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Networking Strategies for Short Sea Shipping Stakeholders and Short Sea Promotion Centres

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Abstract

The objective of this study is to facilitate the Short Sea Shipping (SSS) industry reach its full marketing potential through the deployment of strategies pertaining to co-modal networks[1]. It is shown in the PROPS Business Case[2] that successfully increasing intermodal services between Southeast Ireland and Northern France by one RoRo vessel would provide combined revenues to the ship operator, associated haulage firms and ports / terminals of €61M per year and transport savings of €13.5M to shippers. The outstanding benefit from such a venture would be an estimated combined wealth increase of €429M in the two trading states if, over time, 10% of the cargoes carried by the vessel were accounted for by new trades stimulated by cost savings and service excellence associated with the extra vessel. The objective of the study, therefore, is of importance to every European state.

The measures that are proposed to realise the study objective are divided into two sections:
Section 1 is the determination of the key parameters affecting short sea shipping. It has six sub-sections:

- 1.1 Identifying the logistical priorities of shippers;
- 1.2 Quantifying unitised cargo movements between states;
- 1.3 Establishing the operational characteristics of transport modes;
- 1.4 Quantifying the hinterland and foreland markets surrounding trading ports;
- 1.5 Identifying the specific transport requirements of targeted shipper segments.

Section 2 is the devising of co-modal transport solutions for short sea shipping. It has four sub-sections:

- 2.1 Identifying the various types of networks in intermodal transport;
- 2.2 Defining Co-Modal Transport Networks;
- 2.3 Alignment of Co-Modal solutions with shippers' marketing requirements;
- 2.4 Realization of Co-Modal Transport Solutions.

The conclusion of this study is that co-modal transport is an essential part of shippers' marketing function and it requires cooperation between shippers and transport service providers for its potential to be realised. The collective benefit of individual co-modal efficiencies is the facilitation of trade between European states and between Europe and the rest of the world, which is a proven mechanism for sustainable wealth generation in the trading states.

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[1] Co-modal networks are defined in Section 2.1 of the study.

[2] PROPS D2.3 'Business Case: Maritime Service Ireland – France'

Introduction

The central theme of this study is that Short Sea Shipping (SSS) is a major facilitator of intra-European trade and it is through trade that the wealth of European states can be increased. The objective is to help SSS deliver to its potential through the deployment of strategies pertaining to co-modal networks[3].

The formal relationship between trade and wealth generation was first propounded by David Ricardo in the early part of the nineteenth century. It is probably the most important tenet in international trade and yet is widely misunderstood. This is illustrated by the much-repeated story of how the economist and Nobel laureate Paul Samuelson was challenged by the mathematician Stanislaw Ulam to name a proposition in the social / economic sciences that is both true and non-trivial. It was several years later that Paul Samuelson gave his response – Ricardo's Comparative Advantage, stating:

> "That it is logically true needs not be argued before a mathematician; that it is not trivial is attested by the thousands of important and intelligent men who have never been able to grasp the doctrine for themselves or to believe it after it was explained to them."

Comparative Advantage from trade provided the theoretical underpinnings to the colonial expansionist policies of the nineteenth century to secure captive trading partners. It provided justification for wars of territorial acquisition or protection, and eventually to the formation of the General Agreement on Tariffs and Trade (GATT) in 1948 and the present World Trade Organisation (WTO), which have been instrumental in achieving a liberalisation of trade on a world-wide scale and an unprecedented growth in world economies.

The current recession, associated with the 'discovery' of alternative economic theories, such as self-regulating markets and runaway growth allied to financial and property bubbles, has resulted in a reappraisal of the need to strengthen trade links and of improving SSS services to facilitate intra-European trade.

The study is based on contributions from participants in Tasks 2.1, 2.2, 2.3 & 2.4 of PROPS. It is closely aligned with PROPS Deliverable 2.3 'Business Case: Maritime Service Ireland – France', in which the routines that are described in this study are applied to the transport of unitised cargoes between Ireland and France. An important finding of the Business Case is that a new service comprised of one RoRo vessel, complementing existing RoPax services between Ireland and France, would potentially achieve annual revenues of €28.7M, trucking revenues of €25.3M, port & terminal revenues of €6.9M and savings to exporters / importers of €13.5M. In addition, with appropriate marketing, trade between the two states would be expected to increase because of the benefits of the service to exporters and importers. The combined trade-generated wealth in the two states would be approximately €429M per year if, over time, 10% of the vessel's load were accounted for by new trades. Hence, commencing a one-ship extra service would be a major undertaking for the participants and especially for the affected states. It would require careful preparation and planning to achieve the annual benefits that would continue year-on-year once initially realised.

A schematic representation of the study's logic is presented in Figure 1 on the following page.

[3] Co-modal networks are defined in Section 2.1 of the study.

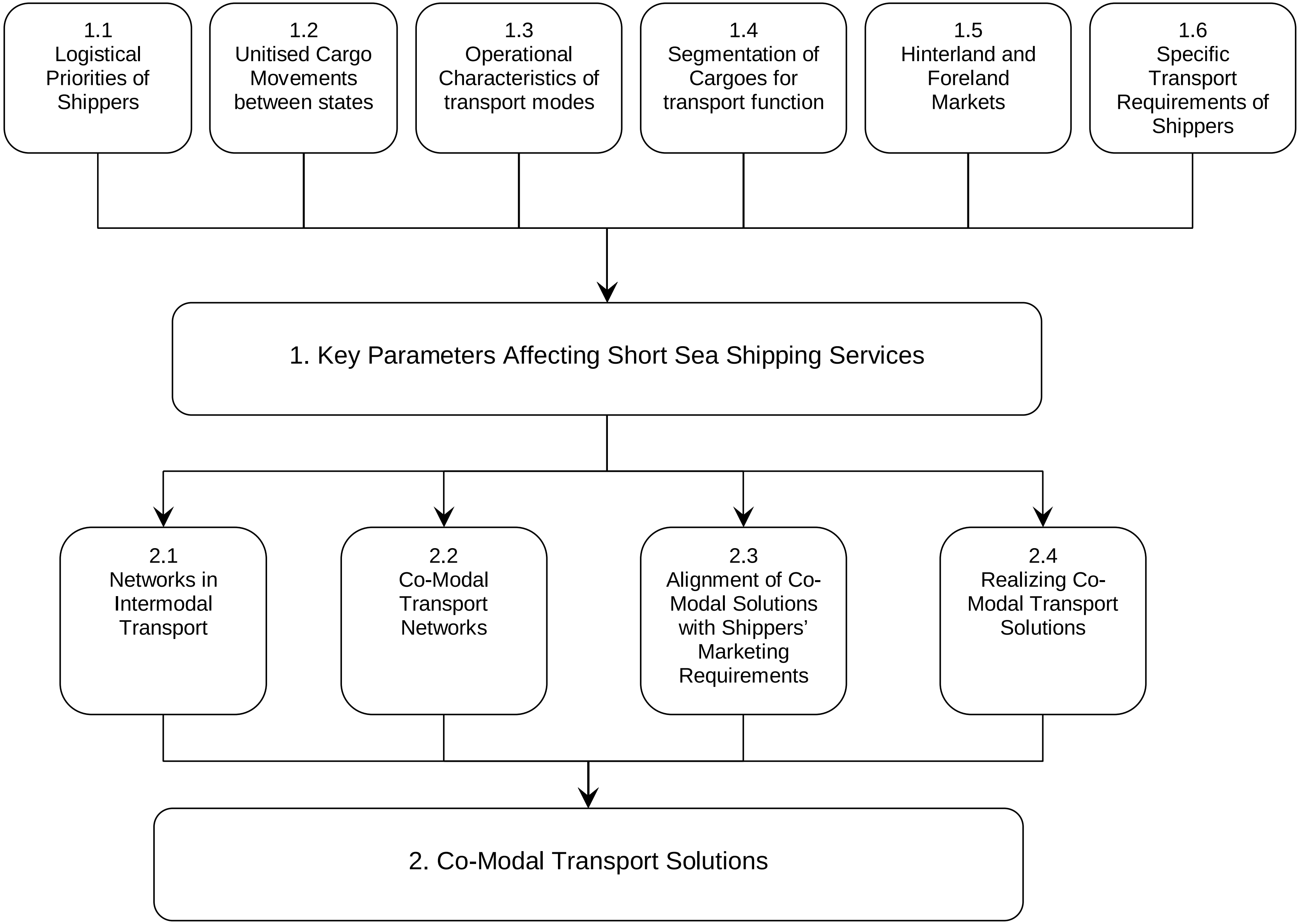


Figure 1: Schematic Representation of Study Logic

1. Key Parameters Affecting Short Sea Shipping Services

1.1 Logistical Priorities of Shippers

The transport requirements / preferences of shippers are determined by survey. The two generally used survey methods are:

a. The preferences of transport managers to a series of hypothetical transport options are captured using a questionnaire and are subsequently analysed. This is the Stated Preference method and is widely used.

b. A complementary approach is the Revealed Preference method, in which the actual services that are used by transport managers are compared with feasible alternatives.

There is extensive literature on determining the logistical priorities of shippers; reference [4]is an example. It is found that there are quite a number of indicators that influence a shipper's choice of transport service. As these affect different segments of shippers differently, the list below is not necessarily in rank order.

- Price,
- Delivery Time,
- Reliability of Deliveries,
- Environmental Footprint of Deliveries,
- Security of goods in transit,
- Stability of Services,
- Flexibility of services,
- Frequency of services.

There are several other indicators, which are mostly operationally oriented, whereas the above eight are mainly focussed on the shipper.

It is helpful to differentiate between **Leading Indicators** and **Lagging Indicators**. Leading Indicators are used for pre-assessment of possible solutions, whereas Lagging Indicators are used for after-the-event assessments. Price is the principal, and often the only, contractual indicator; hence, it is the primary Leading Indicator. Prior knowledge of other indicators is obtained from previous experience and from the claims and reputation of the Service Provider.

A brief comment on each Performance Indicator is appropriate:

Price: Because price is clear, quantified and contractual, it is a key indicator. It is the primary indicator for relatively low-to-medium value durable goods that are purchased for stock.

Delivery Time: Door-to-Door delivery time is an important indicator for a large cargo segment, which includes foodstuffs and high value goods. To emphasise and quantify the importance of delivery times for these goods, the concept of **Value of Time (VoT)** is often used. The Value of Time can be deemed to be the value that a shipper attaches to each hour that unitised cargo takes to be delivered, over-and-above a reference and faster delivery time. This is usually taken to be that provided by trucking.

[4] MOSES D27.1 'Marketing Research Report: Research in Transportation Decision Making' Agatha Rialland et al.

Value of Time is beloved of transport theoreticians as it provides a quantifiable link between price and delivery time, although it is abhorrent to both business and scientific principles, as it mixes "apples and oranges". Nevertheless, it highlights the fact that for certain goods relatively short delivery times are essential. This enables two transport solutions with different unit prices and different delivery times to be compared.[5] Estimates for values of time for different goods may be obtained from surveys, as outlined at the commencement of this section. There are large differences between VoTs for foodstuffs and VoTs of medium-to-low value durable goods, which indicate that these are important segmentations in cargo types.

Reliability of Deliveries: Reliability is a general term. It can be taken to mean the extent to which deliveries are late, making it quantifiable and assessable for every service provision along the supply chain. The concept of **Value of Reliability (VoR)** can also be introduced. The VoR for specific situations can be established by survey, but is more difficult to determine than VoT. From two surveys carried out by Nautical Enterprise in this area it was found that the value attributed to reliability by shippers is three-to-five times the value attributed to time, regardless of the value assigned to time. That is, the value or cost of being one hour late is three-to-five times more important to a shipper than the value of having a one hour faster delivery. The implications of this are far-reaching and affect every aspect of intermodal transport. That is, sustainable success in intermodal transport services requires consistent reliability at every service provision along the supply chain.

Environmental Footprint of Deliveries: There is little doubt that authenticated green transport would have resonance in the market, as shippers do not want to be associated with pollution; rather, they wish to portray an environmentally friendly image for their products. This is particularly relevant to internationally branded goods and to state purchases of goods, as both wish to portray a virtuous image for their transport and procurement policies and would be vulnerable to attack if associated with environmentally damaging transport or products. It is feasible to assign energy ratings to the transport function, which would have the effect of reducing emissions of CO_2, NO_X, SO_X and PM[6] over time. Reducing CO2 and noxious emissions can be achieved through a combination of improved energy efficiencies, cleaner fuels, slower average speeds and scale economies over appropriate distances.

Security of Goods in Transit: SSS / Intermodal transport has to comply with the International Ship & Port Facility Security Code (ISPS Code) and has to incur the initial and ongoing costs of compliance, whereas goods transported by long-haul trucking do not have to comply with any such requirement. It is feasible that a security brand for SSS / Intermodal Transport be devised, based on adherence to the ISPS Code. The case favouring the security of SSS / Intermodal transport needs to be authenticated in terms of the frequency of security breaches by sea versus those by road, and insurance costs by sea versus those by road.

[5] Refer to 'Feasibility of New RoRo / RoPax Services between Ireland and Continental Europe' Irish Marine Institute (2007)

[6] PM: Particulate Matter

Stability of Services: Stability is associated with reliability; that is, the shipper can trust the service provider to consistently deliver to his promise of maintaining high quality deliveries. This enables the shipper to concentrate on production, marketing and all the exigencies of running a business, without having to worry unnecessarily about his supply and distribution networks. It helps reinforce the relationship between service provider and shipper and makes it difficult for a new entrant to gain a foothold in the market.

Flexibility of Services: The term 'Flexible Freight Transport' could be used as a synonym for trucking. Not only is trucking flexible in itself, but it provides all the necessary linkages between departure points, terminals, ships, trains, inland waterway systems and arrival points. Trucking is also an economical form of freight transport over short-to-medium distances. Its carbon footprint is relatively low and its SO_2 emissions are negligible.

Frequency of Services: High frequency of services is a major factor in achieving reduced delivery times. Rather than the shipper having to adapt his output to the availability of transport services, high frequency ensures that services are available virtually when required. High service frequency is associated with hub ports and confers on them a distinct advantage over regional ports that have significantly less frequency of services.

In conclusion, it would be difficult for a transport service provider to simultaneously address all the logistical priorities of shippers. Rather, it would be more feasible for him to concentrate on specific segments of the transport market and to excel in addressing the logistical priorities of shippers in these segments.

1.2 Unitised Cargo Movements between States

The determination of unitised cargo movements between two states is necessary in order to obtain a breakdown of cargo categories, an estimation of the number of units in each category, the trends over several years and the trade gaps.

Cargo categories and estimations of numbers of units in each category can be obtained as follows:

a. Cargo movements between states can be obtained from EUROSTAT. The cargoes are identified by their Standard International Trade Classification (SITC) and can be obtained for net weight and value for different years.

b. Expert knowledge can be applied in order to:

   - Identify the SITC cargoes that are unitised and the cargoes that are bulk;
   - Estimate the percentages of each unitised cargo type that are RoRo and LoLo for specific origins / destinations;
   - Individual estimates need to be adjusted so that the whole system balances.

c. The number of units of cargo can be estimated using average weights per unit. As LoLo and RoRo are competitors for unitised cargoes, either TEUs or Trailer Units can be used for this purpose.

d. The unitised exports and imports from & to one state with another can be ranked in order of estimated TEUs (or Trailer Units) and the Top-20s can then be determined. The Top-20s normally account for about 90% of all unitised cargoes, with the residual 10% composed of a large number of various cargo types.

Trends can be determined by carrying out the above exercise for several years.

Trade gaps are identified by comparing unitised trades, segmented into different categories, with comparable states. Trade gaps can also be identified by computation of 'normalised trades', that is, trades based on GDPs and distances of trading states from a reference state.

The following is an example of the estimated Top-20 cargoes exported from Ireland to France, which were derived in the manner described above.

Table 1: Top-20 Exports from Ireland to France (2007)

			EXPORTS			
Rank / Ref. No.	**SITC Code**	**SITC Description**	**Est TEUs**	**% of Total TEUs**	**Value (€000)**	**Value/ TEU (€)**
1	1	Meat & meat preparations	12,663	22.84	328,619	25,951
2	55	Essential oils, perfume; toilet & cleansing	11,134	20.08	394,570	35,439
3	2	Dairy products & birds' eggs	4,239	7.65	90,777	21,416
4	3	Fish, crustaceans, molluscs, preparations	3,559	6.42	88,784	24,949
5	63	Cork & wood manufactures, not furniture	3,361	6.06	17,657	5,254
6	89	Miscellaneous manufactured articles	3,226	5.82	301,065	93,321
7	75	Office & data processing machines	1,979	3.57	1,409,717	712,174
8	25	Pulp & waste paper	1,765	3.18	1,153	653
9	59	Chemical materials & products	1,364	2.46	256,548	188,030
10	74	General industrial machinery & equipment	1,321	2.38	174,746	132,302
11	54	Medical & pharmaceutical products	1,247	2.25	665,601	533,698
12	11	Beverages	986	1.78	40,869	41,445
13	28	Metalliferous ores & metal scrap	953	1.72	1,347	1,414
14	72	Machinery, specialised	895	1.61	33,227	37,140
15	21	Hides, skins & furskins, raw	853	1.54	8,120	9,524
16	57	Plastics in primary forms	581	1.05	14,543	25,048
17	58	Plastics in non-primary forms	560	1.01	48,086	85,877
18	32	Coal, coke & briquettes	523	0.94	267	510
19	71	Power generating machinery	519	0.94	23,405	45,098
20	6	Sugar, sugar preparation & honey	426	0.77	16,114	37,846
		Totals	**52,152**	**94%**	**3,915,215**	

1.3. Operational Characteristics of Transport Modes

The operational characteristics of transport modes were examined in the SKEMA study 'Weathering the Economic Crisis'[7] and are presented here in a simplified format in which the performance of RoRo, LoLo, Bulk Shipping and Freight Trains are displayed relative to the performance of a Euro V Truck.

The data is based on a simple Point-to-Point (P2P) comparison between the various transport modes and long-haul trucking. There are several assumptions:

- The same points of origin and destination are used in the comparisons. The points of origin and destination are ports in which the ships are loaded and discharged.
- Distances and ship speeds are selected in order to simulate regular ship schedules.
- The RoRo ship that is considered is a substantial vessel of 230 trailers capacity and 19 knots service speed. A second, smaller RoRo vessel is also considered, but data is not displayed as it adds little to the overall picture.
- The LoLo vessel that is considered has 868 TEU capacity and 14 knots service speed. A second, smaller vessel is also examined but its data is not displayed.
- One dry bulk ship is considered, a relatively small vessel of 2,000 dwt capacity and service speed of 10.5 knots.
- The train service that is used is modelled on the top-of-the-market freight trains that operate between Gothenburg and Stockholm, powered by Swedish generated electric energy, which is particularly 'green''.

Table 2: Comparison of transport modes over a common medium distance

Distance 300 Nautical Miles (556 km)

Comparison Criteria	**EurоV Truck** **75% average Utilisation**	**RoRo Ship** **65% Average Utilisation**	**LoLo Ship** **65% Average Utilisation**	**Bulk Ship** **75% Average Utilisation**	**Freight Train** **20 Trailers**
P2P Cost per Trailer Equiv. (€ / Trailer)	1	0.62	0.45	0.33	0.27
P2P Delivery Time (hours)	1	3.05	4.32	5.46	1.49
CO2 per Trailer Equiv. (tonnes)	1	1.71	0.43	0.71	0.03
SO2 per Trailer Equiv. (kg)	Negligible	Medium	Low	Medium	Negligible

[7] 'Weathering the Economic Crisis' SKEMA Study (2010).

Table 3: Comparison of transport modes over a common long distance

Distance 800 Nautical Miles (1,482 km)

Comparison Criteria	**EuroV Truck** **75% Average Utilisation**	**RoRo Ship** **65% % Average Utilisation**	**LoLo Ship** **65% % Average Utilisation**	**Bulk Ship** **75% % Average Utilisation**	**Freight Train** **20 Trailers**
P2P Cost/ Trailer (€ / Trailer)	1	0.40	0.24	0.19	0.20
P2P Delivery Time (hours)	1	1.10	1.52	1.98	0.52
CO_2 / Trailer (tonnes)	1	1.67	0.33	0.61	0.03
SO_2 / Trailer (kg)	Negligible	Medium	Low	Medium	Negligible

The comparative tables show:

- For short-to-medium distances, a Euro V (or Euro 1V) truck has no competitor for short, reliable delivery times. For long distances, a freight train of Swedish standards, if available, would have faster deliveries than a truck. RoRo delivery times for long distances would be comparable to those of trucks.
- A freight train of Swedish standards, if available, would excel in all other criteria.
- RoRo is more economical than trucking for medium and long distances; its delivery times are comparable to trucking for these distances and are considerably better than LoLo. Its carbon footprint per cargo unit is moderate, as are its SO_2 emissions.
- LoLo is significantly more economical than trucking & RoRo for medium and long distances. Its carbon footprint is good and SO_2 emissions are low. Its delivery times are relatively poor; if this is compounded by unreliable delivery times, then its services can be devalued to commodity status.

Note: The above computations are based on specific RoRo, LoLo and Bulk vessels. If ships of different characteristics were used, such as greater capacity, slower speeds and higher average utilisations, then different, more favourable relative values would be obtained.

1.4 Segmentation of Cargoes

A key requirement for the marketing of transport services, as with any service or type of goods, is the segmentation of the market into identifiable and quantifiable segments. The requirements for effective segmentation[8] are that the segments should be measurable, accessible and substantial. In the determination of cargo flows between states the unitised cargo segments are measurable with reasonable estimations; they are quite substantial, but access to markets can be difficult, which is common to many businesses.

The following table is provided as an example and is based on Table 1. The data in this table presuppose equal distances for trucks, ships and rail. Because of the complex geography of Europe, this is not always the case and in practice one mode may have a distinct distance advantage over another. In addition, the particular requirements of shippers or receivers may bias the modal choice towards a specific mode. The preferred transport solution in many instances would be electric freight train with nuclear-powered mains electricity, if available.

Other than these caveats, indicative transport solutions would be as shown.

Table 4: Segmentation of cargoes and indicative transport solutions

Ref.	Cargo Categories	Transport Indicators	References in Table 2	Est. TEUs	Indicative Transport Solutions
1	Consumables; Perishable goods	Delivery Time; Reliability; Price	1, 3, 4, 12, 20	21, 873	Trucking for fast, reliable deliveries; RoRo for more price-sensitive and longer range deliveries.
2	Medium value, durable goods	Price, Reliability, Delivery Time	55, 72, 21, 57	13,981	LoLo for price-sensitive & Long Range deliveries; Trucking or RoRo for more time-sensitive deliveries; LoLo or trucking for 'green' deliveries; Large integrated service provider or freight forwarder for B2B trading.
3	Low value, durable goods	Price	63, 25, 28, 32	6,601	LoLo, RoRo, Trucking – in that order
4	High value, durable goods	Security, Reliability, Delivery Time	89, 75, 59, 74, 54, 58	9,698	Trucking for short / medium distances; RoRo for medium distances; LoLo for long distances

[8] Ref. 'Marketing Management' by Prof. Philip Kotler et al. 'The world's most widely used graduate-level textbook on marketing'

The segmentation of unitised cargoes by the requirements of Shippers, by the quantification and categorisation of cargoes and by the characteristics of transport modes provides a broad picture that helps in the derivation of generalised transport solutions. Specific solutions require greater detail, which can be obtained by examining the hinterland surrounding a departure port and the foreland surrounding the arrival port, as well as specific requirements of shippers.

1.5 Hinterland & Foreland Markets

A port's hinterland can be deemed to be the area surrounding the port that it serves for both exports and imports. It should be noted that a port's hinterland is not exclusive, but overlaps the targeted hinterlands of competitor ports. A port's foreland is essentially the hinterland of a port with which the port is connected by trade. A port, therefore, has a single hinterland and can have several forelands, depending on the number of ports with which it is trading.

The geographical extent of a port's hinterland or foreland depends on a number of factors, such as road, rail, inland waterway connections, natural & statutory boundaries, population densities, proximity of competitive ports and by the ambition of the port's management. Ultimately, the extent of a port's hinterland and forelands can be determined by the competitiveness of the intermodal services operating from the port vis-à-vis those operating from competitor ports. Within a port's hinterland, the port, terminal managers and transport service providers should be aware of the potential unitised market for imports and exports.

Estimation of potential import units from different states / regions within a port's hinterland:

Section 1.2 describes a methodology for estimating the number of import and export units traded between two states. A reasonable assumption for imports is that the number of imported units in a hinterland from a specific trading state is in proportion to the GDP or GNP of the hinterland, whichever is the more applicable. This assumption can also be applied to the distribution of unitised exports within a foreland.

Estimation of potential export units to different states / regions from a port's hinterland:

Determination of exports from a port's hinterland requires considerably more investigative work than for imports. Estimations of total exports for different commodities to specified states can be obtained for the state as a whole (refer to Section 1.2). Productive facilities for different commodities within the hinterland can be obtained from a relevant state agency. The number of container or trailer units produced is not readily available for individual facilities; the numbers of employees usually are, as companies are justly proud of this social aspect of their business. Using the number of employees as a proxy for production, the number of units exported by each facility within the hinterland can be estimated in proportion to the total for the state.

All this takes a considerable amount of work. However, it not only gives estimates of the numbers of units of different commodities exported from within a hinterland, it also provides the locations of productive facilities for each commodity type. This is invaluable information for direct marketing to these exporting firms and facilitates grouping of complementary cargoes that are exported to the same states or regions.

1.6 Specific Transport Requirements of Shippers

Shippers / Receivers can have specific requirements that strongly affect the choice of mode. These requirements include, not in any particular order:

Just In Time (JIT) deliveries: This applies to consumables, perishable goods and associated durable goods that are transported to supermarkets. It also applies to Business-to-Business (B2B) trades where the aim is to minimise inventory. To achieve this, the transport solution must be reliable, flexible and fast, which is almost a definition of trucking.

Secure, low cost storage on arrival: Receivers of durable goods that have limited warehouse capacity may require secure, low cost storage where they can leave their unitised goods on arrival and draw on them as required. Many LoLo terminals have precisely that: storage spaces for their clients that meet the International Ship and Port Facility Security Code (ISPS Code). This can bias the receivers' transport requirements towards LoLo.

Shippers / Receivers of international branded products and Business-to-Administrations(B2A) trades: For such goods, 'green' labelling or certification is becoming necessary to avoid the repercussions of unfavourable publicity or, more positively, to be compliant with their organisations' policies regarding environmental protection. In that regard, electric freight trains supported by nuclear-powered generating stations are particularly 'green'. Where such an option is not available, LoLo shipping has the lowest carbon footprint per unit of cargo, with trucking coming second and RoRo shipping a poor third.

B2B trading: Business to Business trading involves shipping partly completed or finished goods from one state to another for finishing, marketing and distribution or for transfer pricing purposes. Key transportation requirements for such trades are stability of services and the international reputation of the service provider.

Non-Quantifiable Factors: Such as

Trust built up over multiple transactions between Shippers & Transport Providers, based on positive repeat performance; or restricted choice of feasible transport options, resulting in Shippers and Transport Providers being effectively joined-at-the-hip, requiring them to work together to achieve optimal transport solutions in ongoing interdependent relationships.

1.7 Summary

It is established in the Introduction to this study that external trade is the economic life-blood of European states and it is through efficient transport services that trade is facilitated and fostered. Establishing, improving or sustaining an intermodal transport service is a major undertaking, requiring considerable investigation and information gathering. Section 1 of the study describes what are deemed to be the key parameters affecting short sea shipping. This includes:

- The determination of the transport priorities of shippers within the catchment area of an intermodal service,
- A quantification of the unitised cargo movements between the states that are being serviced,
- The characteristics of alternative transport modes for intermodal operations,
- The segmentation of cargoes into categories that are relevant to the transport function,
- The quantification of hinterland and foreland markets for specific services,
- The particular requirements of shipper segments that are targeted by an intermodal service.

In addition, competitive services must be taken into account. These are considered in some detail in the complementary study ‘Business Case for Short Sea Shipping Solutions’.

2. Co-Modal Transport Networks

Co-modality is the efficient use of different transport modes on their own and in combination, resulting in an optimal and sustainable utilisation of resources[9]. There is a natural tendency when considering surface transport to concentrate on a particular mode, or to compare transport modes in different situations. It is particularly challenging to specify intermodal services with the best combination of modes under a wide range of circumstances. This is the principal objective of this section of the study.

2.1 Networks in Intermodal Transport

There are four forms of networks that can be considered in the context of intermodal transport. They are:

A. **Ferry operations and road haulage**, which are geared to the requirements of haulage companies, with sea distances minimised.

B. **Integrated Intermodal Networks**, in which there is central control over shipping, trucking and terminal operations through ownership, leasing or contracting. Integrated Intermodal Operations can achieve a high level of efficiency and make best use of the different transport modes. They can, however, be exposed to considerable risk in a market downturn due to financing of assets and contingent liabilities.

C. **Intermodal Networks with Independent Modes,** in which ships, terminals and trucks operate independently of each other and in which the risks are distributed amongst the different functionaries, facilitating relatively easy movement of ship and truck operations into and out of the network. The system is flexible and is particularly suited to interregional services, connecting the large network of common-user terminals in Europe's regions with each other and with large hub ports. Associated with this flexibility there are, however, many difficulties:

- The different operational elements in an intermodal network can move out of synchronisation very easily, thus incurring costs that have to be absorbed by clients;
- The system requires a considerable amount of buffer capacity for it to function,
- Under-performance or modifications to a schedule for short-term advantage can have serious repercussions elsewhere in a network,
- Marketing is difficult, if not impossible except through the good offices of freight forwarders and logistics service providers.

D. **Co-Modal Transport Networks** can be defined as being similar to B (Integrated Intermodal Networks, but with the risk mitigated, and to C (Intermodal Networks with Independent Modes) with the functional elements coordinated and having none of the weaknesses of either B or C.

[9] Ref. http://ec.europa.eu/transport/transport_policy_review/doc/2006_transport_policy_review_en.pdf

2.2 Co-Modal Transport Networks

The specifications[10] for a sustainable co-modal network are:

a. The opportunity for establishing such a network must be identified.
b. A Key Player (Network Manager) is necessary to lead the formation and operation of the network. A port is in a focal position in this regard, but normally would not wish to get involved in a commercial operation, although it could help initiate it. A more likely candidate would be a ship operator that has considerable experience in intermodal transport and has much to gain from the success of such an enterprise; or a 'facilitator' that may have shipping, freight forwarding or port community interests.
c. The participants in the network should have agreed objectives, such as improving services to clients, achieving a targeted share of a specified hinterland market or extending the geographical range of services into new markets.
d. The network should be structured and operated so as to avoid both conflict with EU competition law and excessive liability exposure of participants. (Refer to Appendix 1 of this study 'Obstacles to Setting Up Co-Modal Transport Networks')
e. There should be clearly defined entry and exiting criteria to & from the network, in order to avoid the formation of an organisational structure that may be deemed to be monopolistic.
f. A Decision Support System is necessary to cope with the multiple variables and constraints in specifying, adjusting and maintaining the network. (Refer to Appendix 2 'Specification for Co-Modal Network Decision Support System')
g. The network needs to be supported by an IT infrastructure that will facilitate central management and optimal use of resources, together with marketing and booking capabilities that are distributed throughout the network.
h. Support funding is highly desirable under any one of MARCO POLO, MOS or TEN-T programmes because of its catalytic effect in helping to secure investment funding, as well as cooperation amongst network participants in what would be a major undertaking with considerable downside risks.

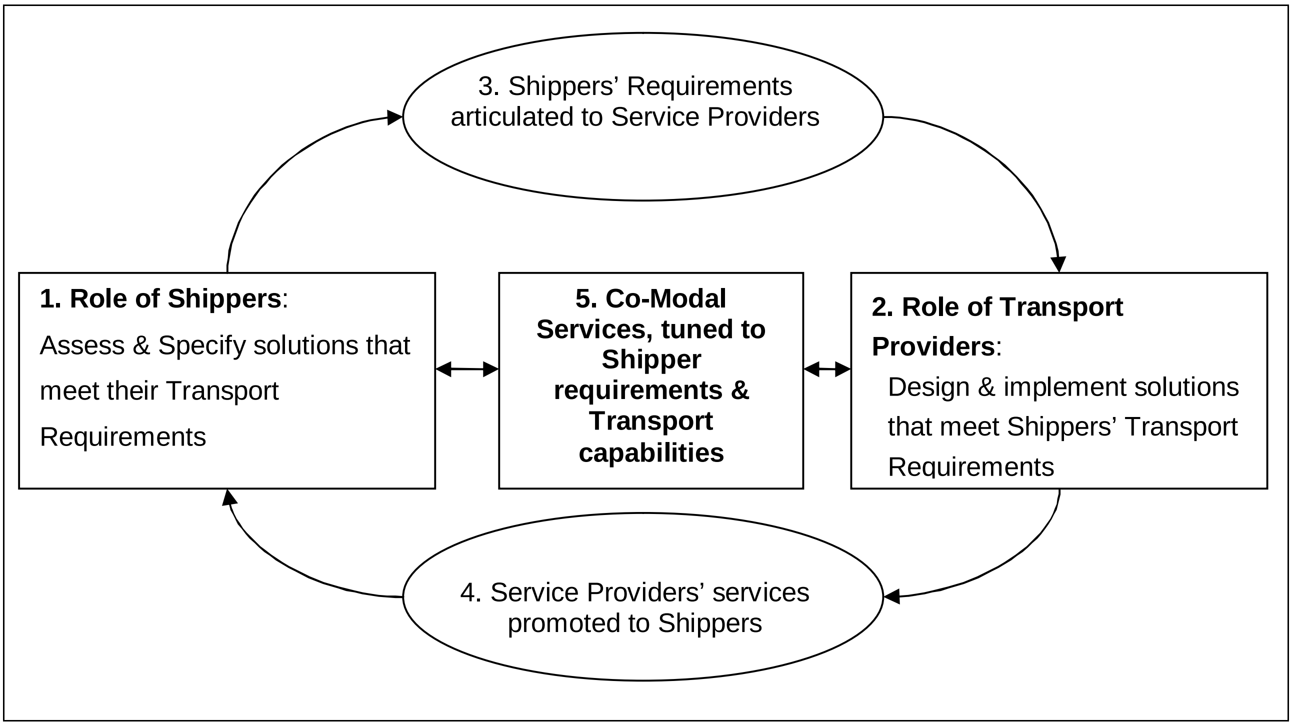
2.3 Alignment of Co-Modal Solutions with Shippers' Marketing Requirements

Shippers are often deemed to be passive players in the transport function, with their role being simply to select a transport solution from available services with the aid of a freight forwarder. The role of a transport service provider can also be misconstrued to simply providing services in response to competitive market forces and to promoting these services to shippers. A more realistic portrayal of the interdependent relationships between shippers and transport service providers is presented in the following two sub-sections, 2.3.1 & 2.3.2.

[10] Refer to PROPS D1.2 'Business Networking & Short Sea Shipping' (Nov. '08)

2.3.1 Interdependent Relationships between Shippers & Transport Providers

Schematic representation of the interdependent relationships between Shippers and Transport Providers



The idealised roles of the two sets of participants in their interdependent relationships and the functions of the connecting links between the two of them are as follows:

1. Role of Shippers: The ability to assess & specify solutions that meet their transport requirements would be valuable to Shippers, who generally know little about the details of the various elements of the transport function that are offered to them by the logistics industry. There are significant advantages in making available assessment capabilities to Shippers that would enable them to clearly input their own ethos into transport solutions and ensure best balance between the various transport characteristics, such as price, service levels and risk.

2. Role of Transport Providers: Transport Providers need to be agile in assessing and availing of opportunities for their Shipper clients and in identifying and addressing emerging risks, such as capacity shortages, currency volatility and fuel surcharges. In addition, they must fend against competitive intrusions and reach a balance between the stability associated with management of long-lived assets and risk of changing market circumstances.

3. Articulation of Shippers' requirements to Service Providers: Transport has long been identified as part of a Shipper's marketing function. There is an onus on a Shipper, therefore, to incorporate transport possibilities into his international marketing campaigns. The benefits of successfully incorporating transport possibilities into international marketing can be of immense value to the shipper's company and to the state in which his company is located. He needs to articulate his requirements to Transport Providers and to work with them so that solutions are provided that advance his international businesses.

4. Promotion of Transport Services to Shippers: Transport Providers can be excessively focussed on the utilisation of their resources. Intelligent promotion of services should entail an involvement with shippers' marketing requirements and providing them with an optimal mix in response to market variations, such as economic growth / decline, fuel price changes, currency variations, fashion trends and, in particular, a Shipper's own marketing objectives.

2.3.2 Difficulties in achieving balance in the interdependent relationships between Shippers and Transport Providers

There are quite a number of interrelated variables and constraints that make it difficult to achieve balance in the relationship between shippers and transport providers. They include:

- There are operational bands within which each of the transport modes has particular advantages, as seen in Section 1. Efficient intermodal services, therefore, must deploy the best combination of modes if they are to excel.
- The logistical priorities of targeted segments of Shippers, which are covered at some length in Section 1, are a key feature in the determination of optimality of individual services. It can be difficult to transfer these logistical priorities into transport imperatives.
- The capacity utilisations of transport modes, ports and terminals are dependent on different factors, such as economic growth or decline, size of different freight market segments, level of competition, as well as physical characteristics of the individual transport units. It is convenient to treat capacity utilisations as independent variables in the analysis process, with a need to identify the underlying factors that cause changes to capacity utilisations.
- Distances are quite understandable variables, but prevailing conditions can be underestimated, such as weather, sea states and congestion.
- The momentum of current practice makes it difficult for a new or improved service to make an impact on the market. It is reckoned that the least discernable difference between service attributes is about 15%[11], so that a transport service would need to be significantly better than alternative offerings if it is to gain market share. Shippers & freight forwarders are reluctant to change from an adequate service to an unproven alternative unless there is a significant differential in key attributes between the two.

2.4 Achieving Co-Modal Transport Solutions

It is evident from 2.3.1 and 2.3.2 that there are many variables and considerations relating to intermodal services that need to be taken into account in the determination of co-modal solutions and that special technological supports are required in this regard.

[11] This is loosely related to Weber's Law, in which the least noticeable change in a physical stimulus is proportionate to (i.e. is a percentage of) a reference stimulus.

2.4.1 Decision Support for Co-Modal Transport Networks

A Decision Support system has been deployed in Deliverable 'Business Case: Maritime Service Ireland – France' and is being adapted for use in PROPS as an online system. Amongst its several attributes are:

- It can be particularly helpful to Shippers in investigating overseas market opportunities and in supporting them in specifying solutions that address these opportunities;
- It can support the varied role of Transport Providers in the analysis and specification of intermodal solutions that meet the requirements of Shipper / Receiver segments;
- It can assist both Transport Providers and Shippers in assessing the efficiency of intermodal networks that deploy an array of road haulage, terminals, ports, shipping, rail and inland waterway services;
- It can assist in articulating Shippers' transport requirements to Transport Providers, to the benefit of both Shippers and Transport Providers;
- It can be used in the intelligent promotion of Transport Services to Shippers by providing demonstrable benefits of services for Shippers' particular requirements;

It can be accessed through a standard internet browser with multiple simultaneous usages.

2.4.2 Co-Modal Transport Solutions

An optimal transport solution for cargo movements between two states involves:

1. Determination of the unitised cargo movements between the states;
2. Segmentation and quantification of the cargoes into categories that relate to the transport function;
3. Deployment of decision support capabilities to determine 'best' solutions amongst feasible alternatives, taking into account:
    - the generalised priorities of shippers, as well as the specific requirements of targeted segments of shippers,
    - the operational characteristics of transport modes, as well as specific characteristics relating to route options,
    - the interdependent relationships between shippers & transport providers, as well as the specific marketing requirements of targeted shipper segments.

2.5 Summary

The concept of co-modal transport solutions was introduced by the European Commission and refers to the efficient use of different transport modes on their own and in combination, with an optimal and sustainable utilisation of resources. The challenge in Section 2, therefore, is to present a structure for the specification of co-modal services under various circumstances.
Intermodal services operate within networks, of which two are in common usage and a third can be defined. They are:

- Integrated intermodal networks, where there is central control over shipping, trucking and terminal operations through ownership, leasing or contracting. Integrated intermodal networks can achieve a high level of efficiency and make best use of the different transport modes. They can, however, be exposed to considerable risk in a market downturn due to financing of assets and contingent liabilities.
- Independently functioning intermodal networks, in which ships, terminals and trucks operate independently of each other and in which the risks are distributed amongst the different functionaries. The system is flexible, but has many weaknesses, such as the different operational elements can move out of synchronisation very easily; it requires a considerable amount of buffer capacity and direct marketing of a service can be well-nigh impossible.
- Co-modal transport networks can be defined as being similar to integrated networks, but with the risks mitigated, and to independently functioning networks with the functional elements centrally coordinated, and with none of the weaknesses of either.

Specifications are presented for co-modal transport networks that include two technological requirements:

- A decision support system for coping with the multiple variables and constraints in specifying, adjusting and managing a co-modal transport network;
- An IT infrastructure that will facilitate central management and optimal use of resources in a co-modal network, together with marketing and booking capabilities that can be distributed throughout the network.

A decision support system will be accessible for review in PROPS, while an appropriate IT infrastructure is being developed in the project e-Freight.

Implications of Study

The central theme of this study is that Short Sea Shipping is a major facilitator of intra-European trade. It is through trade that the GDP of European states can be increased and the effects of the current recession mitigated. A portrayal of the interdependent relationships between shippers and transport service providers is presented that takes into account the fact that transport is an essential part of shippers' marketing function and shippers should be engaged in the specification and selection of transport solutions that are in keeping with their special marketing requirements. Similarly, transport services for shippers should entail an involvement with shippers' marketing needs and provide them with an optimal mix in response to market conditions and Shippers' own marketing objectives.

In brief, co-modal transport is an essential part of shippers' marketing function and it requires cooperation between shippers and transport service providers for its potential to be realised. The collective benefit of individual co-modal efficiencies is the facilitation of trade between European states and between Europe and the rest of the world, which is a proven mechanism for sustainable wealth generation in the trading states.

Appendix 1: Obstacles to Co-Modal Transport Networks

Introduction

This brief exposition examines the legal and regulatory obstacles that may present themselves in setting up Co-Modal transport networks.

Competition Law

We are at an important juncture in Maritime Competition Law due to the fact that Regulation 1419/2006 put a finish to Liner Conferences and therefore all shipping companies operating on routes into and out of Europe can no longer act in conference with the aim of fixing price and capacity. Arising out of this important development the Commission adopted guidelines on the application of competition rules to maritime transport services. We need to examine the different ways whereby the creation of co-modal networks may distort competition either through horizontal agreements i.e. agreements between different networks and vertical agreements that would consist of agreements as between network partners.

The Relevant Market

Article 82 of the EC Treaty prohibits the abuse of a dominant position in a relevant market. It is possible for a co-modal network to have a dominant position in a relevant market by virtue of its geographical location or the product / service on offer. The abuse of a dominant position leads to the breach of EU legislation. It is sufficient to say at this stage that the co modal network system could lead to the creation of a relevant market for the purposes of competition law and the individual networks and indeed the network partners need to ensure that their agreements are not breaching EU competition rules.

Market Share

A network may, through its network partners, attract a market share of the community which would put it into the category of holding a dominant position. In deciding market share the Commission and the European Court of Justice have looked at volume and / or capacity data in respect of liner shipping; they have also looked at the following criteria in relation to tramp shipping markets:-

(a) the number of voyages,

(b) the parties volume or value share in the overall transport of a specific cargo,

(c) the parties share in the market for time charter contracts

(d) data in relation to the parties contract negotiations,

(e) the parties capacity share in the relevant fleet (by vessel type and size),

Horizontal agreements between different network partners can also be taken into account, as would horizontal agreements between different networks in determining market share.

Information Exchanges

Co-Modal networks will be, amongst other things, a source of information exchange between the network partners. The exchange in itself could be deemed to be anti-competitive, pursuant to Article 81 of the EC

Treaty as it would take away to a great degree the market uncertainty that would otherwise remain in the absence of such an exchange. This would have an obvious effect on the price, quality and frequency of services.

European Community case law has given us some assistance in this area in determining whether an information exchange is anti-competitive. While the anti-competitive nature of an information exchange needs to be examined on a case-by-case basis a number of traits have emerged from the courts. In particular the structure of the market where the information exchange takes place and the characteristics of the information exchanged are deemed to be two critical factors.

Market Structure

The level of concentration and the structure of supply and demand within a particular market is of relevance. Information exchanged within highly concentrated markets is likely to have more of a distortion on competition than in less highly concentrated markets. That is not to say that when the market is not highly concentrated then competition cannot be distorted. Supply and demand within a market and the level of structural links between competitors also needs to be taken into account in determining market structure. This again can be an obstacle to the co-modal network system as the supply and demand within a particular network may give rise to a situation whereby the Commission may determine that the information being exchanged is leading to a distortion of competition.

Characteristics of Information Exchanged

A second trait that has emerged from the European court, when determining whether or not an information exchange is anti-competitive, is the characteristics of the information being exchanged. While it is accepted that information made available to the public is not generally deemed to be in breach of Article 81(1), it is important to establish that such information is not enhanced with other information, which may or may not be available to the public and by doing so the information being exchanged becomes commercially sensitive and anti-competitive.

Information can be historic, recent or future. Historic information is deemed to be information of over one year generally, whereas anything less than one year is generally regarded as recent. Historic information does not generally come under Article 81(1) whereas recent information needs to be dealt with on a case-by-case basis and by paying particular attention to when information becomes obsolete in that particular market.

Future information is particularly problematic in that it has the real possibility of distorting competition. The argument will be made by the networks, however, that this exchange of information creates efficiencies and while it may seem anti-competitive on the face of it, the efficiencies are saving money and the benefit of this is being passed onto the customers. Article 81(3) sets out four pillars whereby Article 81(1) will not apply to anti competitive arrangements. All four pillars need to be satisfied; one of which is that the consumers are receiving their fair share of the benefits of this restrictive arrangement. In order to benefit from Article 81(3) a network would have to show the following:-

1. The network improves the transport services and promotes technical or economic progress. The network must show efficiency gains.
2. The economic efficiency gains must not only benefit the network partners but they must also benefit the consumer to the extent that the consumer must be compensated for the loss resulting from a restrictive agreement.
3. There aren't less restrictive ways of achieving similar benefits.
4. The network must not be afforded the possibility of eliminating competition in respect of a substantial part of the services in question.

Liability Regime

The historical rules that applied to contracts of carriage culminated in the formulation of the Rotterdam Rules, which were adopted by the United Nations Commission on International Trade Law in December 2008. These rules increased the carrier's liability and extended the time period for bringing a claim. The practical affects of various applications of different liability rules and the formulation of standard clauses between stakeholders has led to a situation where the rules of liability in relation to the international carriage of goods have become fragmented and uncertain and has led to litigation.

The liability regime is important to the establishment of the network system, as it is vital that all network partners operate the same regime. The contract as between the network partners and the network management and the contracts that exist between the various network partners will need to contain a standard set of liability clauses. Indeed should a network need to engage with another network, then both networks need to use the same liability rules; otherwise there may be a shortfall in compensation which would need to be picked up by the contracting network or their insurance company.

In addition to the use of varying conventions in relation to liability, many stakeholders use generic clauses in relation to liability in order to govern liability issues. This gives rise to a number of difficulties. The negotiations in relation to liability clauses may not take place on an equal basis, usually due to the financial or geographical strength of one or more of the parties. In the new Rotterdam Rules, for example, the term "maritime performing parties" is used and therefore the port or terminal may now be incorporated into the liability regime of the carrier. These rules therefore would not suit the port and in such circumstances the port would seek to exclude the Rotterdam rules as the applicable rules of the contract between the network parties. This could give rise to a situation where the networks would not benefit the smaller partners within the networks and would therefore undermine the effectiveness and viability of the network system.

When looking at the different liability regimes for the different modes of transport, there is a variation between the liability rules in respect of the limits of time within which to bring a claim, and in particular, in relation to the amount that can be claimed. Again, the lack of a uniform liability regime for all modes of transport has the potential to undermine the whole system.

It is envisaged that in the event that a claim is issued against the network that the network management company would bear the claim and in turn that the individual wrongdoer would be identified by the particular leg of the overall contract. The wrongdoer would in turn compensate the network manager. This system would be required as the client's contract would be with the network management company and the network in turn would contract with the individual network partners.
In this situation the network management company would require insurance to protect itself against claims. Unfortunately, due to the different liability rules which exist for the different modes of transport it would be difficult for such insurance to be issued due to the fact that it would be difficult to assess the risks per mode of transport under the various conventions which apply to each mode.

In the current system of offering a multi-modal contract there has been much litigation in trying to identify the wrongdoer within the contract. In order to do this the claimant needs to identify the time and place of the occurrence. In addition to this a situation may arise whereby two contracting parties have carriage of the goods at the same time, and again, while the time and place is identified the responsible party needs to be identified under the contract. If this situation remains we will find that the network manager would spend his time in litigation, which would result in increased costs and would ultimately make the insurance costs prohibitive.

In conclusion, therefore, it is necessary to introduce a uniform set of liability rules for co-modal transport contracts. All stakeholders, including insurance companies, need to be involved in this consultation. All modes of transport need to be consulted in order to reach a fair and balanced agreement. The certainty of a single liability regime for a co-modal based contract would provide certainty and a large saving in costs.

Relationship between network partners

From the foregoing sections, it can be seen that the legal structure of the individual network is of great importance. If the network is set up as a consortium, then it may avail of Regulation 823/2000 and by doing so may not be subjected to the same competition rules as other undertakings.

In deciding the legal structure we must also take into account the limited liability that some legal structures would give to the network partners. It would be envisaged that the network manager would be a separate legal entity and operated independently of the partners and therefore the liabilities of the network manager would not impinge on the network partners and, consequently, the liabilities of the network partners would not impinge on the network manager.

One must also be aware of the different liability rules that exist and therefore the setting up of a consortium may lead to a precarious situation for network partners in the event of there being a major liability claim.

The commercial realties of the network partners are also of importance. On the one hand a partner may be a multinational shipping company and a local partner may be an owner / driver trucking company. The huge differences that would exist from an undertaking such as this could hinder a consortium-type arrangement.

We also need to consider that a joint effort needs to be made by the network partners in relation to expenditure on advertising and on some aspects of marketing. In addition, a business operating locally in the geographical area where the network is based can bring customers to the network without the expenditure of money and this also needs to be taken into account.

We must also consider the effects of a partner who is not performing. As mentioned previously, it is very difficult to apportion liability in the event of cargo being late and in such circumstances a network would probably bear the cost within itself. If a partner is constantly under-performing it will result in difficulties with other partners within the network and provision needs to be made for remedial action.

The ease at which a partner may enter and exit the network is also of significance. This needs to be considered from two perspectives. Firstly, from a competition law perspective it is important that no undue barriers are placed in allowing an entity enter the network and, additionally, due to the variation of business models that exist across the different modes of transport it is equally important that these partners are allowed to operate outside the network.

In all the circumstances it is envisaged that a situation would pertain where the network partners contract with the network manager. The terms of the contract would have to deal with:

- (i) Liability clauses,
- (ii) Marketing and advertising of the network,
- (iii) Performance standards and penalties for non performance,
- (iv) Pricing mechanisms and availability of the network partners,
- (v) Criteria for selecting one network partner over another for specific business,
- (vi) Payment terms,
- (vii) Termination and renewal of network participation contracts.

While this list is not exhaustive, these are probably the main elements to be agreed between the parties.

Conclusion

In conclusion therefore we can see that network managers have much to consider in ensuring that they are not in breach of competition regulations. The maritime industry is going through significant change at the moment from a competition perspective due to the introduction of recent legislation in this area, as already outlined. We will see over time how matters develop in this regard but there are exemptions still available to the industry by way of the extension to Regulation 823/2000 to April 2015. In this regard the legal structure of the network would be of importance, together with the make-up of the contracts between the individual partners. In addition, the network may avail of Article 81(3) as set out above if it can satisfy the four pillars contained therein.

We can also see that while there may be difficulties in relation to competition law and difficulties in relation to the legal structure of the network and the legalities in relation to the relationship between the parties, a major obstacle in setting up co-modal networks is the need to have a uniform liability regime. The need to reform this area of law is long overdue and while the Rotterdam rules are in their infancy it appears that they are not well received. The fact that under the rules any party can opt out is a cause for concern in itself. In addition we have seen that a number of rules which are derived from various conventions and national laws govern the different modes of transport in relation to liability, which reinforces the point that a uniform system needs to be established.

Appendix 2: Specification for Co-Modal Network Decision Support System

Technical Specification & Architectural Design

1. System Architecture

The following section outlines each component of the architecture in some detail. Figure 1 depicts the architectural concept for an online decision support system. An intuitive GUI is presented to the user through a Web based interface, which gathers information about the transport network he / she may wish to model. From this data the system generates an accurate model of the network, providing information such as: charter times, fuel costs, CO_2 emissions, etc.

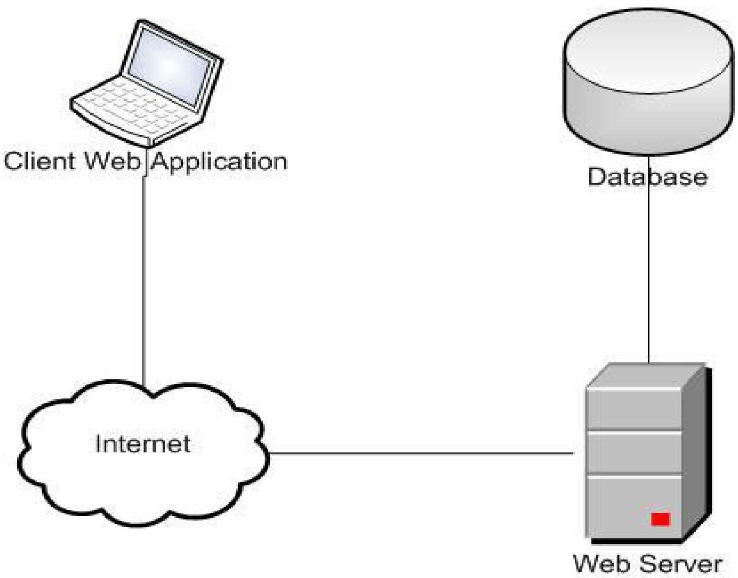


Figure 1 : System Architecture

Web Server

It is the primary function of this component to act as an intermediary between the Web application and the database in the transmission of both user and transport network information. It is important to note that the provision of a RIA (Rich Internet Architecture) mandates a client/server structure.

Database

This component of the architecture acts as a storage point for the reference information pertaining to the transport networks. This data store, in combination with user input data is used to model the network. The database also holds user login credentials facilitating varying levels of access to the support system.

Client Web Interface

As the DSS is designed to model transport networks for many end users, it is necessary to have a means of distributing this data. A user interface will gather information specific to the network being modelled. This information will then be combined with reference information in the data store and transformed into the network model. The Web application is the client component of the RIA mentioned in the server section and contains the user interface.

2. Implementation

The previous section outlined a generic architecture for the provision of a Web based maritime network modelling application. This section gives more specific information on the implementation of the proposed architecture.

2.1 Rich Internet Architecture

The management of registered user accounts and a graphical/statistical representation of their specified network is a crucial component of the architecture. Any implementation also needs to facilitate rapid changes to network parameters by the user in real time.

Constructed as a result of these requirements is a Rich Internet Application (RIA). This type of application capitalises on the strength of both Web and desktop applications, featuring highly responsive user interfaces and interactive capabilities. The key differentiator between a RIA and standard website is that a RIA is focused on a task. The notion of a task orientated Internet application can be applied to multiple domains, for example in the context of eCommerce; the task is geared towards locating, personalising and purchasing a good/service. For the purpose of this system, the task becomes visually representing maritime transportation networks.

Another difference with RIA's is the way that they handle and process information. Traditional desktop applications rely almost exclusively on client-side processing. When a task is initiated, the local systems resources are leverages to process the request. In contrast, Web applications rely on server-side resources to process a request. With RIA's, the work is shared by both client and server side technology. To clarify, the data is partially processed by the client, so a full page refresh and return trip to the server is not necessary for each and every action performed. This means that a user can perform an action, and the results of that action can be seen immediately without the page being fully refreshed. The addition of this choice of Web application to the implementation facilitates a great increase in efficiency of the system as we can now delegate much of the resource have work to the client Web application, freeing up precious server side resources.

2.1.2 Google Web Toolkit

The RIA that has would be recommended for the implementation of the DSS is the Google Web Toolkit (GWT), in combination with SmartGWT. This is an open source development toolkit that simplifies the process of building sophisticated AJAX applications. It allows for the development and debugging of these applications entirely in Java. As shown in figure 2, deployment of the final application on the Web simply involves invoking the GWT compiler which transforms the working Java code into highly optimised Javascript that works in any modern Web browser. Compiled GWT applications are standalone JavaScript and therefore do not require a Java virtual machine on the client, nor do they require any server side support while running. The next sections will discuss the rationale for the selection of GWT as the toolkit for the DSS.

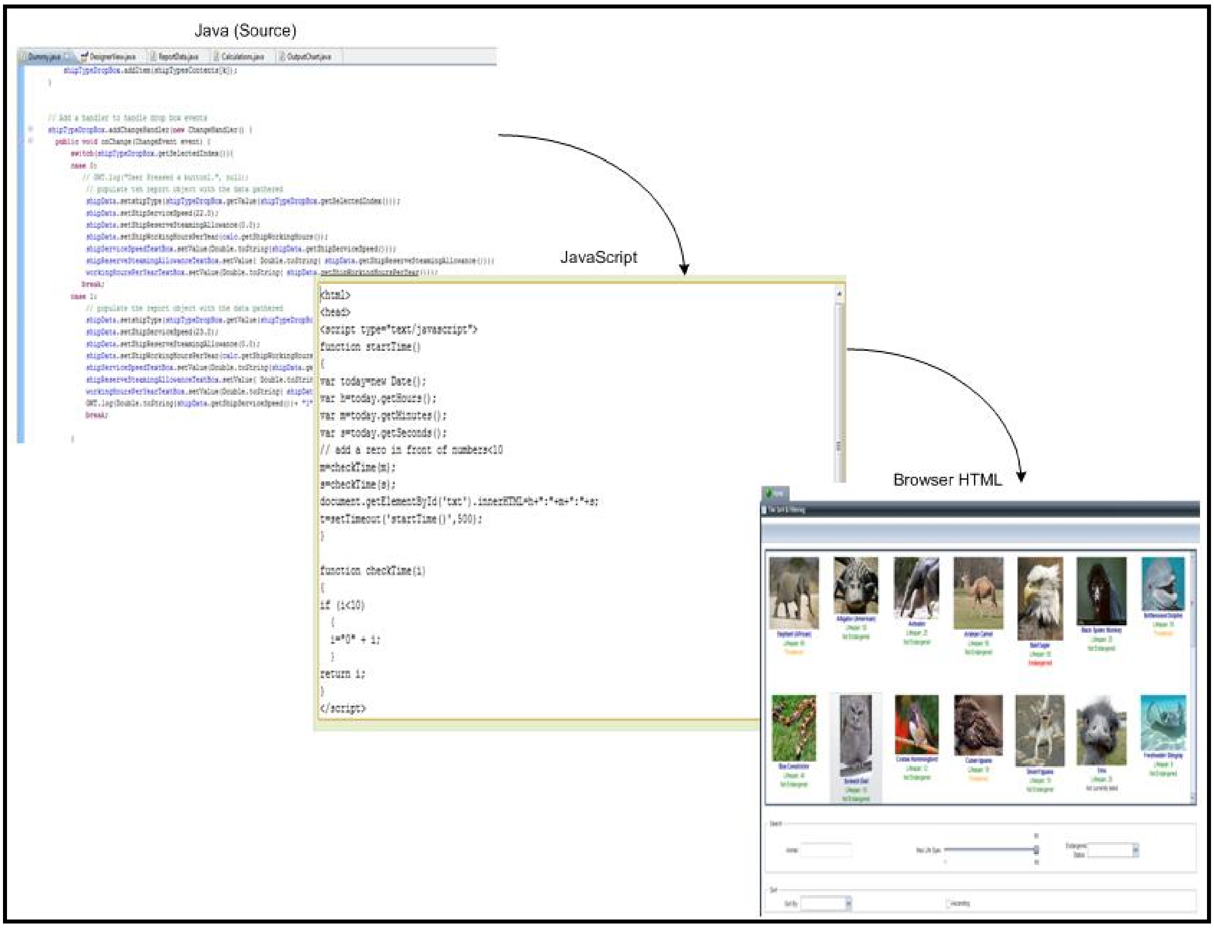


Figure 2: GWT Approach

2.1.2.1 Leveraging the Web

GWT is designed with a Web tier in mind. The centrally hosted distribution model that Web offers is fully leveraged, and updates to applications are transparent and seamless in this model. The URL is the application download location and the browser is the application platform. Concepts that users know are also present and are intentionally not hidden or disabled. Browser buttons can be put to work rather than disabled, and can do exactly what they are expected to do. Bookmarks are also present and again they work even when deep-linked into a particular area of the application. This leveraging of the parts of the Web that do work is intentional with GWT, as is GWT's extension of the RIA landscape to provide tooling and testing support.

2.1.2.2 Tooling and Testing

Another reason that GWT is significant and different from some other RIA's is that it provides tooling and testing support. GWT includes a powerful debugging shell that allows for the testing and debugging of code as it interacts with the native browser on a platform.

The testing support GWT provides is based on JUnit and on a few extensions that the platform provides. GWT code can be tested as Java, from the shell. After the code is compiled into JavaScript, the same test can be used again in that form by using further scaffolding provided by GWT. This allows testing on various browser versions and, if desired, even on different platform and browser combinations.

The Java language also comes with first-class tooling support. Invaluable tools such as code parsers like PMD, static analysis tools like Checkstyle and FindBugs, advanced refactoring engines available in most Java Integrated Development Environments (IDEs), and debuggers and profilers all function perfectly normally within the context of the GWT shell.

Tooling support and testing facilities are very much standard in traditional programming, however are far less common for client-side web technologies. This is not the case with GWT. Along with this support, GWT provides a great deal of help for developers in other areas. One of the biggest advantages that GWT offers is that aids in overcoming browser difficulties

2.1.2.3 Single Code Base

Traditionally, Web development required in-depth knowledge of browser mechanics in order to cope with many differences in behaviour among browser types and versions. Along with knowing details about multiple versions of HTML, the Document Object Model (DOM), CSS, JavaScript, and HTTP standards, developers have also needed to be aware of the way quirks and bugs affect the browser. With the addition of XML and XHR, it is not difficult to see how Ajax development has a reputation of being highly challenging.

GWT does not avoid this difficulty directly; however it does encapsulate it, allowing developers to worry about their applications, rather than the differences between browsers. GWT allows the developer to work on a single code base (Java), then cross compile that code into Ajax-enabled HTML and JavaScript for most of the major browser types and versions currently in use. This is a huge benefit to developers, saving them the time and effort that goes into creating multiple versions of the same code for various browser types.

This abstraction isn't always perfect, but it works well most of the time. If a problem does occur, it can usually be resolved quickly with open access to the source and the expertise of the community (and that expertise is put back into the toolkit, so that others avoid the same problem in the future).

2.1.2.4 Mapping

The decision support system has been created with the intention of modelling maritime networks. The output of the Web based system will be a combination of data, charts and maps. At present, SmartGWT easily facilitates the transformation of static data into visual representations. As GWT is a Google creation, it also readily integrates with their Web based mapping technologies. The Google Maps API provides a convenient JavaScript API which allows a developer to add mapping functionality to an application. The

Google Maps library for GWT allows access to this JavaScript API from Java code compiled with the GWT compiler. An example of this mapping integration is shown in figure 3 below.

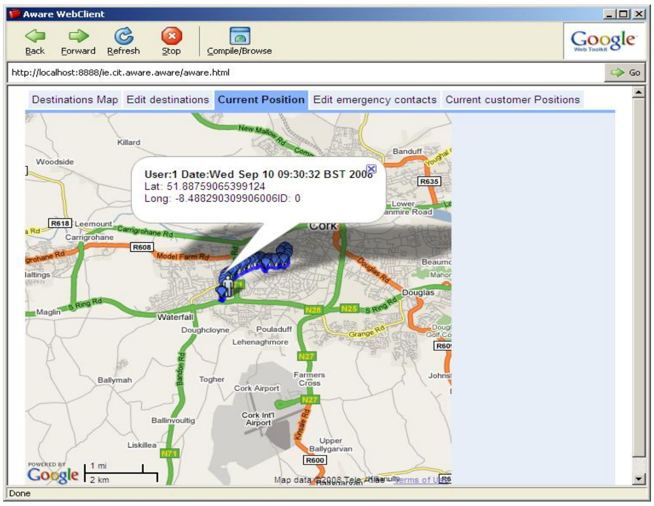


Figure 1 : GWT Mapping Integration

2.1.2.5 Summary

GWT is much more than another Ajax library or another Web development tool. GWT adopts a fundamentally different approach by moving familiar development patterns around providing a cross-compiler from Java to JavaScript and making greater user of the Web browser as a 'chubby client'. This represents a step between the three-tier architecture of the 1980s fat clients, and the thin client architecture of both the 1970's and 1990's. GWT borrows from the approaches that have come before it and takes things in a new direction, expanding the web development frontiers. All the while, GWT maintains the advantages of traditional compiled language development by starting out from Java: and it adopts the successful component-orientated development approach, applying these concepts to the Web tier in a responsive Ajax fashion.

In addition to starting with Java, GWT also embraces the parts of the Web that have worked well and allows developers and users to remain on familiar ground. This is an overlooked yet significant aspect of GWT. GWT does not abstract the Web just to achieve its richness; instead it readily integrates with and uses HTML, JavaScript and CSS.

2.1 Database

The data store, as will be used by the DSS will be the central repository for both reference information pertaining to the transport networks and also for user information. As the system will be used to accurately model transport network, it is foreseen that a spatial element will be necessary. Integration with spatially aware software agents is also a distinct possibility, which would allow the system to facilitate the provision of location aware services. Consequently a database must be selected that has the ability to store spatial geometries and geo-referenced data. The database can be used as a means of segmenting a region and localising service provision. In order to achieve this, a RDBMS (Relational Database Management System) must be able to accommodate this spatial dimension.
Several potential candidates exist:

- MySQL 5.1 with its spatial extension.
- PostgreSQL 8.3 with PostGIS
- Oracle Spatial

From these, it has been decided to implement a PostgreSQL database incorporating their geospatial add-on PostGIS. The rational behind this decision is discussed in the next section.

2.1.1 PostgreSQL & PostGIS

In terms of spatial databases, PostGIS is the most capable open source spatial database extender. While MySQL does have some spatial capabilities, these capabilities are extremely limited, particularly in the selectivity of the spatial relation functions which are all MBR (Minimum Bounding Rectangle) only, the ability to create spatial indexes on non-MyISAM stores, and a lack of the majority if OGC (Open Geospatial Consortium) compliant functions such as intersection and buffering. It is hoped that the Transplan-IT system will use the database to determine services by region based on a co-ordinate system. This would involve checking co-ordinates against the spatial regions in the database. A problem that can occur with MySQL's spatial extension is that the MBR based function queries can sometimes result in co-ordinates being places inside regions in error. It is as a result of these errors, from which PostGIS does not suffer, that MySQL was ruled out as a potential RDBMS.

When compared with commercial spatial databases, PostGIS has most of the core functionality seen in commercial databases (Oracle Spatial, DB2 Spatial Blade, Informix Spatial Blade), had comparable speed and fewer deployment issues. It does however lack some of the advanced add-ons found in these commercial versions. For example, the Oracle Spatial network topology model, Raster Support and Geodetic support. However the database will not require any of these extra functionalities to perform its task and would not in any way be enhanced by their presence.

3. Summary

This document outlines how the requirements and specification for a DSS can be implemented. A system architecture was given, each component was explained and its context given. Then a rational was given for some of the implementation recommendations that have been made.