40% of maximum power.

In the case of the fast ferry, $5 per mile will be allocated to the engines, with a time between overhauls of 20,000 hours (or about four years and a half) and a 10% or $1/2 per mile will be allocated to the engine and other machinery. For hull maintenance the estimate will be of $1 per mile. Those figures must be understood as first estimators, and not as exact amounts free of all risks. A similar procedure will be applied to the conventional unit.

- **Manning (seafarers + hotel).** For both the fast and the conventional service, two complete crews are to be considered round the season. The crew will include the officers, seafarers and cabin attendants. Salaries of officers, seafarers and hotel staff will be the same for both the fast and the conventional service.

- **Insurance and Classification Fees.** Here we will combine Hull & Machinery, Protection & Indemnity as well as Classification Fees in an annual estimate.

Overhead Costs

These costs are assumed to be the same in both cases and are not included in the comparison. Some sources indicate that some indirect costs, like marketing costs, can be smaller in the case of fast ferries because it is a "more appealing" service. In any case, this information seems to be highly speculative and difficult to verify. In the case of a major operator, overhead costs will not be the key to influence the decision of what unit to operate.

Others

The costs associated with potential duty-free sales or in general sales on board are not considered, excluded manning (hotel) costs. Operators on routes granted with the possibility of duty-free sales (international routes) claim that onboard sales constitute a major source of revenue. From a cost viewpoint, sales induce manning cost and costs of goods sold. The only consistent way to treat the latter is as a percentage of sales, and we have chosen to exclude it from the comparison. In any case, we must point out that one counterproductive effect of the introduction of a fast service is that reduction of onboard time and space can affect negatively on board sales, especially in the case of short routes.

As we said in Chapter 1, reliability is a major concern for the fast ferry operator. Most of the ships operating have reported operational problems. The main causes for cancellations are due to propulsion and engine failure and to weather conditions. To include this factor, we have estimated a certain number of cancellations as explained later on.

When the ferry operator manages his own terminal (instead of paying harbor dues), terminal costs must be allocated somehow to the passengers transported or to the vessel. The most straightforward way to do that would be to divide the total cost (lease plus terminal operating cost, etc) by the number of passengers transported or by the number of port calls. This approach is assuming that a percentage of the lease and operating expenses can be allocated to a well-defined passenger and private vehicle activity, which may or may not be the case.

Costs associated with developments needed to optimize terminal operations to a given vessel (say, a given fast ferry) may also be considered. From our generic perspective, it can prove very difficult to put accurate figures in those costs since it is not possible to clearly separate the operator's investment from government subsidies, port authority supportive actions, etc. On the other hand, certain operators claim cost savings in terminals to justify the introduction of fast ferries: since the number of passengers and cars per hour are lower, the facilities do not need to be expanded[5]. Is it realistic to include this "cost saving" in a cost comparison? We have chosen not to do it. Finally, for the comparison the fast ferry will be a monohull. Among the available designs, this is maybe the one that needs less improvement in the shore side to be fully operational.

4.3 Definition of the Generic Routes

[5] This argument has been used by BC Ferries to justify their Fast ferry investment. See Appendix 2.2

The characteristics of the routes relevant for this study are summarized in Table 4.3.1 For the purpose of this analysis, we will assume that both routes are operated all the year (excluding maintenance periods).

The numbers shown in Table 4.3.1 are rounded numbers and not exact figures. The operating time has been considered equal to 15 hours per day for fast and conventional services and for both the long and the short routes. The conventional ferry will have the potential to schedule overnight slow crossings in the case of the long route. This potential source of extra-revenues and extra-cost, like in the case of freight transportation, has not been considered.

	Short Route	*Long Route*
Distance (nm)	40	120
# Seats per day Capacity	7500	3000
# Cars per day Capacity	1850	750
Fast Ferry Max. Operating time, (h/day)	15	15
Conv. Ferry Max Operating time, (h/day)	15	15 + overnight
Total trip time, Conv. Ferry	3	7
Total trip time, Fast Ferry	1.5	3.5
Navigational time, Conv. Ferry @ 20k	2	6
Navigational time, Fast Ferry @ 40k	1	3
Frequency (trips per day) Conv. Ferry	15/3 = 5	15/7 ~2 (+1 overnight)
Frequency (trips per day) Fast Ferry	15/1.5 = 10	15/3.5 ~ 4
Avg. Fare per 5 pass + 1 car Conv. Ferry	$F	$2F
Avg. Fare per 5 pass + 1 car Fast Ferry	$1.1*F	$1.1*2F

Table 4.3.1: Characteristics of the Generic Routes

The total trip time includes the average navigational time and the average time necessary for the passengers and cars to enter and exit the ferry (a longer time for the conventional ferry, since the vessel is bigger and they will have to deal also with the freight).

The fare, due to the lack of comparability between fares in the different areas where fast ferries are operating or can be potentially operated, might be kept as a parameter. To generate a numeric result, an arbitrary fare equal to $100 for one car plus five passengers in the short route and $200 in the long route will be used for the conventional ferry. Fast Ferry fares are assumed to be 10% over the conventional ferry fares.

4.4 Cost Structure: Fast and Conventional Service

For the given characteristics of the routes as defined in the previous section the following units will be compared: A fast ferry service with one ship sailing at 40 knots versus a conventional ferry service sailing at 20 knots.

Fast Ferry Service: 750 Seats, 187 Cars Fast Ferry

We have chosen a monohull fast ferry as the option to be compared with the conventional ferry. The information contained in Appendix 1 serves us as a general guideline. The use of a monohull will provide an extreme cost differential in our comparison, since monohull newbuilding prices are reported to be lower than those of pure catamarans or wave-piercing catamarans. Also it will allow us to minimize possible distortions created by different subsidy schemes in different countries. The reason for that is that, as discussed in Chapter 1, the major catamaran builders (and thus with significant influence on price formation) are Australian shipyards, while no conventional ferries are constructed in this country. Monohulls allow keeping the comparison inside Europe, where subsidy schemes are more homogeneous.

The ratio passengers-to-cars has been made equal to 4. The car capacity is maybe the most important parameter when determining the newbuilding price, for a given required speed. The passenger capacity can easily be increased, being the main constraint safety requirements and excessive comfort diminution.

The operating life for fast ferries is assumed to be 15 years. This statement is a "best guess" supported by depreciation schedules used by operators. No existing car ferry has yet reached the end of her operational life. Construction time is assumed to be equal to 1.5 years from contract signature to delivery (the main items when defining this schedule are propulsion and engine construction times). This figure is conservative: the construction times proposed by the builders of monohull car-ferries similar to the one used here are in between 14 and 16 months.

Reported fuel consumption is always controversial. In general, we can say that for monohulls is more costly to achieve high speeds (they use higher power) than comparable catamarans. Thus, reported consumption for catamarans tend to be lower than those of single hull units are. The figure that we are using is conservative and includes other consumables (lube oil and fresh water).

Concerning crew size, the minimum requirement to operate the vessel is about 12, depending on flag requirements. Manning for operating the vessel will include one master, one chief officer, one chief engineer, first engineer, second engineer, third engineer and one customer service officer (total: 7), the rest of the crew being cabin attendants. Extra cabin attendants are normal practice specially when the operator has the opportunity of duty-free sales extra-revenue. The number of crewmembers is also very sensitive to the ship's flag and specific labor agreements. When dealing with ferries, salaries are also affected by regional factors not common to shipping in general. Here we have assumed a 25-members crew, including 4 officers. By considering such a high number, we intend to capture the manning cost associated with onboard sales.

The direct cost associated with the reliability of the service –the need to book passengers in an alternative service and/or compensate them when a trip is cancelled- will be calculated assuming an average number of cancellations per season (a percentage of the total number of trips), with a 75% load factor. Indirect costs, such as lost goodwill or others are not taken into account. Cancellations may be the result of bad weather conditions or unexpected technical problems. The percentage due to weather conditions is strongly dependent in the area where the vessel is operating. Here a 2% benchmark will be used.

The estimate of the time the vessel will be out of the service per year for maintenance reasons is 30 days. Table 4.4.1 summarizes the main cost items for the proposed vessel. The main particulars of the ship are based on the characteristics of the Seacontainers' SuperSeacat, a modified version of Fincantieri's Pegasus MDV1200 (see Appendix 1).

Concept	*Value*	*Notes*
Contract Price	30	Reported price
Financial Conditions(% contract,int,years)	80% @8%,8.5yr	OECD conditions
Signature-delivery time (years)	1.5	Fincantieri
# Crew (officers)	25 (4)	SeaContainers ships
Average wage per person per year ($)	50,000	Estimate
Consumption (T/hr) @ service speed	5.5	Estimate
Fuel price $/T (mdo)	150	Lloyd's. List Feb 10, 98
Port call charges, excluded pass. fee ($)	1,100	Drewry Shipping Cons
Insurance and class fees per year (m $)	0.2	Drewry Shipping Cons
Repair and maintenance ($ per mile)	6.5	Estimate
Days out of service per season	30	Estimate
Cancellation expense:	1.5 x Fare	Estimate

Table 4.4.1: Fast Ferry Cost Items

Conventional Ferry Service: 1500 Passengers and 375 Cars + Freight

The major problem faced when trying to define a comparable unit is the lack of a wide basis of modern and more or less homogeneous tonnage. The fact that conventional ferries are oriented towards both freight transportation and passenger transportation make it difficult to know the targeted percentage lane meters oriented towards private vehicle transportation. Unlike fast ferries, there is no design constraint in the ratio passengers-to-vehicles. The result is a wide range of vessels, each designed for a particular route.

It is necessary to differentiate between the long and the short route. In the latter, the ideal conventional ferry will be provided only with seats while in the former it is likely that the ferry will have seats and cabins, thus having the flexibility of overnight operation. The capital costs of those vessels will not be the same, being the short route ferry less expensive than the long route one.

To have an idea of the type of vessels operating in those routes, Table 4.4.2 summarizes some relevant vessels operated by P&O Stena, P&O European Ferries and Stena Line in the European routes as well as examples of the fleet operated by BC Ferries (British Columbia, Canada). In the all the cases, they are competing directly or indirectly with Fast Ferries. In the British Columbia case, Fast Ferries are going to start operations in 1998. In the case of the P&O Stena service, the recent merger between P&O and Stena for operations in the English Channel (see Ref. [19]) has allowed them to reduce the number of units keeping on the service those who best fitted the characteristics of the route.

Vessel Name	*Route*	*Time*	*Pass.*	*Cars*	*Freight*
Pride of Dover&Pride of Calais (P&O Stena)	Dover-Calais	75 m	2,290	650	100 lorries
Stena Empereur (P&O Stena)	Dover-Calais	75 m	2300	550	100 lorries
Pride of Kent (P&O Stena)	Dover-Calais	75 m	1825	460	64 lorries
Stena Fantasia (P&O Stena)	Dover-Calais	75 m	1800	600	100 lorries
Queen of Coquitlaim & Queen of Cowichan (BC Ferries)	Horseshoe Bay – Nanaimo	95 m	1,466	365	n/a
Pride of Rathlin (P&O)	Larne-Cairnryan	135m	1035	340	60 lorries
Stena Danica (Stena)	Goteborg-Frederikshavn	210m	2274	555	76 lorries
Pride of Bilbao (P&O)	Portsmouth-Cherbourg	5-8h	2500	600	62 lorries
Pride of Le Havre (P&O)	Portsmouth-Le Havre	5.5-7.5 h	1600	570	89 lorries

Source: Seaview (www.seaview.co.uk)

Table 4.4.2: Selected Conventional Ferries

We have chosen to maintain the same ratio that has been used for fast ferries, 4-to-1, in both the short and the long route. In a route requiring a smaller ratio (say, 3) the only available possibility would be the conventional ferry. In fact, as Table 4.4.2 shows, most of the vessels are in between 4 and 3. Analyzing more complete data, we can conclude that there is a certain trend for this ratio towards 4 in the Stena fleet, while P&O is more likely to have smaller ratios. This ratio will be in direct relation with the freight transported by the company.

Operational life of the conventional ferry will be assumed to be 25 years. The ferry will comply with the new SOLAS requirements and sail at 20 knots. Construction time, from signature to delivery, will be in between 2 and 2.5 years. We will assume 2 years for the short route and 2.5 for the long route. Like in the case of fast ferries, since the operating hours per day are the same (15 hours), 2 complete crews are assumed to be needed throughout the season. The size of the crew is significantly higher than in the case of fast ferries, and is estimated around 50 crewmembers. In the case of the long route it can be argued that the number of crewmembers will be higher, especially if the vessel is prepared for overnight service. That will be in direct relation with the product that the company wants to offer. Fifty can be a smaller number for a cruise-ferry, but is a consistent figure to cover the transportation needs, including on board sales. We assume that there will be no cancellations. Table 4.4.3 summarizes the main cost items for the proposed vessel.

Concept	*Indicative Figures*		*Notes-Sources*
	Short route	Long Route	
Contract Price (million U.S. $)	75	100	Reported prices
Financial Conditions	80% @8%,8.5yr		OECD conditions
Signature-delivery time (years)	2	2.5	Recent Contracts
# Crew	50		Estimate
Salaries expense per year ($)	50,000		Estimate
Consumption (T/hr) @ service speed	4.8		Estimate
Fuel price $/T (HFO, EU average Feb-98)	75		Lloyd's. List Feb 10, 98
Port charges per call, excluded pass. fee, $	6,000		Drewry Shipping
Insurance and class fees, million $ /year	0.5		Drewry Shipping
Repair and maintenance ($/miles)	42		Drewry Shipping
Days out of service per year	15		Estimate

Table 4.4.3: Conventional Ferry Cost Items

4.5 Cost Comparison: Results and Sensitivity Analysis

The results of the comparison in a per day basis are presented in Tables 4.5.1 and 4.5.2 for the two generic routes. Table 4.5.4 shows a detailed calculation of capital costs.

The percentages are calculated over the total cost, overhead excluded. The costs are distributed over 365 days to obtain per day values.

Short Route: 40 nautical miles, 1.5 hours fast service or 3 hours conventional service

Cost Concept	*Fast Ferry*		*Conventional Ferry*		*Savings*
	$/day	*% total*	*$/day*	*% total*	*($/Day)*
Capital	10,399	25%	18,377	26%	7,978
Voyage					
Fuel	7,572	18%	3,452	5%	(4,120)
Port dues, excluding pass. fee	10,100	24%	25,890	37%	15,790
Operating					
Manning	6,849	16%	13,699	19%	6,849
R&M	2,386	5%	8,055	11%	5,669
Insurance and other fees	550	2%	1,370	2%	820
Cancellations (2% trips)	4,259	10%	0	0%	(4,259)
Total, overhead excluded	**42,115**	**100%**	**70,843**	**100%**	**28,728**

Table 4.5.1: Cost Comparison Results, Short Route

Long Route: 120 nm, 3.5 hours fast service or 7 hours conventional service

Cost Concept	*Fast Ferry*		*Conventional Ferry*		*Savings*
	$/day	*% total*	*$/day*	*% total*	*($/day)*
Capital	10,399	28%	24,502	38%	14,103
Voyage					
Fuel	9,086	24%	4,142	6%	(4,944)
Port dues, excluding pass. fee	4,038	11%	11,507	18%	7,469
Operating					
Manning	6,849	19%	13,699	21%	6,849
R&M	2,864	8%	9,666	15%	6802
Insurance and other fees	550	2%	1,370	2%	820
Cancellations (2% trips)	3,407	8%	0	0%	(3,407)
Total, overhead excluded	**37,193**	**100%**	**64,886**	**100%**	**27,693**

Table 4.5.2: Cost Comparison Results, Long Route

The cost structure can be very sensitive to deviations in certain parameters. Basically, these parameters will reflect issues that affect in different manner the conventional and the fast modes. We have identified a number of them that are especially important, either because the fundamentals of the assumptions on which they are based are not enough solid or because they are subjected to a high degree of volatility. Those are:

1. Contract Price
2. Rate of return
3. Economic life of the fast ferry
4. Bunker prices
5. Cancellations

For each one of them, a sensitivity analysis will be conducted in the following terms: A percentage deviation will be assumed for each cost item, and the effect of the increase or decrease in the cost item will be computed, all other things equal. Cancellations will be computed only for fast ferries assuming 1%, 5%, 10% and 15%. For the rate of discount, we will use 2% and 5% deviations from the base case. The results of this analysis are presented in Table 4.5.5 for both the short and the long route and they are discussed in the following section.

A very special item in the cost structure developed here is port dues. The percentage of port dues can be very important. As we explained before, the calculation is based in a fixed fee per net registered ton. This is common practice in shipping, including cruise ships. But in the case of ferries, the massive use of the terminal can lead to special agreements with the port authority to reduce this burden. In other cases, the ferry operator also operates the terminal, thus internalizing in the company's overhead cost structure this cost. For the reasons outlined, it may be interesting to compare the fast and the conventional services excluding port dues. The results of this comparison are shown in Table 4.5.3.

Route	Fast Ferry	Conventional Ferry	Difference
Short Route ($/day)	32,015	44,953	12,938
Long Route ($/day)	33,155	53,379	20,224

Table 4.5.3: Cost Comparison, excluding port dues

4.6 Discussion of the Results

The results, in the way they have been presented in the previous section, show a clear advantage on the side of the fast ferry. The capital cost, after being adjusted to take into account the different economic life of the two assets (discounting the remaining value of the conventional unit after the 15th year) are clearly beneficial to the fast ferry. In the sensitivity analysis, three of the parameters have an impact on the capital cost: contract price, discount rate, and economic life of the vessels. Only in the case of a 50% increase in fast ferry prices and a 20% diminution of conventional ferry prices, the conventional ferry will be more convenient. Rising interest rates will have a higher impact on the more capital-intensive investment, the conventional ferry, broadening the cost differential.

Assumptions for the Calculation	Fast Ferry	Short route Ferry	Long Route Ferry	
Contract Price: m $	30	75	100	*million $*
Payment conditions				
Downpayment at signature: 20%	6	15	20	*million $*
Payment at delivery: 80%	24	60	80	*million $*
Construction Period (years):	1.5	2	2.5	*years*
Financial conditions:				
% contract price	80	80	80	*million $*
Annual interest:	8	8	8	*%*
Repayment period:	8.5	8.5	8.5	*years*
Instalments payable each:	0.5	0.5	0.5	*years*
Operating life of the vessel:	15	25	25	*years*
Scrap value (5%contract price):	1.5	3.75	5	*million $*
Annual discount rate:	10	10	10	*%*

Results	Fast Ferry	Short route Ferry	Long Route Ferry	
Loan Payments (6 months, P+I):	1.96	4.90	6.54	*million $*
PV loan payments at delivery:	22.31	55.77	74.36	*million $*
Operating period annuity:	**3.84**	**8.05**	**10.73**	*million $*
PV remaining value after year 15:	0.36	12.19	16.25	*million $*
Discount on the operating annuity:	0.05	1.34	1.79	*million $*
Adjusted operating annuity for 15 yrs:	3.80	6.71	8.94	*million $*
Capital Cost per day	**10398.90**	**18376.68**	**24502.25**	*$*

Table 4.5.4: Capital Cost Analysis

Item	Fast Ferry:				Conventional Short Route Ferry:				Conventional Long Route Ferry			
Contract Price (m. $)	**27**	**33**	**36**	**45**	**60**	**67.5**	**82.5**	**90**	**80**	**90**	**110**	**120**
Capital Cost ($/day)	9,359	11,439	12,479	15,598	14,701	16,539	20,214	22,052	19,601	22,052	26,952	29,403
Discount Rate	**5%**	**8%**	**12%**	**15%**	**5%**	**8%**	**12%**	**15%**	**5%**	**8%**	**12%**	**15%**
Capital Cost ($/day)	8,629	9,686	11,117	12,205	11,743	15,672	21,089	25,096	15,658	20,896	28,119	33,461
F. Ferry life (yrs)	**12**	**13.5**	**16.5**	**18**	**12**	**13.5**	**16.5**	**18**	**12**	**13.5**	**16.5**	**18**
Capital Cost ($/day)	11,560	10,906	9,997	9,673	16,451	17,483	19,151	19,823	21,935	23,310	25,535	26,431
Conv. Ferry life (yrs)	**20**	**22.5**	**27.5**	**30**	**20**	**22.5**	**27.5**	**30**	**20**	**22.5**	**27.5**	**30**
Capital Cost ($/day)	10,399	10,399	10,399	10,399	20,829	19,399	17,629	17,072	27,772	25,866	23,505	22,763
Fuel ($/Ton)	**120**	**135**	**165**	**180**	**60**	**67.5**	**82.5**	**90**	**60**	**67.5**	**82.5**	**90**
Fuel Cost ($/day)												
short route	6,058	6,815	8,329	9,086	2,762	3,107	3,797	4,142	-	-	-	-
long route	7,269	8,177	9,995	10,903	-	-	-	-	3,314	3,727	4,556	4,970
Cancellations	**1%**	**5%**	**10%**	**15%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Cancel. Cost ($/day)												
short route	2,130	10,648	21,296	31,944	-	-	-	-	-	-	-	-
long route	1,703	8,518	17,037	25,555	-	-	-	-	-	-	-	-

Table 4.5.5: Sensitivity Analysis of the Cost Structure

Because of the method chosen to account for the different economic life of the two options, changes in the fast ferry economic life will have a double impact. First, a direct impact over the fast ferry annuity and, second, an indirect one through the remaining value of the conventional ferry over the conventional ferry annuity. It must be mentioned that this approach includes a risky forecast about second hand market prices in the conventional ferry market, since we are saying that the company will be able to sell the vessel at its book value (assuming straight-line depreciation).

Rising fuel prices will contribute to decrease the cost differential. We have assumed for the sensitivity analysis that prices for Fuel Oil and Diesel Oil are totally correlated.

Cancellations are especially important. Under the assumptions that we have done in this study, a rate of cancellations to total annual trips of 10% can eliminate the cost advantage of the fast ferry. This shows how important reliability can become, and how carefully a given route must be evaluated (statistics about sea states) prior to the introduction of a fast ferry. It also shows what can be the effect of unexpected technical problems. The know-how of the company entering the high-speed segment is therefore a key issue.

The cost differential also holds if we discount the most controversial cost item, port dues. Although the assumption of a fixed fee per Net Registered Ton is maybe too simplistic, some cost difference beneficial to the fast ferry is to be expected.

To summarize, the results show very important cost savings, both in capital and non-capital items, in the side of the fast ferry. This cost saving has some disadvantages. What potential revenue are we giving up, if any, by choosing fast ferries? First, freight can be carried in conventional ferries but not in a fast ferry similar to the one chosen to perform the comparison. This is a major concern for ferry operators, since freight is a much less seasonal business that often provides operators with the necessary stability in revenues during the off-peak season.

Second, there is empirical evidence that onboard duty-free sales, in the routes where they are possible, are smaller in fast ferries. And finally, in the case of the long route, the conventional ferry offers the possibility of a different service, the "cruise ferry", where the customer satisfaction comes from a combination of a transportation service with leisure activities.

These facts relate the decision of whether to introduce a fast or a conventional ferry on a given route to other issues apart from the cost structure. Among those, the type of customer to whom the service is oriented and the revenue structure of the company (the percentages of freight, passengers and private vehicles as well as onboard sales) are especially important.

Using the basic cost structure proposed here, and estimating the potential revenues associated with these other sources and their associated costs, it will be possible for the operator to make a decision about the type of ship that better suits his needs.

Chapter 5

FEASIBILITY ANALYSIS: LINKING DEMAND, COSTS AND STRATEGIES

This chapter responds to the question of whether a fast ferry might be feasible for a given route and provides guidelines concerning strategic issues in fast car-ferry operations. The approaches followed in this chapter are based on the results of previous chapters, including not only the numerical estimations of demand and costs but also non-quantifiable competitive issues.

To better account for the latter, we have selected different base cases to perform the analysis. We will continue using the generic routes proposed in Chapter 1, but we will also include different competitive situations. In particular, we will be focusing on three cases:

- A monopolistic operator decides to introduce a fast ferry service and continue operating conventional units, although restricting capacity.

- An independent operator enters a route dominated by one or more major conventional ferry operators. This independent operator does not provide conventional ferries, only fast car-ferries. In a first stage, the new operator is competing with the conventional tonnage previously on the route.

- Following as the second case, the major operator decides to introduce its own fast ferry service. Or, after the situation described in the first case, an external operator decides to enter the route with fast ferries. In these situations there will be different fast ferries competing among them and with the conventional ferry service.

The study of each case will consist of a revenue-cost analysis. After defining the decision-maker(s), the analysis will provide a rationale for estimating market shares and prices as well as the revenues generated and costs associated. Competitive and strategic issues will be considered as well. First, the rationale will be presented in general terms and then we will perform a sample calculation for each one of the three generic routes using the cost data obtained in Chapter 4.

In all cases, it will be assumed that the ratio passengers-to-cars of the routes is 4-to-1, and that the ferries are designed with this ratio. The routes to be studied are also assumed to be experiencing increases in demands, and the companies operating on the route are assumed to be in economically sound condition. The chapter will conclude reviewing different strategic issues not included in the case-by-case analysis.

5.1 Monopolistic Operator Introducing Fast Ferries Backed up with Conventional Ferries

In this case, market reactions are the most predictable. In idealistic conditions, there will be a single decision-maker with good knowledge about the market in the route that will be able to produce good estimates taking into account only mode attributes. This should be the case that best suits the theoretical approach developed in Chapters 2 and 3. It is not necessary to discount competitive reactions or other disturbances.

Some examples of real situations well modeled by this base case include routes such as the ones in the Cook Strait, Nice-Corsica in France, Barcelona-Palma de Mallorca and Algeciras-Ceuta (not in 1997) in Spain. In the future Horse Shoe-Nanaimo in British Columbia (in the transitory process, before the announced full substitution occurs) will be added to this list.

In this scenario, it is also clear who is the decision-maker: the monopolistic operator. When the operator is about to decide whether to introduce the fast ferry, the basic data available may include demand data for previous operational periods and forecasts for future seasons, as well as cost estimates of both the fast and the conventional ferry. Given the route, the operator will have to decide about three major issues: the fast ferry capacity to be offered (a function of the ship and the frequency of the scheduled crossings), the pricing strategy, and the diminution of conventional ferry capacity offered on the route.

In this case, the price can be defined using the conceptual model proposed in Chapter 2 and developed in Chapter 3. A targeted market share, chosen *a priori* by the operator, may be used as input to estimate the price (average, and in relative terms to the conventional ferry fares) for the fast ferry mode. Then, the revenue can be estimated and compared with the total cost of the service to define the feasibility of the service by itself. Studying different market shares, the service (ship capacity combined with number of crossings) can be defined and priced so that the required return is achieved.

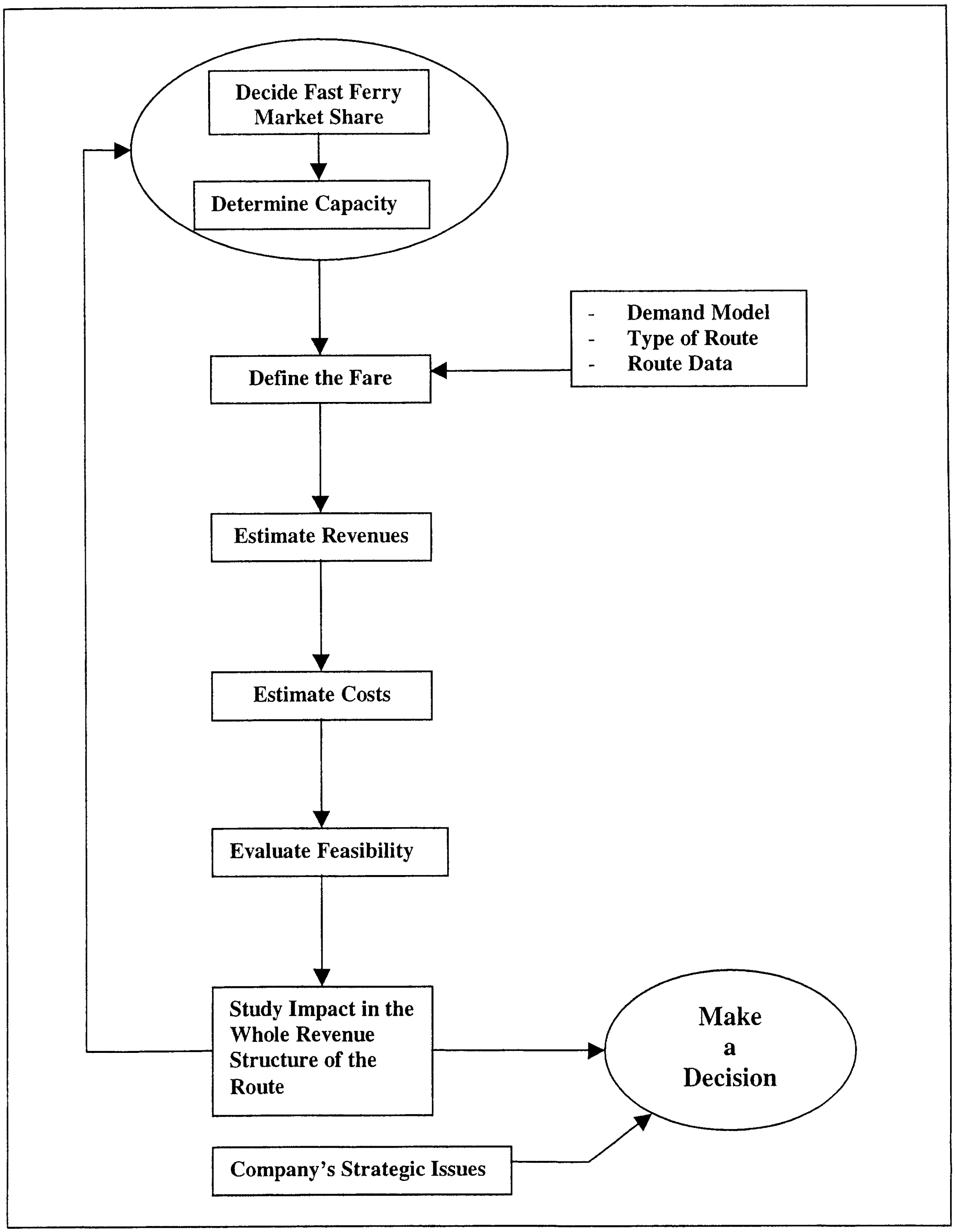
In the second stage, the effect of introducing the service over the revenue/cost structure of the conventional ferries on the route may be taken into account, in order to evaluate the total impact of the new service on the company.

Figure 5.1.1 shows the proposed rationale for making a decision in this scenario. Table 5.1.1 shows a sample calculation of the economic feasibility for the particular case of the three generic routes defined in Chapter 1. A further restriction of the calculation performed here comes from the fact that only one fast car-ferry and one conventional ferry have been taken into consideration (the same ships that were used in the cost estimation). While Figure 5.1.1 captures the issues to be taken into account in the decision and how they are related in general, Table 5.1.1 shows a particular situation.

To obtain the total cost of the fast ferry unit, we have used the estimation obtained in Chapter 4 (the basic cost in the table) and we have expanded this result assuming 80% overhead cost and a 20% margin in onboard sales. From the viewpoint of revenues, an onboard sale of $15 per passenger on the short route and $25 in the long routes has been used. These figures assume international routes with duty free sales granted and have been estimated using revenue information of major ferry operators in Europe. Table 5.1.1 also shows the same results discounting the onboard sales and the costs of goods sold (but maintaining the same manning requirements).

The information contained in this Table is also a tool to estimate the minimal required market size to make a given vessel profitable (in this case, a 750 Passengers 187 Cars Fast Car-Ferry Monohull). Since the market share and the price are directly related, but the costs are independent of those factors, the spreadsheet supporting this table can help to estimate the fast ferry market share that will maximize income for the fast ferry service. The margin is different for the three generic routes. This is due to the different pricing strategies, time sensitiveness, and costs for the different routes. In general, the margin will be higher in the short-recreational route and smaller in the long non-recreational route.

Figure 5.1.1: Decision Chart: Monopolistic Operator Introducing Fast Ferries In Competition with Conventional Ferries



Competitive Scenario:	**Monopolistic Operator Introducing Fast Ferries Backed up with Conventional Ferries**		
New Fast Ferry:	750 pass	187 cars	
Conventional Ferry:	1500 pass	375 cars	
Route Type	**Short Non-Recreational**	**Long Non-Recreational**	**Long Recreational**
Route Attributes			
Frequency	10	4	4
Market Size	5000	2000	2000
Distance	40	120	120
Conventional Ferry Price	270	420	336
Total Time, Conv. Ferry	180	420	420
Total Time, Fast Ferry	90	210	210
Targeted Market Share	60%	60%	60%
Price	313.691	604.402	403.354
Load Factor (%pass day)	40%	40%	40%
On board sales per pass.	15	25	25
Revenues ($/day)	209893	157551	114124
Costs			
Basic Cost	42115	37193	37193
CoGS on board(20%margin)	36000	24000	24000
Overhead(@ 80%basic)	33692	29754.4	29754.4
Total cost ($/day)	111807	90947.4	90947.4
Result	**98085.9**	**66603.5**	**23177.1**
% Revenues	**47%**	**42%**	**20%**
Result, Discounting Onboard Sales	**93585.9**	**63603.5**	**20177.1**
% Revenues	**50%**	**44%**	**21%**

Table 5.1.1: Sample Revenue-Cost Calculation: Monopolistic Operator Introducing Fast Ferries Backed up with Conventional Ferries

5.2 Fast Ferry Specialized Operator Entering a Quasi-Monopolized Route with Only Conventional Ferries

Under this scenario, the operator cannot expect great results from theoretical models based on mode attributes with respect to price formation. Its weak competitive situation in comparison with the Quasi-Monopolistic operator will force him to fix the price in relation to the existing conventional ferry fares. Therefore, in this case, the first input will be the price, and the market share will be a consequence of both the given price and the capacity introduced on the route.

Examples of such situations are not rare. The Frederikshavn-Gothenburg route in 1995, or the Belfast-Stranraer route in 1995 and 1996, where Stena was in a quasi-monopolistic situation and Seacontainers started operations with fast ferries, are good examples.

The transportation capacity to be introduced should take into account competitive responses from the major operator on the route. If the targeted market share is not excessive, the newcomer will not threaten the dominant position of the major operator, and thus will not force him to enter into an open fare war. On the contrary, if the newcomer is targeting an important market share, the outcome will be difficult to predict, since existing load factors and fares cannot be considered to remain unchanged. The new operator cannot expect the former monopolistic operator to reduce transportation capacity on the route, at least not in the short term, and thus overcapacity in the route will be an issue, at least in an unclearly defined transition period.

Assuming that the capacity introduced by the new operator is small in comparison to the capacity offered by the now quasi-monopolistic operator, and that major fare changes do not occur, the rationale for the evaluation of the route from the viewpoint of the new operator entering the route may be as follows. Taking as a starting point the fare, derived from the conventional ferry fare in place, the operator can derive a market share by using the model proposed in previous chapters. The share will be limited to the maximum capacity offered, assuming a reasonable load factor. We have:

Market Share = Min (max. share allowed by capacity, share predicted by the model)

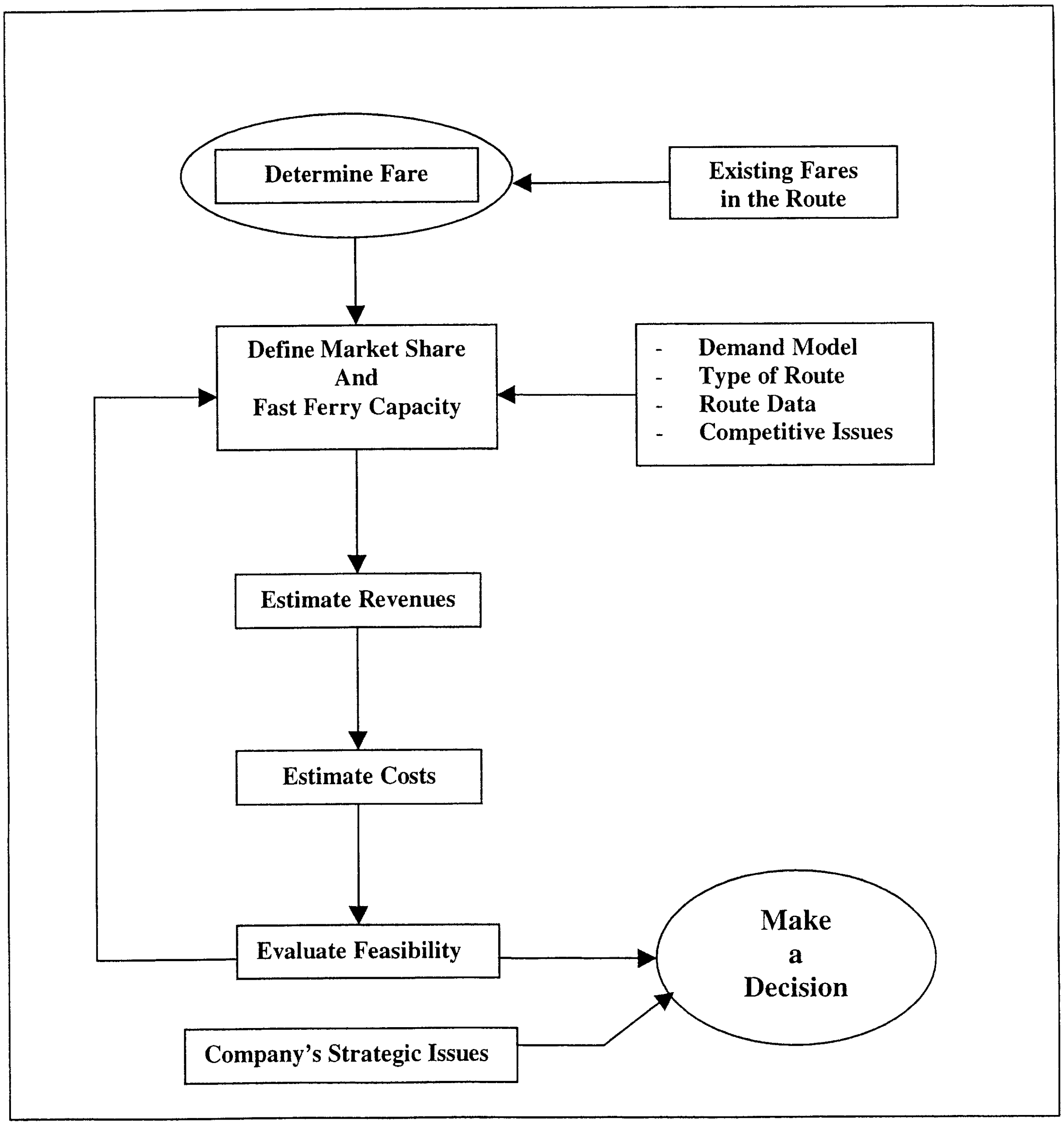
Due to the extreme seasonality of the ferry demand (and remembering that the average load-factor in an industry much more developed in these matters, like the air transportation industry is, is about 70-75%) an operational maximum average load factor can be estimated to be around 65%. Once the revenue has been determined, the cost incurred will show if the service fulfills the required return expectations.

In this scenario, it would be meaningless to extend the use of the model to maximize the return on the route if the targeted market share exceeds a certain limit. Over a certain market share, the characteristics of the route that do not depend on the fast ferry company will be unknown: the major operator will redefine its pricing strategy and the capacity offered in terms that are unknown to the newcomer.

Figure 5.2.1 shows the decision rationale proposed for this scenario. Table 5.2.1 provides the result of a sample the calculation under the scenario described in this section and based on the general assumptions stated in the previous section. For the calculation, it has been assumed that the market share targeted is small in relative terms to the major operator on the route.

As in Table 5.1.1, the calculation is restricted to the three generic routes and given the vessel size. In this case, the demand model is used only to verify that the small market share that the capacity of the vessel allows is actually reachable for the given price. The price is related to the existing fare structure in the market, rather than being calculated using the demand model. The reason for this approach (which will not mathematically maximize revenues) is that it seems unrealistic to market a service at a much higher price than the existing one. In this situation, the newcomer will achieve its maximum operating load factors. We can observe the same trend of the margins for the three generic routes that was identified in the previous case: the higher value corresponds to the short non-recreational route and the recreational route offers the lower margins.

Figure 5.2.1: Decision Chart: Fast Ferry Specialized Operator entering a Quasi-Monopolized Route with Only Conventional Ferries



Competitive Scenario:	**Specialized Operator entering a Quasi-Monopolized Route with Only Conventional Ferries**		
New Fast Ferry:	750 pass	187 cars	capacity
Conventional Ferry:	1500 pass	375 cars	capacity
Route Type	**Short Non-Recreational**	**Long Non-Recreational**	**Long Recreational**
Route Attributes			
Frequency	10	4	4
Market Size	30000	12000	12000
Distance (nm)	40	120	120
Conventional Ferry Price	270	420	336
Total Time, Conv. Ferry	180	420	420
Total Time, Fast Ferry	90	210	210
Price(10,15 and 20% over CF)	297	483	403.2
Market Share, model	64%	86%	60%
Market Share, max capac	16%	16%	16%
Estimated Market Share	16%	16%	16%
Load Factor	65%	65%	65%
On board sales per pass.	15	25	25
Revenues($/day)	326430	213408	185398
Costs			
Basic	42115	37193	37193
CoGS on board(20% margin)	58500	39000	39000
Overhead(@ 80% basic)	33692	29754.4	29754.4
Total cost ($/day)	134307	105947	105947
Result	**192123**	**107461**	**79450.8**
% Revenues	**59%**	**50%**	**43%**
Result, Discounting Onboard Sales	**180423**	**99660.6**	**71650.8**
% Revenues	**70%**	**60%**	**52%**

Table 5.2.1: Sample Revenue-Cost Calculation: Specialized Operator Entering a Quasi-Monopolized Route with only Conventional Ferries

5.3 Fast Ferry Specialized Operator Competing against Major Operator with both Fast and Conventional Ferries

This is the most difficult scenario to be analyzed. There are two decision-makers, and the strategies that the two companies will follow are likely to be different. Under this scenario, inter-company competition is not the same as inter-mode competition, although there will be interaction between them.

Some examples of routes analyzed in this section include the present situation in the Gothenburg-Frederikshavn route during the summer season, or in the Belfast-Stranraer route. Also, Buquebus is trying to break Trasmediterranea's quasi-monopoly in the Algeciras-Ceuta route, and tried (unsuccessfully) to do the same in the Cook Strait in 1996.

While the competition between modes should be explained, other things being equal, regarding to their attributes, the competition between the companies will be driven by their relative competitive positions on the route under analysis. A new issue in this case will be how fast ferries of different sizes interact between them. To compare different ships, we will assume that the cost structure (but not the costs themselves) is the same for both vessels (i.e., the same design, manning requirements, flag and port charge, etc).

We will assume that the schedule offered by both companies is comparable, the capacity of the fast ferry mode will be enough to discount capacity constraints on its market share (i.e., the maximum market share possible due to capacity constraints will be slightly over the market share predicted by the demand model). In this case, it will be necessary to split the customers between the two fast ferry services. A given percentage will be taken as a parameter to split the demand.

Under these assumptions, the price, from a demand viewpoint, will tend to be the same for both fast ferry services, and the market share of fast ferries compared with the market share of the conventional ferries can be estimated with the demand model.

But the cost structures of the two companies may be different, so that the margins of the two fast ferry services may be different. There are several reasons for the cost structure to be different: first, fast ferry units of different size induce different costs (scale effects). Second, the overhead costs differ for different companies. Third, cancellation costs will be smaller in the case of the major operator, since he is backing up the fast service with the conventional units. We will focus in the second factor, and different overhead burdens will not be considered in this study.

The key question is *what* fast ferry must be introduced in a given route. A Fast Ferry of the same size as the existing vessel, or a bigger one? We will distinguish two cases, different by nature. They constitute "second steps" in the development of the industry, after the situations described in the previous two sections.

On one hand, we have identified the case of the specialized operator entering the service monopolized by a single operator with fast ferries and conventional ferries. On the other hand, the case of a conventional ferry company reacting to the deployment of a fast ferry unit by a specialized operator by introducing its own fast ferry.

The choices to be considered include the deployment of a unit of the same characteristics (transportation capacity, cost structure) or the use of a bigger unit. The cost per revenue-unit (car + five passengers), assuming fully loaded condition, will be smaller for the bigger vessel. The reason is that there are scale economies in capital, overhead and operating costs (not for that portion of manning, that depends on passenger capacity). But, will load factors become smaller?

Specialized operator entering a monopolized route.

If the vessel introduced has the same capacity that the one of the existing ship, the price will have to be the same as the price charged by the major operator. The reason is that the cost structure of both ships is basically the same, and the specialized operator does not have any competitive advantage to define prices.

If the margin of the major operator was excessive, the price fixed by the independent operator can be smaller, but the major operator will match it rapidly. In the process, there will be a shift of demand from the conventional to the fast service, assuming that conventional ferry fares remain unchanged.

Assuming that the newcomer is able to overcome the competitive disadvantage existent in the route, an optimistic result for him would be to capture half of the fast ferry market share.

Now let's assume that the vessel introduced is bigger than the existing vessel. The costs of the unit will be lower in per car terms than for the existing service, if the same load factor is achieved. The newcomer can charge the same as the existing operator and achieve smaller load factors, and at the same time diminish the load factors of the major operator (due to the over capacity created), or can charge less than the major operator, attracting demand both from the conventional ferry segment and from the other fast ferry. That will lead the major operator to reduce fares, to match the fares of the bigger fast ferry. In the process, conventional ferries are likely to lose most of their passengers' share, restricting their activities to freight transportation.

But, as we described under the previous heading, the entrance in the market of a vessel with double the capacity of the fast ferry unit will have unpredictable effects. The competitive advantages of the former monopolistic company will make difficult for the newcomer the adaptation to the new route if he is targeting a major market share. The outcome of this action-reaction game will be unpredictable to a great extent.

Figure 5.3.1 shows the decision chart for this case, from the newcomer's perspective. Within the set of different alternative scenarios analyzed, this is the case with the higher degree of uncertainty, especially if the newcomer decides to introduce the bigger vessel.

Table 5.3.1 is a sample calculation in the case that a vessel of the same size as the existing one is introduced. The major assumption made here relates to the percentage of the total fast service that the newcomer is going to take (here, we have arbitrarily chosen 30%). Since the price is the same as the existing tariff, the results shown in Table 5.3.1 are implicitly assuming that the fast ferry operator already in the market was obtaining high load factors. The reason to assume this is because an independent operator is not likely to try to operate on a non-profitable route. In this scenario, margins across the different route types show the same trend that was pointed out in the previous cases.

Major Operator reacting to the introduction of an independent fast ferry

In this case, the former monopolistic operator, still with a very important market share, wants to compensate the incipient danger personalized in the independent owner. His strong competitive position allows him to have direct influence in price formation.

If the major operator decides to introduce a vessel similar to the fast ferry already in place, prices can match the fares in place or follow a different strategy: the independent operator will be obliged to match the new fares if they are lower. Assuming that the independent operator was achieving high load factors, a shift from the conventional ferry customers might be expected. Once the price has been defined, the demand model developed in previous chapters can estimate the market share and compare it with the total fast ferry capacity offered, in order to determine the load factors.

But the major operator has also an opportunity to retake part of the lost share. If a bigger unit is introduced, and fares are reduced, the new fast ferry will capture passengers previously using conventional ferry services and will put under pressure the margins of the independent operator. In the process, conventional ferries are likely to lose most of their passenger demand, tending to be each time more and more dependent on freight. Unlike in the previous case, there are no major fears about competitive pressures on the new vessel, since the major operator has a dominant position.

Figure 5.3.2 shows the decision chart proposed in this section. The three generic routes are then analyzed in Table 5.3.2, under the assumption that the major operator decides to introduce a bigger unit that the existing one. The price has been determined as the minimum of the prices calculated with the demand model and the price charged by the independent operator. It has been assumed that the independent operator will maintain its market share. Again, margins show, across the different route types, the same trend that was pointed out in the previous cases.

Figure 5.3.1: Decision Chart: Specialized Operator Entering a Quasi-Monopolized Route with Conventional and Fast Ferries

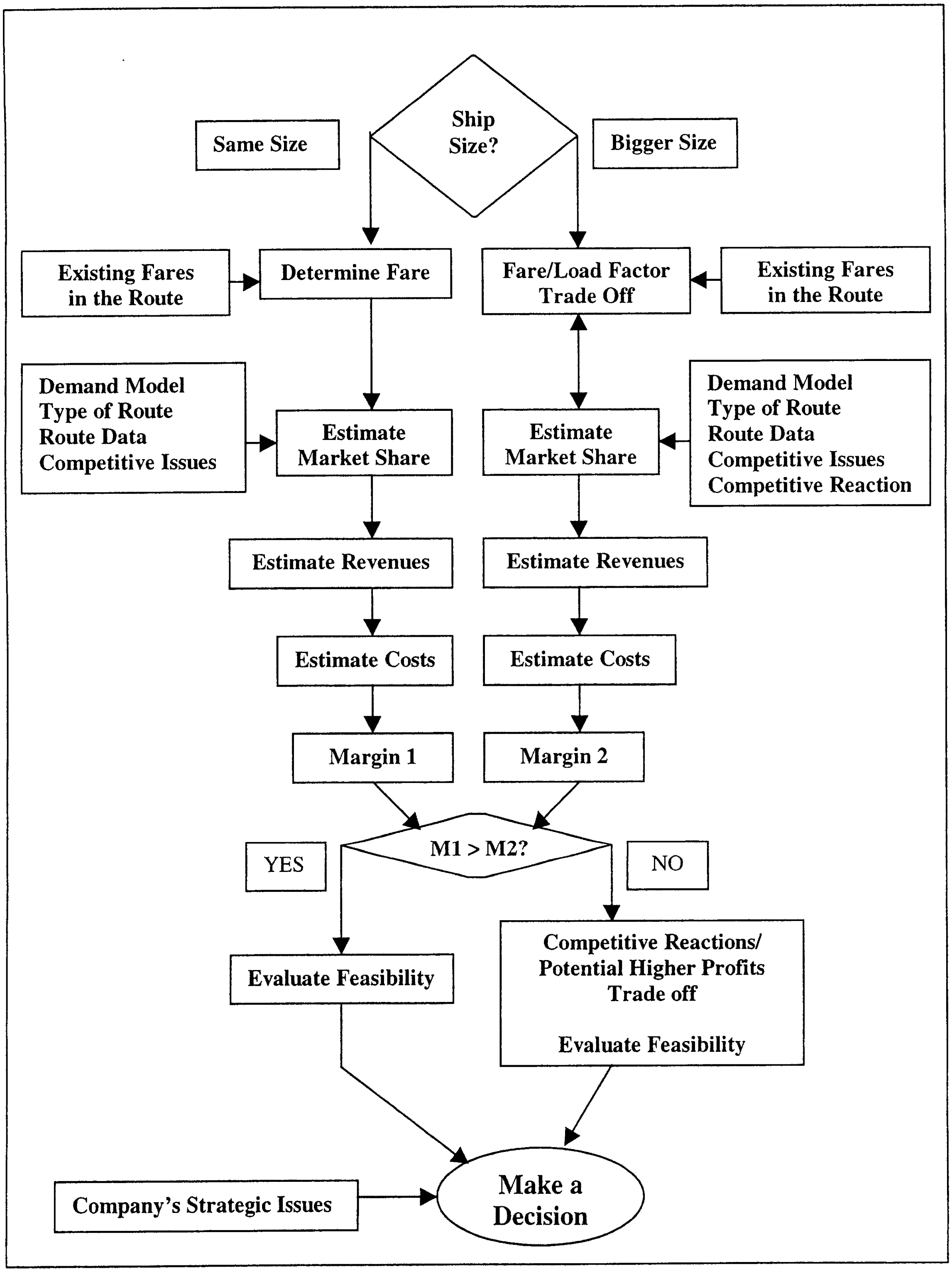
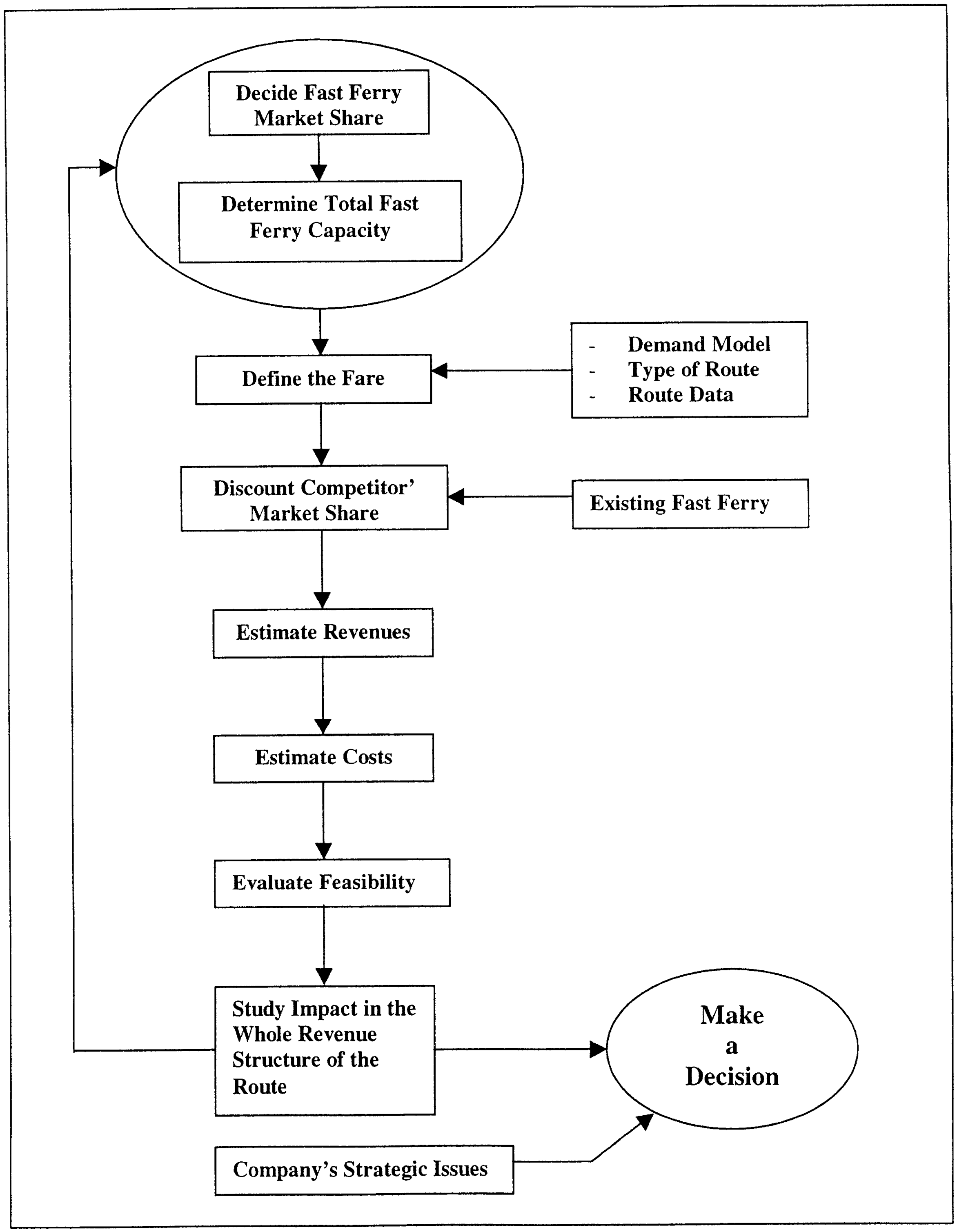


Figure 5.3.2: Decision Chart: Major Operator Reacting to the Introduction of an Independent Fast Ferry



Competitive Scenario:	**Specialized Operator Entering a Quasi-Monopolized Route with Conventional and Fast Ferries**		
New Fast Ferry	750 pass	187 cars	
Fast ferry:	750 pass	187 cars	
Conventional ferry:	1500 pass	375 cars	
Route Type	**Short Non-Recreational**	**Long Non-Recreational**	**Long Recreational**
Route Attributes			
Frequency, new Fast ferry	10	4	4
Market Size	15000	4500	6500
Distance	40	120	120
Conventional Ferry Price	270	420	336
Existing Fast Ferry Price	297	483	403.2
Total Time, Conv. Ferry	180	420	420
Total Time, Fast Ferry	90	210	210
Price	297	483	403.2
Total FF Mrkt Sh, model	64%	86%	60%
Total FF Mrkt Sh. max. capac	65%	87%	60%
Total FF Mrkt Share	64%	86%	60%
New FF % of Total FF Mrkt Sh	30%	30%	30%
New Fast Ferry Load Factor	39%	39%	39%
On board sales per pass	15	25	25
*Revenues**($/day)*	194287	126657	111239
Costs			
Basic	42115	37193	37193
CoGS on board(20% margin)	35100	23400	23400
Overhead(@ 80% basic)	33692	29754.4	29754.4
Total cost ($/day)	110907	90347.4	90347.4
Result	**83379.9**	**36309.2**	**20891.5**
% Revenues	**43%**	**29%**	**19%**
Result, Discounting Onboard Sales	**74956.9**	**30776.3**	**15041.5**
% Revenues	**50%**	**31%**	**18%**

Table 5.3.1: Sample Revenue-Cost Calculation: Specialized Operator Entering a Quasi-Monopolized Route with Conventional and Fast Ferries

Competitive Scenario:	**Major Operator Reacting to the Introduction of an Independent Fast Ferry**		
New Fast Ferry:	750 pass	187 cars	
Fast Ferry:	375 pass	93 cars	
Conventional Ferry:	1500 pass	375 cars	
Route Type	**Short Non-Recreational**	**Long Non-Recreational**	**Long Recreational**
Route Attributes			
Frequency	10	4	4
Market Size	8000	3000	3000
Distance	40	120	120
Conventional Ferry Price	270	420	336
Existing Fast Ferry Price	297	483	403.2
Total Time, Conv. Ferry	180	420	420
Total Time, Fast Ferry	90	210	210
Targeted Mrkt Sh. new FF	50%	50%	50%
Existing FF Mrkt Sh	15%	15%	15%
Total FF mrkt Share	65%	65%	65%
Price	295.001	483	387.133
Load Factor	53%	50%	50%
On board sales per pass	15	25	25
Revenues ($/day)	296001	182400	153640
Costs			
Basic	42115	37193	37193
CoGS on board(20% margin)	48000	30000	30000
Overhead(@ 80% basic)	33692	29754.4	29754.4
Total cost ($/day)	123807	96947.4	96947.4
Result	**172194**	**85452.6**	**56692.5**
% Revenues	**58%**	**47%**	**37%**
Result, Discounting Onboard Sales	**160194**	**77952.6**	**49192.5**
% Revenues	**68%**	**54%**	**42%**

Table 5.3.2: Sample Revenue-Cost Calculation: Major Operator Reacting to the Introduction of an Independent Fast Ferry

5.4 Summary of the results

The results shown in the sample calculation tables are very positive, although they must be analyzed cautiously. There are a series of issues that must be taken into account in the analysis of a specific case. These issues have not been addressed in the sample calculations because they depend either on each route itself (demand behavior) or on each particular operator (cost structure).

The route-related issues include fare structure, demand pattern and market size. The real average fare charged per minute of conventional ferry crossing time used to calculate the fares (see Chapter 3) will depend on the fare distribution along the low-high fare range, a particular characteristic of each route. In relation to the demand pattern, the calculations have been done assuming a constant number of passengers for all the year (assuming 335 operating days), when in reality the demand will be affected by the season, the day of the week, etc. Also, we have used the market size as a parameter to obtain consistent results. The market size will be a major constraint when introducing a fast ferry in real situations.

The issues related to the operator affect the cost structure of the service. First, we are assuming an arbitrary 20% margin on sales. Second and more important is that overhead cost will vary from operator to operator.

But these sample calculations do show relative differences. Analyzing the results obtained across the three generic routes, we can see that not all the routes will offer the same margins, due to differences in price per mile, time sensitiveness and costs. Comparing now the same route type across different competitive scenarios, the revenues in absolute value and the margins are different. To compare in homogeneous terms, we would need to restate the results for equal load-factors. In this case, the differences are a function of the different pricing strategies, imposed by the different competitive situations.

5.5 Strategic Issues

The previous sections of this chapter did not take into account a series of important issues that will be determinant in the decision making process. In this section, the most relevant ones are identified and briefly discussed.

Freight Transportation

Among them, the most important one is the implicit restriction of the problem to the transportation of passengers and private vehicles. As we said in previous chapters, freight is a major source of income for all conventional ferry operators at a little extra-cost to be added to the one estimated for conventional ferries in Chapter 4. Freight is especially important because it is a source of revenue much less seasonal than passenger and private vehicle transportation, thus providing a helpful stream of cash in off-peak periods.

There are three possible approaches to including freight in the operations. The first would be to design fast ferries capable of handling trucks. This is the case of Stena's HSS 1500 series. In this case, the construction cost will be much higher (comparable to the cost of a conventional ferry) and, since the inclusion of freight will lead to bigger units, the manning requirements will be the same as for conventional ferries. In the case of the HSS1500, the crew, including catering, is an average of 50-60 people. Also, fuel consumption will increase and the reliability issue will still be there. On the other hand, the fast service will be complete, offering the same potential sources of revenues as the conventional ferry twice as fast. To put it simply, assuming no major reliability concerns, one high-speed ferry will be able to replace two existing conventional ferries.

A variation of the same idea will be tested in the Tirrenian Sea starting in the summer season of 1998. The monohull *Jupiter 3000* (See Appendix 1) will start operating with a CODAG propulsion plant that will allow her to sail either at 24 knots with only diesel engines or at 40 knots with diesel and gas turbines combined. The vessel, prepared to carry up to 30 trucks, will be able to maximize service time through overnight operations if necessary. The use of a monohull design has also decreased the capital costs of the project.

The second approach would be to separate freight, using freight-only ships and passenger-only fast ferries. This approach will require identifying the potential advantages of such a service in comparison with the classical ro-pax solution. Such a comparison must be performed at the company level and not at the vessel level. SeaContainers has been involved in some freight-only ventures in the English Channel, apparently with positive results.

The third approach, the most straightforward one for the major ferry operators, is to combine ro-pax capacity with fast ferries. In this scenario, reliability problems will be less acute, since the company will be offering a second alternative internally. Fast ferries can be used to absorb high peaks. When the fast ferry capacity is comparable to the size of the market, conventional ferries gradually tend to lose passengers, and at the end are basically devoted to freight transportation. Therefore, asset utilization decreases, but at the same time we are talking about existing tonnage that must be deployed somewhere...

Freight concerns do not affect different operators in the same manner. In the case of specialized fast ferry operators, they basically are not in the freight market. For the rest, the problem will be a function of the average age of the fleet, their revenue structure, the special characteristics of the demand in each route, etc. The implications in the company logistics of this issue are connected to the next two issues considered, and the possible strategies must also account for them.

Seasonal Demand

Another issue that deserves special attention is the important seasonal behavior of demand in passenger ferry transportation. Demand is very seasonal in all the routes, the extreme case being recreational routes that cannot be operated in the off-peak season.

For non-recreational routes, off-peak periods are used by specialized operators to drydock the vessels and perform part of the extensive maintenance work that these ships require. Sailings are reduced to a minimum or cancelled for short periods. In the case of recreational routes, the options are to lay-up the ship or to charter it out.

In this context, Relocation strategies, either from Southern to Northern Hemisphere or from recreational to non-recreational routes, becomes a major issue. In reference to the first option, namely to place a ship during the northern winter in the Southern Hemisphere and vice-versa, the major constraint is the very limited number of routes in the Southern Hemisphere. In any case, this has been a major strategy for Buquebus, a company based in the Rio de la Plata routes.

The second option requires operating a portfolio of routes different in their nature, so that a ship can be deployed in more than one at different times of the year. The use of CODAG propulsion plants can help this problem, allowing freight-focused routes in the off-peak seasons.

Logistic Implications of the Reliability Problem

The problematic reliability of fast ferries has been analyzed only from a cost point of view, but this issue also has major influence in the overall logistics for the ferry operator. If the service does not achieve the minimum required schedule compliance, the service, and the operator itself, can jeopardize its position in the market.

There are two basic implications to this. First, the technical supervision of fast ferries is different than that of conventional units. The company will need to develop or outsource the necessary expertise in order to handle the new ships (see Ref. [9]).

Second, there is a decision to be made concerning the necessity of a back up to the service. Usually the answer to the question is different for different operators. Most of the major operators, including the regional majors feel that they must be prepared to offer an alternative service in case the fast service has to be cancelled. In the case of the specialized operators, since they do not have the means, they do not back up internally. In case of any problem, the competitors will take advantage of the situation, absorbing the extra-capacity.

This problem should be analyzed in the broader context of the two previous issues discussed, and the solution might take into account the general corporate strategy of the company. To summarize the first three issues, the questions that need an answer are three. First, do I want to be in the freight business, and if so, with ro-pax tonnage (either fast or conventional) or with freight-only ro-ros? Second, do I want to use fast ferries in an extensive way, or just to cover peak-demands? And third, what cancellation risk do I want to undertake? The answer to these questions, closely related, and the general strategy of the company will provide consistent support to make future decisions.

Not a Pure Transportation Problem

A fourth issue that was mentioned in Chapter 4 but that was not specifically taken into account in the feasibility analysis is the competition of the so-called cruise ferries. The key idea for a cruise ferry is to offer something different to a transportation service: leisure activities onboard. From this perspective, the trade-off between price and time becomes meaningless and the analysis loses its validity. Although basically these vessels are focused on longer itineraries, they can be in competition with fast ferries in the long-distance fast ferry segment, especially in recreational routes. An example can be the Melbourne-Tasmania route, where the conventional ferry needs 15 hours and a fast ferry service crossing in 6 hours has been recently introduced for the Southern Summer.

In these cases, the cruise ferries will be marketed in totally different terms. Fares will not be comparable with “day ferry” fares. A certain percentage of the time-insensitive travelers will have to be discounted when defining the total market size before performing the analysis. On the other hand, when the fast ferry service is competing against air transportation, the same reasoning can be used to market it against the airplane.

What to Do with the Existing Conventional Ferry Fleet?

The consequences of new fast ferry units for the conventional ferry operator in the fleet structure are also a concern (see Ref. [20]). On the one hand, fast ferries tend to increase capacity faster than conventional units. On the other hand, ships are capital-intensive assets built to last 30 years. Therefore, for a given operator, that can prove very painful to order new units if it has operative units with no other routes to be deployed in. At the same time, in a market that is going to be deregulated, the operator can feel the threat of newcomers taking important market shares using the fast ferries that he has not introduced.

Since the ships are designed to the very specific requirements of a given route, and being the commitments of the operators to a given route for a long period of time, the ferry Sale & Purchase and Charter markets are not very active. The result is that it is usually difficult to get rid of a vessel in acceptable economic terms. In this situation, the specialized operator, a company with much more flexible assets, can take advantage of the inaction of the major operators.

Other Issues to Account for in Future Developments

To finalize, I would like to mention four other issues to be considered. First, throughout this study we have considered ferries of a well defined speed around 20 knots. It is likely that in the future there will be conventional ferries sailing at speeds slightly under 30 knots, therefore diminishing the time gains and at the same time combining freight capacity and higher reliabilities.

Second, in the future, more fixed links can affect the whole ferry industry negatively. At present, a tunnel-bridge is under construction in the Oresund Strait, and a bidding process is on its way to build a bridge between Buenos Aires and Colonia in Uruguay.

In Chapter 3 we mentioned the possible lack of comparability between pricing strategies of companies in the case that one uses revenue management techniques and the other doesn't. Revenue management is not yet extensively used in the ferry industry: in a business where load factors were so low, it was meaningless to introduce revenue maximizing techniques based on constrained capacities. But with the introduction of the smaller fast ferry, capacity constraints can start to count and revenue management techniques can become interesting.

Finally, in certain routes environmental concerns about the impact of fast car-ferries have been raised (see Ref. [22]). Possible restrictive regulations concerning noise, waves and environmental impacts must be considered when analyzing a potential route.

Chapter 6

CONCLUSIONS

In this chapter, we will briefly summarize the findings of this research, first restricting the problem exclusively to passenger and private vehicle transportation and then extending it to the ferry industry as a whole.

The ferry business is a very specific field within the shipping industry. Traditionally characterized by restricted competition and operators with long term commitments to the routes in which they operate, it is now facing, from inside the EU, a deregulation process similar to the processes that in the past have affected other transportation modes. At the same time, the industry shares with the shipping industry as a whole some of the problems, among them the tendency towards overcapacity driven by a depressed shipbuilding industry.

In this context, technology improvements led in the early nineties to the introduction of a new mode, the fast car-ferry. Offering lower capital and operating costs, the new ships allow the companies to charge higher fares on the grounds of shorter crossing and transit times. These more "handy" ships also offer higher sailing frequencies for smaller capacities, improving asset utilization. The price to be paid is to forego freight revenue and to live with the concern of service reliability.

The development of the new concept has been boosted by its evident potential economic advantages, suffering at the same time from technical failures. The problems of new operators entering markets with very competitive positions occupied by a restricted number of strong operators are also a characteristic of the industry.

6.1 The Fast Car-Ferry, in the Restricted Context of the Car-Passenger Waterborne Transportation Industry

Most of this study has been devoted to the problem of analyzing the waterborne transportation of passengers and private vehicles. Within this framework, the comparison of the operating profit of conventional ferries and fast car-ferries shows, for a variety of scenarios, clear economic advantages on the side of the fast car-ferry. The most important problem identified has been the reliability of the new service.

When the study was extended to take into account the influence of different competitive situations on the viability of the service, the result has been the same: the fast car-ferry offers the operator the possibility of more flexible and profitable operations. The approach to solving the reliability problem is different, though. While the operator specializing in fast car-ferries basically decides to assume the risk and suffer the consequences in the case of cancellations, the conventional ferry operator, who has a dominant position who also operates fast ferries, seems to feel the necessity of assuring the service with back-up ferries. In fact, the specialized operator relays on the back-up ferries of the major operator.

In that situation, the specialized operator takes advantage of the already existing "infrastructure" in a given route, eroding the revenues of the major operator and not bearing the logistic cost of assuring the service. The only response available to the major operator is to try to use its dominant position to limit the market share of the newcomer, and to introduce fast car-ferries himself.

In this context, it seems plausible to think that in the future fast car ferries will be absorbing most of the passenger demand on the routes, while the conventional tonnage will be devoted to the off-peak coverage and the back-up tasks. This idea can be reinforced if new ships entering the market continue to improve in reliability-related issues, such as the stabilizing and propulsion systems. With respect to the route typology proposed in this study, not all the routes will be equally affected by the phenomenon, since the margins are not the same. Clearly the less appealing route for the fast car-ferry will be the long non-recreational one.

The limits to this path of evolution will be imposed by the interest of the operators with conventional tonnage to continue operating the existing fleet. The tools available to them are their dominant positions and the possibility of developing the other aspects of the service, i.e. its non-transportation attributes. A good example is the case of the cruise ferries on the longer routes.

The growth of fast ferries will also be constrained by the need for a minimal market size and the fact that with a fast ferry it is much easier to over-supply a route. External issues, such as the construction of fix-links in the case of short routes, or regulatory constraints (related to noise, waves and environment) can also limit future developments.

Assuming that fast ferries reach the point in which the demand absorbed by conventional ferries becomes marginal, pricing strategies based on conventional ferry fares will become meaningless. In this new scenario, cost differentials among different fast car-ferry designs and required returns will drive the pricing strategies.

6.3 The Fast Car-Ferry, in the Context of the Ferry Industry as a Whole

The real situation is more complex due to the fact that passenger and freight waterborne transportation are not independent. If specialized fast-car ferry operators are excluded, companies involved in passenger transportation are also in the freight business. The cost savings associated with the fast car-ferry are offset to a certain extent by the freight revenue that conventional ferries can provide.

The need to back-up fast ferries and the freight transportation itself unify in the necessity for continued conventional ferry operations. Future ships can be expected to offer higher speeds than existing ones, thus partially offsetting the time savings offered by fast car-ferries. In this context, the comparison of the combined costs of a passenger-only and a freight-only service versus the cost of a mixed service can help the purpose of better understanding to what extent the substitution process of conventional ferries by fast car-ferries can be developed. To some extent, the problem is one of specialization versus flexibility.

What appears clear is that once freight is introduced into the equation, and with an extensive conventional fleet in operation, no substitution process will be immediate. The relative importance of freight in the revenue structure of each operator for each route and the age of the fleet will become very important factors in determining the speed of the process.

Assuming that there are companies in the passenger and vehicle transportation business, but not in the freight business, and assuming markets without barriers to entrance, there is an incentive to use fast ferries on the routes that comply with the minimum market size requirements. Once a standard in crossing times is introduced in a route, it is not likely to disappear. That can gradually lead to increasing fast ferry operations –backed up by the existing conventional units.

Appendices

Appendix 1 **Database of Existing Fast Car-Ferries**

Appendix 2.1 **Major Fast Car-Ferry Services**

Appendix 2.2 **Selected Routes for Fast Car-Ferries**

Appendix 1: Existing Fast Car-Ferries Database

MONOHULL FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	MDV 3000 Jupiter	Alhambra	SuperSeaCat	JetLiner
Designer	Fincantieri	Bazan	Fincantieri	Mjellem & Karlsen
Owner	Tirrenia	Buquebus (BB)	Sea Containers	
Operator	Tirrenia	BB/ Color Line	Sea Containers	1st P&O
Builder	Fincantieri	Bazan	Fincantieri	Mjellem &Karlsen
Flag	Italy	Bahamas	Bermuda	U.K.
Price per unit	$57.5m	$42m	1&2:$33m //3&4: $30m	$40m
Units ordered (+options)	2 (+2)	1	4 (+2+2)	2
Delivery Date	May-98, both	Oct-96	1&2:Jun-9//3&4:Jan-Mar-98	Jun-96
Main Operating Area	Civitavecchia-Olvia	Buenos Aires-Montevideo	U.K & Scandinavia	Larne-Cairnryan
Season	Year Round	Sept-April	All year	all the year
Loa*B // T (m)	146*22 //3.6	125*18.7 //2.5	100*	95*17.4 // 4.65
Construction Material	HTS Hull + Alu superstr.	Aluminum	Aluminum	Aluminum
GRT	10200	n/a	4500	4675
Displacement (T)	3000	1840	n/a	n/a
Deadweight Tonnes	n/a	475	340	600
Service / Max. Speed(K)	CODAG:40 // Diesel: 22	Serv: 38 // Max: 40	Serv. 37.8	Serv 35 // Max 39
Passenger Capacity	1800	1250	774	600
Car Capacity	460	246	175	160
Car+Coach Capacity	n/a	230+4	x+10	55+12
Freight Capacity	150 (Car)+30 (30T.Truck)	/	/	/
Engines	4MTU Dies.+2 GE Gas T.	6 Caterpillar Diesel	4 MTU Diesel	4 MTU Diesel
Max. Output(kW)	4*6.7 MW +2*22 MW	6*5640 KW	4*6875 KW	4*5800 KW
Propulsion	Kamewa Waterjets	Waterjets	4 Kamewa Waterjets	4 Kamewa Waterjets
Comsuption(l/hour)	n/a	n/a	n/a	n/a
Ride Control	2 pairs of roll damping fins	2 Fins +2 Flaps	n/a	n/a
Crew Members	n/a	27, total	26, total	n/a

Appendix 1 – Cont.

MONOHULL FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	MDV 1200 Pegasus	Aquastrada MK-I	Aquastrada MK-I	Mestral
Designer	Fincantieri	Rodriquez	Rodriquez	Bazan
Owner	Ocean Bridge Invst.	Corsica Ferries (CF)	Tirrenia	Trasmediterranea/ Buquebus
Operator	Stena/ColorLine	CF/ Conferry Venezuela	Tirrenia	Trasmed/ Buquebus/Color line
Builder	Fincantieri	1:Rodriquez//2&3: INMA	Rodriquez	Bazan
Flag	n/a	n/a	Italiy	Spain
Price per unit	$30m	n/a	n/a	$26m
Units ordered (+options)	2	3	2	3
Delivery Date	96	1:mar-jul-sept 96	1995	1995-96
Main Operating Area	Several	Western Mediterranean	Western Mediterranean	Algeciras-Ceuta/Tanger
Season	-	Summer Season	Summer Season	Year Round
Loa*B // T (m)	95*16 // 2.7	103.5*14.5 // 2.3	101.75*14.5 //2.12	96.2*14.6 // 2.08
Construction Material	HTS Hull+Alu Superstr	HTS Hull+Alu Superstr	HTS Hull+Alu Superstr	Aluminum
GRT	3750	n/a	n/a	n/a
Displacement(t) @ T	1200	n/a	1033.5	955
Deadweight Tonnes	350	350	231.5	181
Service / Max. Speed(K)	Serv 36 // Max. 40	Serv. 37	CODAG: 43// Diesel: 20	Serv 37
Passenger Capacity	600	520	450	590-455
Car Capacity	170	170	150	84
Car+Coach Capacity	130+6	118 (+3)	100 (+4)	n/a
Freight Capacity	/	/	/	/
Engines	4*MTU Diesel	4*MTU Diesel	2*MTU Diesel+1 GE GasT	4* Caterpillar Diesel
Max. Output(kW)	4*6,000 Kw	4*6,000 Kw	2*3565 +1*20800 KW	4*5000 kW
Propulsion	4 Waterjets	3 Waterjets	3 Waterjets	Waterjets
Comsuption(l/hour)	156 kg/mile	n/a	n/a	n/a
Ride Control	n/a	n/a	n/a	n/a
Crew Members	12, min	n/a	n/a	n/a

Appendix 1 – Cont.

MONOHULL FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	Corsaire 11500	Corsaire 11000	Unicorn
Designer	Leroux & Lotz	Leroux & Lotz	M.H.I.
Owner	Rederi AB Gothland	SNCM	Higashi-Nihon Ferry Co.
Operator	Gothland	SNCM	Higashi-Nihon Ferry Co.
Builder	Leroux & Lotz	Leroux & Lotz	M.H.I.
Flag	Sweden	France	Japan
Price per unit	n/a	n/a	n/a
Units ordered (+options)	1	2	1
Delivery Date	1998	Mar-96 // Jul-96	Jun-97
Main Operating Area	Sweden (Gothland Island)	Nice-Corsica	Hakodate - Aomori
Season	Summer season	in winter, hauled	all the year
Loa*B // T (m)	112*	102*15.4 // 2.5	101*14.9 // 2.7
Construction Material	HTS Hull +Alu Superstructure	Aluminum	HTS Hull+Alu Superstr
GRT	n/a	n/a	n/a
Displacement(T)	n/a	1100trials/1260 max	n/a
Deadweight Tonnes	n/a	n/a	n/a
Service / Max. Speed(K)	35	37	35
Passenger Capacity	700	566	423
Car Capacity	140	148	106
Car+Coach Capacity	n/a	108 (+4)	78 (+5)
Freight Capacity	/	/	
Engines	4x Ruston 20RK 270	4*MTU Diesel	4*MTU Diesel
Max. Output(kW)	4x7080 kW	4*6500 kW	4*6500 kW
Propulsion	4x Kamewa 125 S11	4 Kamewa Waterjets	4 Kamewa Waterjets
Comsuption(kg/hour)	n/a	4107 @37Kn, 1100T	n/a
Ride Control	n/a	MDI system	n/a
Crew Members	n/a	15	n/a

Appendix 1 – Cont.

CATAMARAN FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	HSS 1500	PacifiCat	HSS 900	InCat 91
Designer	Stena	InCat+ R.Allan	Stena	InCat
Owner	Stena	BC Ferries	Stena	n/a
Operator	Stena	BC Ferries	Stena	TT Line
Builder	Finnyards	Vancouver Shpyds	Wastamaran	InCat
Flag	Netherlands-British-British	Canada	Sweden	n/a
Price per unit	$95m	$52m engines: 8.5 mill	$58m	$43m
Units ordered (+options)	3	3	1+1(Cancelled)	1
Delivery Date	1996-97	1st: mid-98	1996	1997
Main Operating Area	UK -Ireland-Holland	British Columbia	Denmark-Sweden	Tasmaia-Melbourne
Season	all year	All the year	All the year	Southern Season
*Loa*B // T (m)*	127*40 // 4.8	122*25.8 // 3.9	88*30 // 3.9	91.3*26 // 3.7
Construction Material	Aluminum + GRP Composites	Aluminum	Aluminum	Aluminum
GRT	19,638	8,000	8631	n/a
Displacement(T)	n/a	n/a	n/a	n/a
Deadweight Tonnes	1,500	532.4	480	450
Service / Max. Speed(K)	40 Knots	n/a	38	38 //43
Passenger Capacity	1500	1000	900	877
Car Capacity	375	250	210	240
Car+Coach Capacity	n/a	n/a	10+151	4+x cars
Freight Capacity	100+50 trucks	/	/	/
Engines	2 xGE LM2500+2xGE LM 1600	4 x MTU Diesel	ABB Stal GT 35	4x Ruston V 20 RK270
Max. Output(kW)	68 MW	24,500 kW	34,000 kW	4 x7080 kW
Propulsion	KaMeWa S216 waterjets	n/a	4 waterjets	4 x Lips LJ145D
Comsuption(l/hour)	n/a	n/a	n/a	212 gr/kW-hr
Ride Control	n/a	MDI	n/a	MDI system
Crew Members	50-70	19-22	40-50	24, max

Appendix 1 – Cont.

CATAMARAN FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	InCat 86	K50	Incat 81	Incat 78
Designer	InCat	Advanced Multihull Designs	InCat	Incat
Owner	Holyman/Condor	Doe-a-Gosok Ferry	Buquebus/Holyman	Holyman
Operator	Condor	Doe-a-Gosok Ferry	Stena/Condor/Holyman	Holyman/Condor
Builder	InCat	InCat	InCat	InCat
Flag	Singapore	Korea		Singapore
Price per unit	$40.5m	n/a	$33.5m	$27.5 m
Units ordered (+options)	2	1	3	3
Delivery Date	1996	Jul-95	1st beginnig 97	n/a
Main Operating Area	UK- Channel Islands	P' ohang - Island of Ullung-do	Several	Weymouth-Jersey
Season	n/a	Seasonal	-	Summer
*Loa*B // T (m)*	86.3*26 // 3.5	79.25 // 2.16	81.75*26 // 3	77.46*26 //3.47
Construction Material	Aluminum	Aluminum	Aluminum	Aluminum
GRT	5005	n/a	4100	n/a
Displacement(T)	n/a	n/a		n/a
Deadweight Tonnes	n/a	174	340	250
Service / Max. Speed(K)	37 // 40	49 @90% +174T// max 53	44 // 39	42 // 35
Passenger Capacity	775	769	700-620	674
Car Capacity	175	32	148	130
Car+Coach Capacity	n/a	/	10+28	/
Freight Capacity	/	/	/	/
Engines	4xRuston 20V RK 270M	4 x Caterpillar 3616	4* Ruston 16 RK270 MKII	4* Ruston
Max. Output(kW)	26,000 kW	4 x 5420 kW	4*5500 kW	4*4320 kW
Propulsion	4x Waterjets Lips LJ 145 D	2 x KaMeWa 80	4*Lips	4*Lips
Comsuption(l/hour)	n/a	n/a	200 gr/kWhour	n/a
Ride Control	MDI system	MDI active trim system	MDI system	MDI system
Crew Members	25, max	n/a	24,max	26, max

Appendix 1 – Cont.

CATAMARAN FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	Incat 74	Cat 70 HL	AutoExpress 82	AutoExpress 79
Designer	Incat	Royal Schelde	Austal	Austal
Owner	Seaco, BB, Holyman	n/a	n/a	n/a
Operator	Seaco, BB, Holyman. Stena	Catamara Ferry Lines	TT line/Sweferry/Polferries	DSB Rederi A/S (DAN)
Builder	Incat	Royal Schelde	Austal	Austal
Flag	-	n/a	-	Bahamas
Price per unit	n/a	$40m	$40m	$38m(Initial contract)
Units ordered (+options)	8	1	4	1
Delivery Date	90-95	n/a	1996	96
Main Operating Area	Several	Greece	Rostock-Trelleborge	Aarhus-Kalundborg
Season	-	n/a	All year	All year
Loa*B*D // T (m)	74*26 // 3.2	76.6*22.15 // 3.65	82.3*23 // 3.2	78.6*23 // 2.5
Construction Material	Aluminum	Aluminum	Aluminum	Aluminum
GRT	3250	n/a	5541	n/a
Displacement(T)	830	n/a	n/a	n/a
Deadweight Tonnes	200	360	346	300
Service / Max. Speed(K)	35 // 42	36 @90% MCR	40,2@100% / 37.5 340 t.	36,4@100%, 300 t. /34.5
Passenger Capacity	600-431	600	900-600	600
Car Capacity	80	152	175	163
Car+Coach Capacity	/	90 (+10)	140 (+4), or 50 (+10)	50 (+10)
Freight Capacity	/	/	/	/
Engines	4x Ruston V16 RK270	4 x Caterpillar	4 x MTU 20V 1163 TB 73	4 x RUSTON 16 RK 270
Max. Output(kW)	4x 4050 kW	4 x 5130 kW	4 x 6500 kW	4 x 5500 kW
Propulsion	4 Waterjets	4KaMeWa Waterjets	4 x KaMeWa 112 S II	4 x KaMeWa 112 S II
Comsuption(l/hour)	n/a	n/a	n/a	n/a
Ride Control	MDI system	n/a	Ocean Leveller	n/a
Crew Members	24, max	18	24	24

Appendix 1 – Cont.

CATAMARAN FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	Seajet 250	AutoExpress 60	K50'	K55
Designer	Danyard	Austal	Advanced Multihull Designs	Advanced Multihull Des
Owner	Mols-Linien A/S	Istanbul Denis Otobusleri	n/a	Buquebus
Operator	Mols-Linien A/S	Istanbul Denis Otobusleri	n/a	Buquebus
Builder	Danyard	Austal	Afai's Southern shipyrd (China)	Incat
Flag	Denmark	n/a	-	Bahamas
Price per unit	$ 35m	n/a	n/a	$20m
Units ordered (+options)	2	2	1	1
Delivery Date	1996	jun-97, aug-97	1998	1996
Main Operating Area	Ebeltoft-Odden	Eastern Mediterranean	n/a	Buenos Aires-Montevideo
Season	All year	All Year	-	All year
Loa*B // T (m)	76.12*23.4*? // 3.54	59.9*	80.1*19 // 2.16	70.40*19.50 // 2.20
Construction Material	Aluminum	Aluminum	Aluminum	Aluminum
GRT	n/a	n/a	n/a	n/a
Displacement(T)	n/a	n/a	n/a	n/a
Deadweight Tonnes	236 T	n/a	167	236
Service / Max. Speed(K)	46.4 / 40.8	34 service	53 //47	45//50
Passenger Capacity	450	450	450	450
Car Capacity	120	94	89	63
Car+Coach Capacity	n/a	56 (+ 3)	/	/
Freight Capacity	/	/	/	/
Engines	2 x Gas T. GE LM 1600	2 x MTU 20V1163 TB73L	4 x Ruston 16RK270	4 x Caterpillar 3616
Max. Output(kW)	2 x 12400 kW	n/a	4 x 5500kW	4x5310 Kw
Propulsion	4 x KaMeWa 112 S II	n/a	4 x KaMeWa 80 SII	4 x KMW 80 S II
Comsuption(l/hour)	n/a	n/a	n/a	n/a
Ride Control	n/a	n/a	n/a	n/a
Crew Members	12 (5 in pass space)	n/a	n/a	n/a

Appendix 1 – Cont.

CATAMARAN FAST CAR-FERRIES OVER 400 PASSENGERS OPERATING OR ON ORDER BY DESIGN AND SIZE

Design	B60	JumboCat 60
Designer	AMD	Kvaener Fjellstrand
Owner	Buquebus	Emeraude Lines
Operator	Buquebus	Emeraude Lines
Builder	Bazan	Kvaener Fjellstrand
Flag	Bahamas	France
Price per unit	n/a	$20m
Units ordered (+options)	1	1
Delivery Date	1997	1996
Main Operating Area	Buenos Aires-Montevideo	St Malo-Channel Islands
Season	All year	All year
Loa*B// T (m)	77.32*19.5 // 2.15	59.9*16.5 // 2.56
Construction Material	Aluminum	Aluminum
GRT	n/a	n/a
Displacement(T)	n/a	n/a
Deadweight Tonnes	142	120
Service / Max. Speed(K)	60 /57 @142T	33 @90%MCR
Passenger Capacity	450	450
Car Capacity	52	52
Car+Coach Capacity	/	/
Freight Capacity	/	/
Engines	2 x ABB Stal GT 35	2 x MTU 20V1163
Max. Output(kW)	2 x 15,7 Mw	2 x 5400 kW
Propulsion	2 x KaMeWa 112	2 x KaMeWa 90 S II
Comsuption(l/hour)	n/a	n/a
Ride Control	n/a	n/a
Crew Members	n/a	n/a

Appendix 2.1: Major Fast Car Ferry Services

Route	Operator	Type of Ship	Season
English Channel/ North Sea			
Dover-Calais	Hoverspeed	Superseacat+ Hover	Full year
Folkestone-Boulogne	Hoverspeed	Incat 74	Full Year
Harwich-Hook of Holland	Stenaline	HSS 1500	Full Year
Newhaven-Dieppe	P&OStena	Incat 81	Full Year
Dover-Ostend	Hoverspeed	Incat 81	Full Year
Poole-Channel Islands	Condor	Incat 86	Full year
Portsmouth-Cherbourg	P&O	AutoExpress 82	n/a
St. Malo-Channel Islands	Emeraude Lines	Jumbocat	Full year
Irish Sea			
Cairnryan-Larne	P&O	Jetliner	Full year
Fishguard-Rosslare	Stenaline	InCat	Full year
Holyhead-Dun Laoghaire	Stenaline	HSS 1500	Full year
Douglas-Belfast	Seacontainers	Incat 74	Seasonal
Liverpool-Isle of Man	Seacontainers	Incat 74	Seasonal
Liverpool-Dublin	Seacontainers	SuperSeaCat	n/a
Stranraer-Belfast	Seacontainers	Incat 74	Full year
	Stenaline	HSS 1500	Full year
Scandinavia/Baltic			
Aarhus-Kalundborg	Cat-Link	InCAt 78	Full year
Dragor-Limhamn	Sweferry	Austal Catamaran	Full year
Gedser-Rostock	Scandlines	Catamarans	Full year
Gothenburg-Frederikshavn	Seacontainers	SuperSeaCat	Full year(10 mo)
	Stenaline	HSS900	Seasonal
Kristiansand-Hirtshals	Colorline	Alhambra	Seasonal
Larvik-Skagen	Colorline	Pegasus MDV 1200	Seasonal
Nynashamm-Visby	Gothlandslinjen	Incat 74	Seasonal
Sjaellands Odde-Ebeltorf	Mols Linen	Seajet Danyard	Full year
Swinoujscie-Malmo	Polferries	Austal Catamaran	Full year
Trelleborg-Rostock	TT Line	Austal Catamaran	Full year
Mediterranean			
Algeciras-Ceuta/Tanger	Trasmediterranea	Mestral	Full year
	Buquebus	Mestral	Full year
Bastia-Genoa	Corsica Ferries	Aquastrada	Seasonal
Bastia-Marseilles	SNCM	Corsaire 11000	Seasonal
Bastia-Nice	SNCM	Corsaire 11000	Seasonal
Golfo Aranci-Civitavecchia	Corsica Ferries	Aquastrada	Seasonal
Olbia-Civitavecchia	Tirrenia	Aquastrada	Seasonal
Olbia-La Specia	Tirrenia	Aquastrada	Seasonal
Palermo-Naples	SNAV	Incat 86	Full year
Palma-Barcelona	Trasmediterranea	Mestral	Seasonal
Piraeus-Cyclades Islands	Minoan Lines	Cat 70m	Seasonal
Other			
Pohang-Ullung	Dae-a-Gosok	AMD Catamaran	Seasonal
Venezuela	Conferries	Aquastrada	Seasonal
Hakodate-Aomori	East Japan Ferry	MHI Mono 101	Full year
Colonia-Buenos Aires	Buquebus	Catamarans	Full year
	Ferrylineas Argentin	InCat 74	Full year
Buenos Aires-Montevideo	Buquebus	Several	Full year
Buenos Aires-Punta del Este	Buquebus	Several	Seasonal
Wellingtom-Picton	Tranzrail	InCat 74	Seasonal
Melbourne-Tasmania	TT line	InCat 86	Seasonal

Source: Drewry Shipping Consultants, updated by the author as of end 1997

Appendix 2.2: Selected Routes with Fast Car-Ferries

SELECTED ROUTES FOR FAST CAR-FERRIES

	Spain	British Columbia-Canada	Denmark-Sweden	
Route:	Algeciras-Ceuta	Horseshoe Bay-Nanaimo	Frederikshavn-Gothenburg	
Year:	***1996***	***1997***	1997	
Operators	Trasmediterranea	BC Ferries	SeaCo, Stena, Lion Ferry	
Distance:			48 nm	
Season:	Full year	Full year	March-Dec	
Total Market, Pass	1,305,000	3,500,000	4,264,000	
Total Market, Cars	168,500	1,200,000	808,000	
Fast Ferry		*Projected service-1998/99*	march-to-december	
Total Time (min):	60	80	125	
Navigational Time (min):	40	60	105	
Frequecy (trips/day):	12	30	6 spring-fall--16summer	
Avg. Passenger Capacity (pass/day):	5400	30000	4,420	
Avg. Car Capacity (cars/day):	912	5250	1,456	
Passenger Carried, per year:	750,000	3,500,000	1,017,000	
Car Carried, per year:	100,000	1,200,000	189,000	
Avg. Load Factor, Pass.:	38.60%	32%	53%	
Avg. Load Factor, Cars:	30%	63%	44%	
Market Share, pass:	57.5%	100%	24%	
Market Share,cars:	59.3%	100%	23%	
Conventional Ferry		Exhisting Service	March-Dec equiv.,Stena	Total
Total Time (min):	120	120	235	
Navigational Time (min):	90	95	195	
Frequecy (trips/day):	6	16	6	
Avg. Passenger Capacity (pass/day):	7800	23456	10548	
Avg. Car Capacity (cars/day):	276	5792	3310	
Passenger Carried, per year:	555000	3500000	2103000	2710000
Car Carried, per year:	68500	1200000	324000	463000
Avg. Load Factor, Pass.:	20%	41.45%	66%	
Avg. Load Factor, Cars:	68%	57.55%	32%	
Market Share, pass:	42.5%	100%	76%	
Market Share,cars:	40.7%	100%	77%	

Appendix 2.2: Selected Routes with Fast Car-Ferries – Cont.

SELECTED ROUTES FOR FAST CAR-FERRIES

	Denmark-Sweden	Irish Sea: Northern Route			
Route:	Frederikshavn-Gothenburg	Belfast-Stanraer	Belfast-Stanraer	Larne-Cairnryan	Belfast-Stanraer
	1995	1997			1995
Operators	Seaco, Stena, Lion Ferry	(Seaco)	(Stena)	(P&O)	Seaco-Stena
Distance:					
Season:		Full year			Full year
Total Market, Pass	3,919,000	2,790,000			2,516,000
Total Market, Cars	743,000	632000			587,000
Fast Ferry					
Total Time (min):	125	120	130	90	120
Navigational Time (min):	105	90	90	60	90
Frequecy (trips/day):	6	10	8	low:10; high:12	10-Jan
Avg Passenger Capacity (pass/day)	2,700	4500	12000	6000	4500
Avg. Car Capacity (cars/day):	480	800	3000	1600	800
Passenger Carried, per year:	471,000	444000	1,171,600	620,000	456,000
Car Carried, per year:	85,000	126000	210,000	168,000	110,000
Avg. Load Factor, Pass.:	58%	28.2%	27.9%	29.5%	31.7%
Avg. Load Factor, Cars:	59%	45.0%	20.0%	30.0%	43.0%
Market Share, pass:	12.0%	15.9%	42.0%	22.2%	18.1%
Market Share,cars:	11.4%	19.9%	33.2%	26.6%	18.7%
Conventional Ferry					
Total Time (min):	235		225	165	225
Navigational Time (min):	195		195	135	195
Frequecy (trips/day):	20		8	6	15.5
Avg Passenger Capacity (pass/day)			8000	6210	n/a
Avg. Car Capacity (cars/day):			2240	2040	n/a
Passenger Carried, per year:	3,448,000		292,800	265,400	1,369,000
Car Carried, per year:	651,000		52,500	72,000	312,000
Avg. Load Factor, Pass.:			10.0%	11.7%	n/a
Avg. Load Factor, Cars:			6.4%	9.7%	n/a
Market Share, pass:	88.0%		10.5%	9.5%	54.4%
Market Share,cars:	87.6%		8.3%	11.4%	53.2%

Appendix 2.2: Selected Routes with Fast Car-Ferries – Cont.

SELECTED ROUTES FOR FAST CAR-FERRIES

	Cook Strait (NZ)	Denmark-Norway		
Route:	Wellingtong-Picton	Kristiansand-Hirtshals	Larvik/Moss-Frederikshavn	Larvik-Skagen
	1996-97	1997	1997	
Operators	Tranzrail	Color Line	Color Line	
Distance:		77 nm		
Season:	December-April	1st May-21 Sept	Jul 1st- Oct 1st	
Total Market, Pass	1046000// 515000	828,000	345000	
Total Market, Cars	213000//104000	n/a		
Fast Ferry				
Total Time (min):	125	180		200
Navigational Time (min):	105	145		170
Frequecy (trips/day):	6	4		4
Avg Passenger Capacity (pass/day)	3318	4600		2400
Avg. Car Capacity (cars/day):	456	984		680
Passenger Carried, per year:	250,000	352,000		123,000
Car Carried, per year:	estim 51000	n/a		n/a
Avg. Load Factor, Pass.:	63%	53%		56%
Avg. Load Factor, Cars:	62% estim	n/a		n/a
Market Share, pass:	48.50%	42.5%	35.7%	
Market Share,cars:	n/a	n/a	n/a	
Conventional Ferry				
Total Time (min):	240	315	420	
Navigational Time (min):	200	270	375	
Frequecy (trips/day):	8	4	4	
Avg Passenger Capacity (pass/day)	7220	8000	8000	
Avg. Car Capacity (cars/day):	2184	2120		
Passenger Carried, per year:	265,000	476000	222,000	
Car Carried, per year:	53000, estim	n/a	n/a	
Avg. Load Factor, Pass.:	31%	41%	30.2%	
Avg. Load Factor, Cars:	13.5% estim	n/a	n/a	
Market Share, pass:	51.50%	57.5%	64.3%	
Market Share,cars:	n/a	n/a	n/a	

Appendix 2.2. Selected Routes with Fast Car-Ferries

	U.K.- Continent	Wales-Ireland	Mainland Australia-Tasmania
Route:	Newhaven-Dieppe		Melbourne-Devonport
	1997	1997	1997-8
Operators	Stena Line	Stena, Seaco, Irish ferries, S-C Ferries	TT Line
Distance:			220
Season:		Full Year	Southern Summer
Total Market, Pass	759,000	4224000	129792.5
Total Market, Cars	158,000	813000	40321
Fast Ferry			
Total Time (min):	165	130	390
Navigational Time (min):	135	99	360
Frequecy (trips/day):	4	n/a	1
Avg Passenger Capacity (pass/day)	2680	n/a	900
Avg. Car Capacity (cars/day):	592	n/a	240
Passenger Carried, per year:	n/a	2618880	41040
Car Carried, per year:	94800	471540	15800
Avg. Load Factor, Pass.:	n/a	n/a	38%
Avg. Load Factor, Cars:	n/a	n/a	55%
Market Share, pass:	n/a	62%	32%
Market Share,cars:	60%	58%	39%
Conventional Ferry			
Total Time (min):	285	240	940
Navigational Time (min):	240	210	900
Frequecy (trips/day):	4	n/a	n/a
Avg Passenger Capacity (pass/day)	5200	n/a	n/a
Avg. Car Capacity (cars/day):	1160	n/a	n/a
Passenger Carried, per year:		1605120	88752.5
Car Carried, per year:	63200	341460	24521
Avg. Load Factor, Pass.:		n/a	n/a
Avg. Load Factor, Cars:		n/a	n/a
Market Share, pass:		38%	68%
Market Share,cars:	40%	42%	61%

Appendix 2.2: Selected Routes with Fast Car-Ferries – Cont.

FAST CAR-FERRY ROUTE WITH FIX LINK

	English Channel	
Route:	**Dover-Calais**	**Folkestone-Boulogne**
Year	**1997**	
Operators	P&O Stena, Eurotunnel, Seaco, SeaFrance	
Distance (nm):	23	
Season:	Full Year	
Total Market, (million pass.-year)	30,000,000	
Total Market, (million cars-year)	6,000,000	
Fast Ferry	Seacontainers	
Total Time (min):	35/50+20	55+20
Time:	35/50	55
Frequecy (trips per day) high-low	34-20	8
Passenger Capacity per day high-low	14820-9080	4800
Car Capacity	2120/1300	640
Passenger Carried	2,130,000	1,000,000
Car Carried	375,000	133,000
Load Factor, Pass.	48.0%	57.4%
Load Factor, Cars.	59.0%	57.2%
Market Share, pass	10.4%	
Market Share, cars	8.5%	
Conventional Ferry	P&O Stena, SeaFrance	
Total Time:	75+40	
Navigational Time:	75	
Frequecy	68	
Passenger Capacity	125,664	
Car Capacity	42,545	
Passengers Carried	17,665,000	
Cars Carried	3,204,000	
Load Factor, Pass.	38.0%	
Load Factor, Cars.	21.0%	
Market Share, pass	58.9%	
Market Share, cars	53.4%	
Fix Link	Eurotunnel	
Total Time:	35+20	
On Route Time:	35	
Frequecy	64	
Passengers Carried	9,000,000	
Cars Carried	2,319,000	
Market Share, pass	30.0%	
Market Share, cars	38.7%	

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