

**Development of an Index for Maritime Container Transport Costs,  
Connectivity and Risks for the UK**

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## **Abstract**

### **Purpose**

This study develops an index of maritime container transport costs, connectivity and risks for the UK. Data pertaining to the UK-China maritime container corridor was used as this corridor is typical of container flows in and out of the UK. The baseline year for the index was 2010.

### **Research design**

A mixed method approach, across three phases, was used for the development of the index. A literature review revealed factors affecting costs, connectivity, risks and indices that exist in the maritime transport sector, while a content analysis yielded additional knowledge concerning the indices. In Phase 1 of the research, 26 face-to-face in-depth interviews were conducted for weights extraction. Those weights were used in Phase 2, combined with secondary data for each factor to compose the Prime Index. The index was validated by a focus group of academics in Phase 3a. Thereafter (Phase 3b), a Delphi survey was carried out to derive consensus regarding the factors used for the development of the index, the index weights, the overall index and the data sources used. In Phase 3c a focus group verified the overall index, while Phase 3d provided an assessment of the risk factors and sources via an in-depth face-to-face interview.

### **Findings**

An index was generated comprising of 68 factors and grouped into three categories; cost, connectivity and risk. The overall index improved by 7.15 percent in 2011, compared with its baseline (2010). That finding aligns with experts' observations that, in 2011, it was easier for them to move maritime containers in and out the UK than in 2010.

### **Research implications/limitations**

The index will assist all stakeholders in the maritime container transport chain to better understand the impact of changes in services, costs and risks.

### **Originality/value**

This research created an index of cost, connectivity and risk for the maritime container transport sector and also provides a framework for the creation of such an index. The

index is the first such index developed to date which captures these factors. The framework can also be applied by stakeholders to other maritime transport sectors.

## **Dedication**

This thesis is dedicated to family: Stergios, Maria and Dimitris Karamperidis, and to my partner Andriani Vryoni who have always supported me.

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# Table of Contents

Abstract .....	i
Dedication .....	iii
Acknowledgements .....	iv
List of Figures .....	xi
List of Tables .....	xvii
Acronyms and Abbreviations.....	xx
<b>Chapter 1. Introduction .....</b>	<b>1</b>
1.1 Introduction .....	2
1.2 Background to the Research.....	2
1.2.1 Why the UK?.....	2
1.2.2 Why maritime containers? .....	3
1.3 Use of Indices in the Maritime Sector.....	3
1.4 Research Problem.....	4
1.4.1 Research questions .....	4
1.4.2 Research aims and objectives.....	5
1.5 Overview of the Research .....	5
1.5.1 Structure of the thesis.....	6
1.6 Relevance and Contribution .....	6
1.7 Conclusion.....	7
<b>Chapter 2. The UK Maritime Transport Sector (Research Boundaries).....</b>	<b>9</b>
2.1 Introduction .....	10
2.2 Globalisation and the UK.....	10
2.3 Containerised Trade and the UK.....	11
2.4 The UK Maritime Sector.....	15
2.5 The UK's Maritime Transport Sector (Freight Cargo).....	20

2.6	The UK Container Sector .....	22
2.7	Geographical Boundaries of the Research .....	24
2.8	Maritime Transport Sector Costs, with Focus on the UK .....	25
2.9	Maritime Transport Sector Connectivity, with Focus on the UK .....	27
2.10	Maritime Transport Sector Risks, with Focus on the UK.....	33
2.11	Conclusions and Overview .....	34
<b>Chapter 3.</b>	<b>Literature Review .....</b>	<b>36</b>
3.1	Introduction .....	37
3.2	Critical Factors Affecting Maritime Transport Costs, Connectivity and Risk for the UK .....	39
3.2.1	Maritime transport costs.....	39
3.2.2	Maritime transport connectivity.....	80
3.2.3	Costs and connectivity for the maritime sector.....	85
3.2.4	Maritime transport risks .....	97
3.3	The Nature and Structure of Indices.....	107
3.3.1	Index development and risk theory .....	108
3.3.2	Indices found during the literature review .....	110
3.3.3	Maritime indices.....	116
3.3.4	Economic indicator indices .....	136
3.3.5	Environmental indices.....	139
3.3.6	Miscellaneous indices .....	142
3.3.7	Indices; sources of unexpected information.....	155
3.3.8	Indices comparison.....	156
3.4	Content Analysis .....	159
3.5	Landed Costs .....	163
3.6	Map of a Container Journey .....	165



3.6.1	Cost of moving a container from the Far East to the UK.....	166
3.7	Concluding Remarks .....	170
<b>Chapter 4.</b>	<b>Methodology .....</b>	<b>171</b>
4.1	Introduction .....	172
4.2	Methodological Steps of the Research .....	172
4.2.1	Research philosophy .....	172
4.2.2	Research approach .....	176
4.2.3	Research purpose and research strategy.....	177
4.2.4	Research choices (or research design) .....	180
4.2.5	Time horizons.....	180
4.2.6	Data collection .....	181
4.3	Review of Methods Used in Maritime Transport Research for Weights Generation.....	183
4.4	Brainstorming.....	185
4.5	Mind Maps .....	186
4.6	Sampling.....	188
4.7	Normalisation of Data .....	192
4.8	Weighting and Aggregation .....	194
4.9	The Research Process .....	202
4.10	Primary Data Collection Methods Used for this Research .....	205
4.10.1	In-depth interviews (face-to-face).....	205
4.10.2	Delphi survey .....	207
4.10.3	Focus Group.....	220
4.11	Secondary Data Used for this Research.....	226
4.12	Constructing the Index.....	226
4.12.1	Defining a weighted index .....	226

4.12.2	Typology used for index calculation.....	227
4.13	Conclusion .....	230
<b>Chapter 5.</b>	<b>Results.....</b>	<b>232</b>
5.1	Introduction .....	233
5.2	Results from In-depth Face-to-face Interviews .....	233
5.3	Results from the Delphi Survey .....	235
5.4	Results from Focus Groups .....	239
5.5	Secondary Data Sources .....	243
5.6	The Prime Index of UK Maritime Transport Costs, Connectivity and Risks	247
5.7	Conclusion.....	250
<b>Chapter 6.</b>	<b>Discussion .....</b>	<b>251</b>
6.1	Introduction .....	252
6.2	Relationship of the Findings to the Research Problem .....	252
6.3	Consideration of the Research Implications.....	252
6.4	Critique of the Prime Index .....	252
6.4.1	Relevance of the Prime Index to previous work .....	253
6.4.2	How factors affect the Prime Index .....	254
6.4.3	Explanation of the Prime Index outcomes .....	256
6.4.4	Prime Index importance (usage) .....	258
6.4.5	What has been captured so far .....	260
6.4.6	Use of weights for the Prime Index creation.....	260
6.5	Conclusion.....	261
<b>Chapter 7.</b>	<b>Outcomes .....</b>	<b>262</b>
7.1	Introduction .....	263
7.2	Concluding Remarks .....	263
7.3	Limitations of the Research.....	265

7.4	Recommendations for Further Research .....	269
7.5	Conclusion.....	271
<b>Appendices</b>	.....	<b>273</b>
<b>Appendix A.</b>	Port characteristics.....	273
<b>Appendix B.</b>	Estimates of total freight costs for world imports, by country group	274
<b>Appendix C.</b>	Results of the Quantitative Content Analysis on frequency of indices mentioned in 10 maritime transport journals .....	275
<b>Appendix D.</b>	Methods and techniques found in the literature for weights generation.....	282
<b>Appendix E.</b>	Overview of researcher’s actions.....	283
<b>Appendix F.</b>	Information for focus groups .....	288
<b>Appendix G.</b>	Index components (truncated version).....	290
<b>References</b>	.....	<b>293</b>

## List of Figures

Figure 2-1 UK GDP chained volume measure (2009=100) (right axis) against trade in goods and services balance (£ billion) (Q3 09 - Q4 12) (left axis) .....	12
Figure 2-2 Divisions of UK maritime sector and shipping services definitions .....	16
Figure 2-3 UK international freight lifted; 1980-2008 (million tonnes).....	18
Figure 2-4 UK port freight traffic, imports, exports and domestic; 1981-2011 (million tonnes).....	18
Figure 2-5 UK seaborne trade (in thousand tonnes) against UK real GDP .....	19
Figure 2-6 World seaborne trade (in thousand tonnes) against world real GDP .....	19
Figure 2-7 UK major port traffic, by cargo category; 2011 (gross weight).....	20
Figure 2-8 UK major port traffic, by cargo category groups; 1995-2011 (million tonnes) .....	21
Figure 2-9 UK major port traffic, by cargo category groups; 1995-2011 (share of every category compared with the total traffic, in volume).....	22
Figure 2-10 Full containers segmentation; 2005-2011 (thousand units; TEU).....	22
Figure 2-11 Percentage of all the UK containerised traffic according to countries traded (TEU units, 2010) .....	32
Figure 3-1 Transport cost by containership size (daily operating expenses for containership per TEU .....	38
Figure 3-2 X-ray scan of a container loaded in a truck.....	42
Figure 3-3 X-ray scan of a container loaded in a train.....	42
Figure 3-4 Surcharges as a proportion of total rates from the European Northern range, June 2009 .....	43
Figure 3-5 Total freight rates, base rates plus surcharges in USD, June 2009 .....	45
Figure 3-6 Imbalances in containerised seaborne trade to and from Europe (TEUs, 2004) .....	47
Figure 3-7 Development of container traffic and analysis of container traffic components throughout the years [1990-2014 (e)] .....	47

Figure 3-8 Evolution of the world’s largest containerships; 1985-2013.....	49
Figure 3-9 Operating costs for vessels with a capacity under 7,500 TEUs (Euros per TEU).....	50
Figure 3-10 Container fleet development: Y-O-Y comparison .....	51
Figure 3-11 Vessel deliveries for 2011 according to liner company and vessel sector ..	52
Figure 3-12 Percentage of various containership sizes (in TEU) on key trade routes between January 2006 and August 2012.....	52
Figure 3-13 Slot utilisation rate on the Asia – North Europe trade route (in percentage) .....	54
Figure 3-14 World merchandise trade volume; Q1 2005 – Q4 2013.....	54
Figure 3-15 Idle containership fleet evolution between January 2009 and June 2012 ...	55
Figure 3-16 Average containership size breakdown by trade lane; 2012 vs. 2008 (Aug) .....	56
Figure 3-17 Top 10 container routes in 2010 (measured in TEU / nautical miles) .....	57
Figure 3-18 Fuel consumption (tonnes per day) vs. speed (knots) .....	59
Figure 3-19 Fuel consumption (tonnes per day) vs. speed (knots) .....	59
Figure 3-20 Spare capacity in thousands TEU against fleet utilisation .....	60
Figure 3-22 Capacity absorbed by Extra/Super Slow Steaming; July 2009-Aug 2012..	61
Figure 3-23 Trends of EUR/USD against the Baltic Dry Index (2001-2011) .....	68
Figure 3-24 Crude oil price from 1861 until 2011 in USD per barrel .....	70
Figure 3-25 Freight rates USD/TEU vs. bunker prices USD/ton for the route Far East – North Europe, 2009-2011.....	71
Figure 3-26 Bunker price and BAF on the FE-North Europe trade; 2000-2011 .....	72
Figure 3-27 Bunker costs at 24.3, 22 and 20 knots for a 4,400 TEU Panamax vessel compared with the costs of the vessel since 2003.....	73
Figure 3-28 Daily cost of moving 65,000 metric tons of coal .....	73
Figure 3-29 Average daily costs of a Panamax vessel (4,400 TEU) .....	74

Figure 3-30 IFO bunker prices; Feb 2011-Feb 2012 (USD/tonne).....	75
Figure 3-31 380cst average bunker prices; Jan 2008-Sept 2012 (USD/tonne).....	75
Figure 3-32 Evolution of 380cst global bunker prices; 1-1-2005 - 1-8-2012.....	76
Figure 3-33 Supply, demand and utilisation rate of the world merchant fleet; 1990-2011 .....	77
Figure 3-34 Idle containership fleet evolution; August 2008 until June 2011.....	78
Figure 3-35 New Contex Index; January 2010 until June 2011.....	78
Figure 3-36 Containership idle capacity and Alphaliner charter rate index (2000-2012) .....	79
Figure 3-37 CCFI China-Europe Freight Index: FEFC vs. post-FEFC (period 1998-2011) .....	79
Figure 3-38 Depth of water in various ports compared with various characteristics of containerships.....	83
Figure 3-39 Freight costs as a percentage of value of imports: long-term trend (1980- 2005) (Percentages).....	86
Figure 3-40 Correlation between freight rate (USD) and distance (km). Data extracted from the Caribbean region on July 2006.....	87
Figure 3-41 Transportation costs of various modes for transporting goods, against distance.....	88
Figure 3-42 Monthly Suez Canal transit breakdown by vessel type (2007-2010 Nov)..	89
Figure 3-43 Percent increase of ship size and Suez Canal tolls with 6,000 TEU vessel being the baseline.....	90
Figure 3-44 Northwest Passage and NSR.....	93
Figure 3-45 Average monthly arctic sea ice area extent for September; for years 1979- 2011.....	94
Figure 3-46 Consolidation in the container shipping industry.....	95
Figure 3-47 Major port holdings, 2007.....	96

Figure 3-48 Map of Japan, destroyed ports and exclusion zone due to nuclear accident (19 April 2011).....	101
Figure 3-49 Container box inventory-to-containership fleet ratio; 2000-2011.....	109
Figure 3-50 Baltic Dry Index, annual average; 1985-2010.....	117
Figure 3-51 The four indices which are used for the creation of the BDI (March 2010) .....	117
Figure 3-52 BCTI from Aug 1998 until July 2010 .....	120
Figure 3-53 BDTI from Aug 1998 to July 2010 .....	121
Figure 3-54 Howe Robinson Container Index; April 2010.....	122
Figure 3-55 Howe Robinson Container Charter Rate Index (April 2011-Dec 2011)...	123
Figure 3-56 Containership time-charter rates (USD per 14-ton slot/day).....	124
Figure 3-57 Vessel types and contract duration on left axis and the overall New ConTex index on the right axis (11 Oct 2007 until 23 Aug 2012) .....	124
Figure 3-58 The ConTex Index in comparison with other indices (Oct 2007-March 2010). (The other indices: Maersk Broker, Howe Robinson, Clarksons – Clarksea, Alphaliner) .....	125
Figure 3-59 The Clarksea Index 1990-2010 (created with the use of data provided from the Clarksons Research Services Limited in 2010).....	126
Figure 3-60 Clarksea Index and important events which had shaped the index prices	126
Figure 3-61 The Harpex Index (2010) .....	127
Figure 3-62 The routes of the SCFI and their weightings.....	128
Figure 3-63 The SCFI from February 2010 until February 2012 .....	129
Figure 3-64 The SCFI on the 24 <sup>th</sup> of February 2012.....	130
Figure 3-65 Estimated CCFI-linked share of global containership capacity, 2012 .....	131
Figure 3-66 WCI benchmark rate between Shanghai and Rotterdam .....	132
Figure 3-67 CTS price indices for imports to Europe (Dec 2008 - July 2012).....	133
Figure 3-68 CTS price indices for exports from Europe (Dec 2008 - July 2012) .....	134

Figure 3-69 The BOXi Index (BOXi) from Nov 08 until Nov 10.....	135
Figure 3-70 PMI between January 2001 and July 2010. Reactions of the index presented against the economic recessions of 2001 and 2008 .....	137
Figure 3-71 The effect of ship deadweight on CO <sub>2</sub> emissions design index .....	140
Figure 3-72 Evaluation of the II and the HHI since 2000.....	143
Figure 3-73 LPI over-performers and under-performers in 2010, relative to income per capita .....	144
Figure 3-74 Sample of the GPCI. On the vertical axis the average days of congestion are recorded, while on the horizontal axis the actual day that the index recorded is demonstrated. The sample provides data for the Atlantic and the Pacific Ocean.....	145
Figure 3-75 European Freight Forwarding Index (Jan 09 - Mar 10) .....	151
Figure 3-76 UK Freight Forwarding Index .....	151
Figure 3-77 Sea-freight Forwarding Index .....	151
Figure 3-78 The CostPartner's Seafreight Index .....	152
Figure 3-79 The Capital Link Maritime Index (March 2005 - Sept 2012) .....	153
Figure 3-80 DAXglobal® Shipping index, prices in USD (Sep 2002 - Sep 2012) .....	154
Figure 3-81 Comparison between the BDI and the Howe Robinson Container index .	157
Figure 3-82 Baltic Dry Index against GDP growth of selected countries and regions (1980-2015).....	158
Figure 3-83 BDI against World Trade volume (2003-2010) .....	158
Figure 4-1 The research onion .....	173
Figure 4-2 Mind map of the Index of Maritime Container Transport Costs, Connectivity and Risks for the UK.....	187
Figure 4-3 Percentages of different interviewee groups who had completed the mind map.....	191
Figure 4-4 Photo of the moderator, researcher's supervisor and one of the 17 experts participated in the second focus group (Phase 3c) conducted during the Low Carbon Shipping Conference (12/9/2012) .....	225



Figure 5-1 Index frequency according to industry experts .....235

Figure 5-2 Mind map and questions used for weights validation in Delphi survey .....237

Figure 5-3 Mind map and questions used for sources validation in Delphi survey .....238

Figure 5-4 Poster used for the second focus group (Phase 3c) .....241

Figure 5-5 Final mind map of factors composing the index with their weights .....242

Figure 5-6 Detailed list of sources contributing to the Prime Index .....244

Figure 5-7 The Prime Index of maritime container transport costs, connectivity and risks for the UK and its separate sub-indices; cost, connectivity and risk .....249

Figure 5-8 Graphical representation of an interpretation of the Prime Index outcomes .....250

Figure 0-1 Previously attended workshops and credits.....286

## List of Tables

Table 3-1 Predicted effects of transport cost factor on trade volumes, $\tau = - 3$ .....	57
Table 3-2 Grouping of pooled efficiencies according to functional role of a port and its efficiency level .....	65
Table 3-3 Suez Canal tolls per ship size .....	90
Table 3-4 Percent increase of ship size and tolls. Baseline the 6,000 TEU and its tolls	91
Table 3-5 Comparison of percentages between ships and their increase in size and tolls .....	91
Table 3-6 Factors affecting maritime transport cost, connectivity and risk for the UK (listed alphabetically) .....	106
Table 3-7 Results of the Quantitative Content Analysis (QCA) on the frequency of indices mentioned in 10 maritime transport publications .....	112
Table 3-8 Maritime Indices (wet, dry, container) found in QCA .....	113
Table 3-9 Economic indicator indices found in QCA.....	113
Table 3-10 Environmental indices found in QCA .....	114
Table 3-11 Miscellaneous indices found in QCA .....	115
Table 3-12 Indices found in literature review (listed alphabetically) .....	116
Table 3-13 BDI routes and their weightings .....	119
Table 3-14 Baltic Dirty Tanker Index, routes and ship size - class, as of 8 October 2007 .....	121
Table 3-15 Parameters on which the Howe Robinson Container Index is calculated (on 20/10/2010) .....	122
Table 3-16 CCFI on 10 January 2011 .....	131
Table 3-17 BOXi Index and its indicators .....	135
Table 3-18 LSCI for the UK 2004-2009 .....	136
Table 3-19 Weights for each original indicator as used in constructing the international LPI.....	144
Table 3-20 Journal title and data availability for the content analysis.....	162

Table 3-21 Freight rate for dry 20-foot container shipped from Shanghai to Southampton (on the 7th of May 2011) .....	167
Table 3-22 Local surcharges for a dry 20-foot container (for Europe) (on the 7 <sup>th</sup> of May 2011) .....	168
Table 3-23 Surcharges for a dry 20-foot container (journey Far East – Europe) (on the 7 <sup>th</sup> of May 2011).....	168
Table 3-24 Freight rate for a dry 40-foot standard container 27000 kg from Singapore to Felixstowe on the 1 <sup>st</sup> of October 2012 .....	169
Table 4-1 Comparison of four research philosophies in management research .....	175
Table 4-2 Advantages and disadvantages of different weighting methods.....	198
Table 4-3 Compatibility between aggregation and weighting methods .....	200
Table 4-4 Summary of the research phases .....	203
Table 4-5 Types of Delphi survey designs.....	214
Table 4-6 Consensus ranking .....	217
Table 4-7 Advantages and disadvantages of the Delphi survey .....	219
Table 5-1 Experts’ weights and adjusted weights for LSCI .....	245
Table 0-1 Importance of major criteria for transshipment port selection as perceived by global carriers in the AHP survey .....	273
Table 0-2 Most significant sub – criteria for transshipment port selection as perceived by global carriers in the AHP survey .....	273
Table 0-3 Major criteria weight differences between carrier and port surveys .....	273
Table 0-4 Most significant sub – criteria for transshipment port selection as perceived by carriers and ports .....	273
Table 0-5 Estimates of total freight costs for world imports, by country group (Billions of dollars and percentages).....	274
Table 0-6 Results of the NCA on frequency of indices mentioned in 10 maritime transport journals.....	281

Table 0-7 Methods and techniques used from various academics for weights generation .....282

Table 0-8 Information for focus groups .....289

Table 0-9 Truncated version of the index .....292

## Acronyms and Abbreviations

AHP	Analytical Hierarchy Progress
ASC	Annualised Slot Capacity
BA	Budget Allocation (method)
BAF	Bunker Adjustment Factor
BCI	Baltic Capesize Index
BCTI	Baltic Clean Tanker Routes
BDI	Baltic Dry Index
BDTI	Baltic Dirty Tanker Routes
BFI	Baltic Freight Index
BHMI	Baltic Handymax Index
BHSI	Baltic Handysize Index
BIFA	British International Freight Association
BITR	Baltic International Tanker Routes
BOD	Benefit of the Doubt
BP	British Petroleum
BPI	Baltic Panamax Index
BSI	Baltic Supramax Index
CA	Conjoint Analysis
CAF	Currency Adjustment Factor
CCFI	China (Export) Containerized Freight Index
CIA	Central Intelligence Agency
CILT	Chartered Institute of Logistics and Transport
CLMI	Capital Link Maritime Index
CPI	Corruption Perception Index

CSI	Clean Shipping Index
est	Centistoke
CTS	Container Trades Statistics
DEA	Data Envelopment Analysis
DfT	Department for Transport
DHS	Department of Homeland Security
dwt	Deadweight tonnage
EBA	Emergency Bunker Adjustment
EBS	Emergency Bunker Surcharge
ECLAC	Economic Commission for Latin America and Caribbean
EEDI	Energy Efficiency Design Index
EEOI	Energy Efficiency Operational Index
ELAA	European Liner Affairs Association
ESI	Environmental Ship Index
EU	European Union
EW	Equal Weighting
FA	Factor Analysis
FAF	Fuel Adjustment Factor
FAK	Freight All Kinds
FEFC	Far East Freight Conference
FEU	Forty-foot Equivalent Unit
FMGC	Fuzzy Multi criteria Grade Classification model
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GET	Global Enabling Trade Index

GFPTT	Global Facilitation Partnership for Transportation and Trade
GPCI	Global Port Congestion Index
GRA	Grey Relational Analysis
GT	Gross Tonnage
HHI	Herfindahl – Hirschman Index
ICC	International Chamber of Commerce
ICC-CCS	International Chamber of Commerce, Commercial Crime Services
IFO	Intermediate Fuel Oil
IFW	International Freighting Weekly
II	Instability Index
IMB	International Maritime Bureau
IMO	International Maritime Organization
ISM	Institute for Supply Management
ITF	International Transport Forum
IUMI	International Union of Marine Insurance
JRC	Joint Research Centre
KPI	Key Performance Indicator
LCA	Qualitative Content Analysis
LCPCI	Low Cost Port Competiveness Index
LPI	Logistics Performance Index
LR1	Long Range 1 (tankers)
LSCI	Liner Shipping Connectivity Index
MAUT	Multi-Attribute Utility Theory
MCA	Multi-Criteria Approach

MCDM	Multi-Criteria Decision-Making
MR	Medium Range (tankers)
mt	metric tonnes
NCA	Quantitative Content Analysis
NSR	Northern Sea Route
OECD	Organisation for Economic Co-operation and Development
PCA	Principal Component Analysis
PCS	Panama Canal Surcharge
PMI	Purchasing Managers' Index
PPI	Partnering Performance Index
PPP	Purchasing Power Parity
PPS	Peak Season Surcharge
PRC	Piracy Reporting Centre
RMI	Risk Management Index
RTI	Riverlake Tanker Index
SC	Supply Chain
SCA	Structural Content Analysis
SCFI	Shanghai Containerized Freight Index
SCM	Supply Chain Management
SCS	Suez Canal Surcharge
SEM	Structural Equation Modelling
SFA	Stochastic Frontier Analysis
SI	Specialization Index
SMEs	Small and Medium-Size Enterprises
SSC	Ship Security Surcharge



S&P	Standard & Poor's
TAI	Technology Achievement Index
TCEs	Time Charter Equivalents
TCIk	Transport cost index
TEU	Twenty-foot Equivalent Unit
THC	Terminal Handling Charge
tpd	Tonnes per day
UCM	Unobserved Components Models
UK	United Kingdom
ULCS	Ultra Large Container Ships
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
USA	United States of America
USD	United States Dollar
VaR	Value-at-Risk
VHSS	Hamburg Shipbrokers Association
VLCC	Very Large Crude Carriers
VLGC	Very Large Gas Carriers
WCI	World Container Index
WCO	World Customs Organisation
WMD	Weapon of Mass Destruction
WRS	War Risk Surcharge
WTO	World Trade Organisation
YAS	Yen Appreciation Surcharge

## Chapter 1. Introduction

*“Writing a book is an adventure. To begin with, it is a toy and an amusement; then it becomes a mistress, and then it becomes a master, and then a tyrant. The last phase is that just as you are about to be reconciled to your servitude, you kill the monster, and fling him out to the public”.*

Sir Winston Churchill, British politician (1874-1965)

## **1.1 Introduction**

The purpose of this research is to develop an index of maritime transport costs, connectivity and risks for the UK. Such a tool will be of considerable use not only within the maritime sector, but also in general economic policy. The proposed index allows various factors, such as time, trade imbalance and port infrastructure, to be modelled and ‘weighted’ based on the perceptions held by various practitioners and academics of the impact of those factors on the UK. This section provides an overview of the thesis, which is structured into seven chapters.

## **1.2 Background to the Research**

The UK’s competitiveness could be enhanced if an improvement in maritime container transport costs, connectivity and risks is achieved. By improving UK competitiveness, the nation’s trade imbalance will be addressed. In November 2011, this imbalance stood at -£2.6 billion between exports and imports (Office for National Statistics 2011a); however, if the focus shifts to the goods trade only (i.e. excluding services), the trade imbalance between exports and imports accounted for -£8.6 billion (ibid). By reducing the UK’s maritime transport costs and risks and improving UK connectivity, the exports will become more competitive and the imports cheaper.

### ***1.2.1 Why the UK?***

The UK was selected for this research for two reasons. First, it is a western economy, integrated into global transport systems and economies. The UK accounts for 3.8 percent of world trade (in terms of value) and 1.42 percent (in terms of dwt) (UNCTAD 2008a), with a GDP per capita (adjusted to inflation) in 2010 of £21,110 (Office for National Statistics 2011b). With a population of 62,698,362 (July 2011 est.), it is the ninth largest economy in the world in terms of GDP expressed through purchasing power parity (PPP) (CIA 2011). The UK is representative of most developed countries and it is anticipated that the result of the study could also be applied to other country contexts. The generalisation of results is something that the maritime logistics sector is familiar with. Woo et al. (2008), in a pilot study measuring port performance in South Korea, suggest that regional observations can be applied more widely as ports face similar challenges arising from the globalised logistics environment. The second reason is because the researcher is based in the UK. Thus, the collection of both primary and secondary data was easier, as most of the companies and organisations related to shipping are headquartered in the UK.

### **1.2.2 Why maritime containers?**

This research is focused on the creation of an index to measure maritime container transport costs, connectivity and risks for the UK. Such measurement will be vital for the UK, as the maritime mode in 2011 has lifted 95 percent of the UK's international trade (Department for Transport 2012c). The importance of the container sector, compared with the other maritime sectors for global trade, is highlighted by measuring the cargo carried in terms of value. Container shipping carries 52 percent of all global seaborne trade in terms of value, while in terms of volume, it has a share of 12.9 percent of the global fleet (UNCTAD 2012). The container sector is represented similarly in the UK, carrying 25 percent of the total UK seaborne trade in terms of value. In terms of volume, only 11 percent of the total UK seaborne trade is carried via containerships, as detailed in Chapter 2. Therefore, it could be concluded that the maritime container sector is important for the UK economy as it carries large portion of high value products. For this reason, the index focuses solely on that sector.

### **1.3 Use of Indices in the Maritime Sector**

Indices are used in the maritime transport sector to measure various factors covering a broad field; from freight rates (Baltic Dry Index) to heart attacks (Sudden Cardiac Arrest Index) (detailed information for both indices are quoted in Section 3.3). The maritime sector accounts for more than 80 percent of international volume trade in goods (UNCTAD 2010a). Thus, it makes sense that one of the first indicators developed for the maritime sector was an index with which to measure freight rates for the transportation of goods.

The index used widely for capturing freight rates for dry bulk carriers is the Baltic Dry Index (BDI) (Clarksons 2010b). The BDI, which has replaced the Baltic Freight Index, was first released on the 4<sup>th</sup> of January 1985 (Bloomberg 2012). The base line of the index was 1,000 points and it was constructed from four indices: Capesize, Panamax, Handysize and Supramax (Bloomberg 2012). Since 1985, various maritime indices have been developed. Unfortunately, these were not academic nor container-related, as outlined in the content analysis discussed in Section 3.4.

The first container freight rate index, which was developed on the 1<sup>st</sup> of January 1998, was the China (Export) Containerized Freight Index (CCFI) (Chineseshipping 2010b). A container-related index would have been developed earlier if the container sector had

been developed in tandem with the dry and wet sector. The delay in creating a freight index for container shipping could be explained by the fact that the first container was lifted on the 26<sup>th</sup> of April 1956 (Levinson 2006) when the dry and wet shipping sectors were already in existence. Another possible explanation could be the existence of conferences. The first conference to be abolished, following the European Union (EU) regulation, was the Asia-Europe conference on the 18<sup>th</sup> of October 2008 (Wackett 2008). In addition to the aforementioned difficulties, the study conducted by Glen and Marlow (2009) notes that reliable data are partially absent for the maritime sector. This probably led to the lack of maritime container transport indices.

#### **1.4 Research Problem**

The actions taken, which are described in the following chapters, were conducted in order to solve the following research problem: “Various indices exist in the maritime sector, but there is a possible need for a single unified index which measures costs, connectivity and risks for the maritime transport container sector”.

Finding a solution to the above research problem will benefit the dynamic maritime transport container sector, with regular fluctuations in freight rates resulting from changes in demand and supply. In addition, structural changes in the sector continue to lead to modifications to service provision.

##### ***1.4.1 Research questions***

The following research questions were developed to answer the research problem.

- 1) What relevant indices exist in the maritime transport sector?
- 2) How can a unified index of costs, connectivity and risks be structured and operationalised?

By answering the research questions, in depth knowledge was gained of the existence of relevant indices present in the maritime transport sector. Moreover, knowledge was acquired regarding the structure and operationalisation of an index. Through that knowledge, an index mapping the changes in services availability, risks and costs for the maritime container transport sector was created. Those changes can lead, in turn, to significant changes in the cost of goods: imported goods can be less expensive for consumers, and can, therefore, enhance the competitiveness of UK exporters.

### ***1.4.2 Research aims and objectives***

The research questions were addressed in line with the following aims and objectives.

- 1) To review existing indices in the maritime transport sector via both a general literature review and content analysis.
- 2) Identify factors contributing to maritime costs, connectivity and risk via literature review.
- 3) Structure and operationalise a unified index of cost, connectivity and risk, using the UK as a representative candidate country.

As this research lies in the field of maritime economics and logistics, its accomplishment provides a valid tool with which to measure the performance of the maritime container transport sector. A measurement such as the one proposed provides a valuable academic tool in the area of supply chain management, which is dominated by measurements initiated by practitioners or consultants, rather than academics (Bichou and Gray 2004).

### **1.5 Overview of the Research**

This research is designed to create an index that measures maritime transport costs, connectivity and risks for the UK. Through its design, the most advantageous techniques and methods were chosen to develop an innovative tool for use in maritime container transport sector. In conformity with the existing literature, various methods were used to develop the index. One example is the approach adopted by Yeung et al. (2009).

A mixed method approach was used for the development of the index. A review of commercial and academic literature, followed by a quantitative content analysis conducted with 10 maritime transport-related publications, delivered valuable insights into how maritime indices are both designed and structured. In addition, a review of commercial and academic literature revealed that 74 factors affect cost, connectivity and risk. Those factors were then assessed based on the perceptions of various practitioners and academics about their impact on the UK. That assessment has been conducted with the use of the Brainstorm method with a group of academics, and the Budget Allocation (BA) weighting method via 26 face-to-face interviews with industry experts conducted in Phase 1. The overall index, developed in Phase 2, was validated by a focus group of academics in Phase 3a. Thereafter, in Phase 3b, a Delphi survey was carried out to

derive a consensus amongst industry experts regarding the factors of the index, the index weights, the overall index structure and the data sources used. Additionally, in Phase 3c, a focus group with industry experts and academics was undertaken to verify the overall index. Finally, in Phase 3d, an in-depth face-to-face interview with an academic expert validated the risk sources and factors. The index developed allows various factors, such as trade imbalances, freight rates and average voyage times to be modelled and ‘weighted’.

### ***1.5.1 Structure of the thesis***

The thesis is divided into three parts that focus on existing knowledge, existing methods and the research outcomes. It is comprised of seven chapters. The first part aims to gain insights into the existing literature related to the research subject. Chapter 2 seeks to outline the boundaries of the research. In Chapter 3, an extensive literature review provides an understanding of the factors affecting costs, connectivity and risks; the review is also combined with a content analysis for the exploration of the indices existing in the maritime sector. That exploration provides information on the methodologies used to create indices. This information was used to select the best method available for the creation of the proposed index.

The second part of the thesis comprises the methodological chapter (Chapter 4), which justifies the selection of certain methods in order to extract the weights that compose the index. In other words, this chapter provides support for the third part of the thesis, which discusses the research outcomes presented in Chapter 5. These provide the opportunity to generate the index after the composition of primary and secondary data. For this research, primary data are the weights acquired from experts, while secondary data are the actual measurements of each factor as obtained from various sources. Chapters 6 and 7, respectively, discuss the outcomes of the study and present any limitations and recommendations.

### **1.6 Relevance and Contribution**

The index created will benefit the UK economy as, through the monitoring of its figures, policy makers will be able to determine whether or not the UK maritime container sector is improving. If not, policy makers could be able to find out which factor needs improvement with the help of weights.

According to economists, some of the indices found in this research are able to capture various trends. One example is the well known Purchasing Managers' Index (PMI), which provides information about the direction the economy is likely to take in the subsequent months. It is, therefore, regarded as an extremely valuable indicator of the financial markets (e.g. Wall Street) and the best indicator of factory production (Barnes 2010). One other example yielded from the maritime industry is the BDI, which is used as an indicator of where the shipping industry will be in the following months.

Consequently, it is one of the most popular and studied indices in the sector. One of the studies conducted by Contzias shipping found that similar trends exist between the EUR/USD exchange rate and the BDI for the time period 2001-2011, as presented in Figure 3-23 (N. Contzias Shipping Consultants 2011).

Trends in freight shipments are especially useful. Freight volumes often change before changes in sales and production (Notis 2010). In other words, if the proposed index could consider all of the above factors and work with a mechanism as per the freight indices, it might help the economists to predict/forecast whether economic trends will move upwards or downwards. If that is the case, then the maritime cost, connectivity and risk index will soon become a key index, because it will indicate change in trends' directions before the actual economy does.

The index will assist those involved in the maritime container transport chain to better understand the impact of changes in services, costs and risks to their operations. This will be enabled by tracking the value of the index over time, to gauge the impact of changes in connectivity, cost and risk. Thus, this tool subsequently will provide stakeholders with the necessary information to monitor the highly fluctuating costs, services and risks within the maritime container service and, henceforth, provide a more informed decision-making environment in which to operate. The index and resultant improvements will help each company participating in the maritime container transport industry, and the overall UK economy.

## **1.7 Conclusion**

This chapter provided an overview of how the thesis is structured and the main characteristics of the research. The background of the research is given, with an overview of the important indices used in the maritime transport sector. The research objectives selected for this research approach will be addressed in the corresponding



sections. The relevance and the contribution of the research end the first chapter of this thesis. The next chapter will provide a review of the research boundaries.

## **Chapter 2. The UK Maritime Transport Sector (Research Boundaries)**

*“If there were only one truth, you could not paint a hundred canvases on the same theme”.*

Pablo Picasso, painter (1881-1973)

## **2.1 Introduction**

This chapter describes the boundaries of the research. This is a significant part of the research as, in accordance with M. Saunders et al. (2009), a researcher should obtain a clear view of the subject under investigation in order to effectively plan and conduct the research. This view will be provided through definitions of the UK maritime sector, the UK maritime freight cargo, the UK container sector and the geographic boundaries of the research. The definitions of cost, connectivity and risk for the UK maritime transport sector will also be discussed in this chapter to provide an understanding of the choices made in subsequent chapters.

## **2.2 Globalisation and the UK**

International freight has an impact on trade. Globalisation is based on low freight rates, so any improvements in international transport services are one of the main features of economic globalisation (ECLAC 2002). Globalisation can be expressed by the geographical dispersion of production and heavy reliance on trade between manufacturers and end-customers (OECD/ITF 2009). The value of world trade has experienced a 20-fold increase since 1950, while the share of manufactured products being traded worldwide has increased from 40 percent to over 70 percent (in particular, after 1985). As demonstrated by these figures, such a massive increase in world trade would never have occurred without the development of high performance transport services. Container shipping has changed the way goods are transported around the world (Notteboom 2006). Containerisation has provided the mechanism to enable international markets to expand without losing any of their quality characteristics of distribution and without having much higher freight costs (Notteboom 2006). Containerisation has made the shipping of goods inexpensive and, through this improvement, the shape of the world economy has altered (Levinson 2006). Containerisation has been responsible for integration within the transport chain (Brooks 2000).

The maritime transport sector is one of the most globalised and complicated sectors. As Kumar and Hoffmann (2002 p.36) state: “A Greek owned vessel, built in Korea, may be chartered to a Danish operator, who employs Philippine seafarers via a Cypriot crewing agent, is registered in Panama, insured in the UK, and transports German made cargo in the name of a Swiss freight forwarder from a Dutch port to Argentina, through terminals that are concessioned to port operators from Hong Kong and Australia”. The UK is a

western economy that is integrated into the global systems and economies. The UK accounts for 3.8 percent of world trade in terms of value and 1.42 percent in terms of dwt (UNCTAD 2008a), with a GDP per capita (adjusted to inflation) for 2010 of £21,110 (Office for National Statistics 2011b) [The UK GDP excludes the Channel Islands and the Isle of Man (Office for National Statistics 2011c)]. With a population of 62,698,362 (July 2011, estimate), it is the ninth largest economy in the world in terms of GDP expressed as PPP (CIA 2011).

### **2.3 Containerised Trade and the UK**

The UK economy has a negative total trade imbalance between exports and imports. For example, in 2012, this imbalance stood at -£36.2 billion (Office for National Statistics 2013a). However, if the focus shifts to the goods trade, the trade imbalance between exports and imports for the same period was -£106.3 billion (ibid). As illustrated in Figure 2-1, in the last three years, the trade in goods value for the UK has decreased constantly with the latest figure in Q4 2012 at -£27.13 billion. As the trade in services value has remained stable for the last three years, the goods trade becomes particularly important; from Q3 2009, the figure of -£19.59 billion has now been reduced to -£27.13 billion. This means that the total trade imbalance has increased even further over the last three years.

Trade imbalance could be reduced if the cost applied to the transportation of goods could also be reduced. This could be achieved through the proposed index. With transport costs reduced, the UK economy would benefit in two ways: first, by reducing the trade imbalance as imports will be cheaper and second, by achieving more competitive exports through the reduced transport costs achieved. Of course as reduced cost of imports is achieved, that would equate to greater imports and thus the trade imbalance could finally increase regardless of the gains from the lower transport costs. But, as found by Baier and Bergstrand (2001), the trade growth would only be marginally affected (eight percent) from transport cost reductions, while it could be affected by 67 percent by the income growth of a country and 23 percent by tariff rate reductions. As shown in Figure 2-1, the UK income since Q3 2010 has remained stable with a prediction from the IMF (on April 2013) that the UK economy will grow by 0.7 percent, instead of 1 percent; as forecasted in January 2013 (Flanders 2013). Additionally, UK tariffs (imports and exports) remained flat over the last five years as suggested by The World Bank (The World Bank 2007; The World Bank 2008; The

World Bank 2009; The World Bank 2010; The World Bank 2012). Thus, the determinant which could affect the trade growth for the UK is the reduction of transport costs. But since the reduction of transport costs only has a small effect on trade growth, the current economic environment the UK economy could therefore benefit from the transport costs reduction and the total trade imbalance could be reduced.

Consequently, a measurement in place to the imbalance in goods trade, such as the proposed index, could mend the total UK trade imbalance.

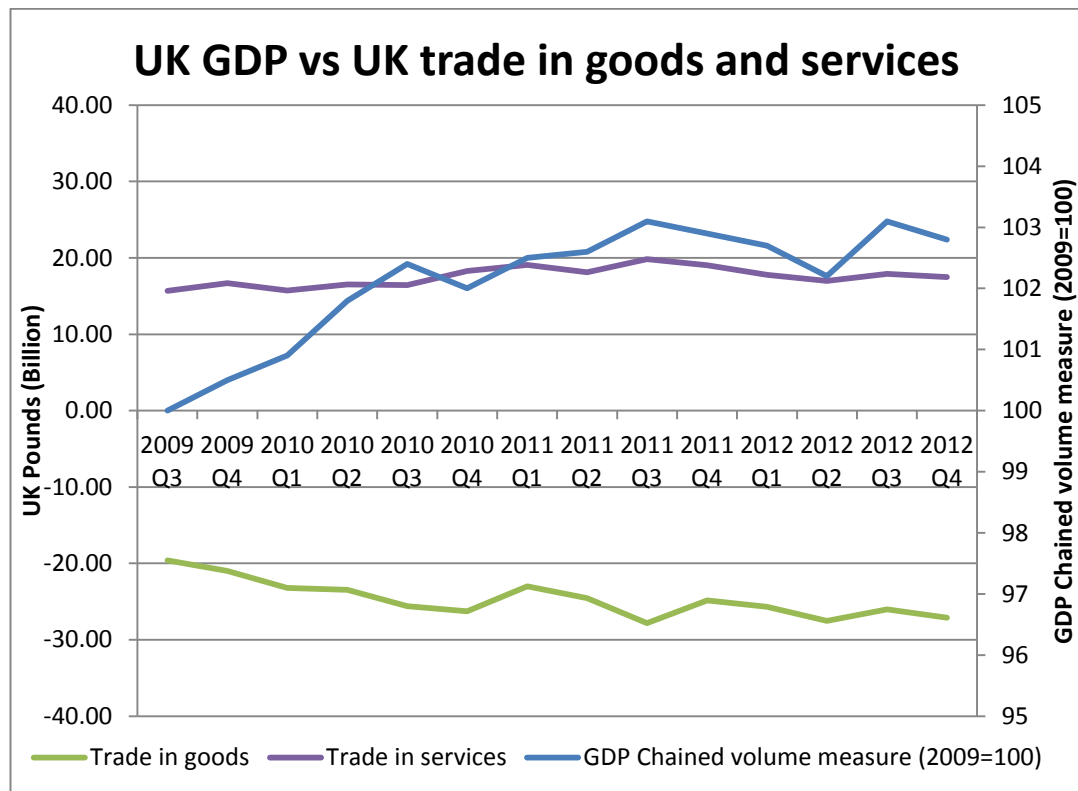


Figure 2-1 UK GDP chained volume measure (2009=100) (right axis) against trade in goods and services balance (£ billion) (Q3 09 - Q4 12) (left axis)

Source: Author, based on data from Office for National Statistics (2012); (2013c) and (2013b)

The UK is an island nation, and most of its international trade, in terms of volume, is transported via sea. In 2011, 95 percent of the UK international trade freight tonnage was lifted by sea (Department for Transport 2012c). This figure has remained stable since 2009, when only four percent was lifted by the Channel Tunnel and less than one percent by air (Department for Transport 2010). In 2009, the total value of the seaborne trade for the UK was USD 840 billion (HM Revenue & Customs 2012), while the value of seaborne containerised trade was USD 196 billion (World Shipping Council 2012).

Therefore, almost 25 percent of the products, in terms of value, entering and exiting the UK via maritime transport mode are transferred by containerships. During the same period, the maritime container transport mode lifted 11 percent (in terms of volume) of the total seaborne UK traffic (Department for Transport 2009). It can be concluded from these figures that seaborne containerised trade is important for the UK economy as it carries relatively high value cargo in large volumes. Of course, cargo carried within the air transport sector is usually more valuable than that carried by the seaborne container sector. However, the volumes carried by air are significantly smaller than those carried by the maritime container transport sector for the UK. In conclusion, if cost factors could be measured and better managed, as well as the related factors of connectivity and risks, the competitiveness of the UK economy could be improved through cheaper import costs and competitive exports, due to lower maritime container transport costs. The proposed index will help to achieve this.

“Transport costs are key determinants of a country’s trade competitiveness. Excessive shipping costs are considered a major barrier to trade, often surpassing the cost of duties” (UNCTAD 2011 p.64). The growth of economic development relies on shipping as international trade, and related business depends on efficient and available shipping services (Lun et al. 2010). As Lun et al. (2010 p.4) state: “Sea transport and economic development always go hand in hand with each other”.

In order to measure the impact that changes in containerisation can have on the UK economy, this index was created based on cost, connectivity and risk. An index will provide a valuable tool to assist in improving the UK economy; for instance, if the costs of imports decline, then the costs of products (in the UK) will also fall. Correspondingly, if the costs of seaborne containerised exports from the UK decline, then UK products will become more competitive (cheaper) in the global market.

Creating an index that can track separately imports and exports could be of great interest, as it has been observed in some reports that, historically, the cost of imports for the UK is higher than the cost of exports from the UK (The World Bank 2012b). But, as this index is intended to be something unique and new, the first step for the researcher was to create an index that could capture the cost, connectivity and risk for the overall UK trade. Another reason for not segmenting the index into imports and exports is that the ‘gap’ between those two categories has been reduced over the years (The World Bank 2012b).

The abovementioned scenarios can reinforce the UK economy, especially if only containerised trade is considered by this research. So, in order to accomplish the above aim (improvement of the UK economy), it is essential to focus solely on the container sector, rather than the entire maritime transport sector. This is because containerships carry high-value products in comparison with dry bulk or tanker carriers, which carry large volumes with low unit values. A comparison conducted by the UNCTAD (2012) demonstrates that if the seaborne trade (in monetary terms) between containerships and dry bulk carriers is compared, it could be concluded that each tonne of a containership deals with 27 times more trade than each tonne of a dry bulk carrier. The importance of the containership trade will be explained in more detail in Section 2.6. Another reason for the selection of the container sector for this research is the standardised nature of containers, which are a unit of cargo. This is a key point of efficiency as this characteristic cannot be observed in the bulk or wet (tanker) sectors; for example, where measurement and comparison of various bulk cargoes is difficult, as various products with differing values exist (M. Pellew 2011, pers. comm., 15 July).

An argument against the previous statements is that the proposed index also needs to measure the factors relating to connectivity and risk, when only the cost of moving goods could achieve a match with the UK economy. The answer regarding connectivity comes from Cullinane and Wang (2009), who have discussed that shippers and carriers are no longer loyal to specific ports. This has resulted from the continued growth of containerisation and the globalisation of production and consumption (Cullinane and Wang 2009). In other words, all carriers and shippers search for cost-effective ports, which leads to an imbalance of international port charges. Some ports can take advantage of economies of scale, while others are affected negatively by the cost-price squeeze.

Risk is one of the factors that could have a significant effect on the shipping industry. As Stopford (2009) demonstrates, factors such as economic conditions, trade growth and so forth can be modelled and extrapolated. However, unexpected factors, such as the closure of the Suez Canal, port congestion and strikes could trigger booms and slumps in shipping cycles. By reducing risk, maritime transport companies will face fewer losses but, simultaneously, they will have reduced the potential for large and rapid gains, as noted between 2002 and 2007. In time, the shipping industry will benefit from the stable and slow increase of its profits and, through these, the sector will

prosper. This trend will be also be boosted by the anticipation of the uncontrollable factors and by giving various options; those factors should not be as crucial for the industry as they are today.

Of course, at the same time, factors related to cost, connectivity and risk can provide a quantifiable link to the cost of moving containers within the economy. Therefore, this research effort is attempting to identify and map the factors affecting the cost, connectivity and risk to the UK maritime transport sector by creating a specific index to consider those three factors as variables. This research belongs to the profound topic of maritime supply chains, which is a relatively new area of research (J. S. L. Lam 2011).

#### **2.4 The UK Maritime Sector**

The maritime sector, as stated by Sea Vision UK (2011), comprises the following subsectors: 1) oil and gas; 2) shipping services; 3) shipbuilding; 4) maritime services; 5) ports; 6) defence/naval; 7) leisure marine; 8) renewable energy; 9) telecommunications; 10) research and development; 11) new technologies; 12) education and training; 13) ocean survey; 14) safety and salvage; 15) minerals and aggregates; and 16) fisheries.

This research focuses mostly on the shipping services sub-sector, as is illustrated in Figure 2-2. The definition of shipping services, in accordance with Sea Vision UK (2011), is “Shipping services utilised in the carriage of goods and passengers and the chartering of vessels”.

It is often considered that the the term ‘shipping services’ and its definition are ‘old fashioned’. Recent literature favours the term ‘maritime transport’, especially when referring to the costs of maritime transport (e.g. Wilmsmeier and Martinez-Zarzoso 2010). The term ‘maritime transport’ has been defined by the Global Facilitation Partnership for Transportation and Trade. The definition is similar to that provided by Sea Vision UK for the shipping services: “Maritime transport is the shipment of goods (cargo) and people by sea and other waterways” (GFPTT 2011). This research effort will adopt the term ‘maritime transport’ as it is most recently used in the literature.



# UK Maritime Sector

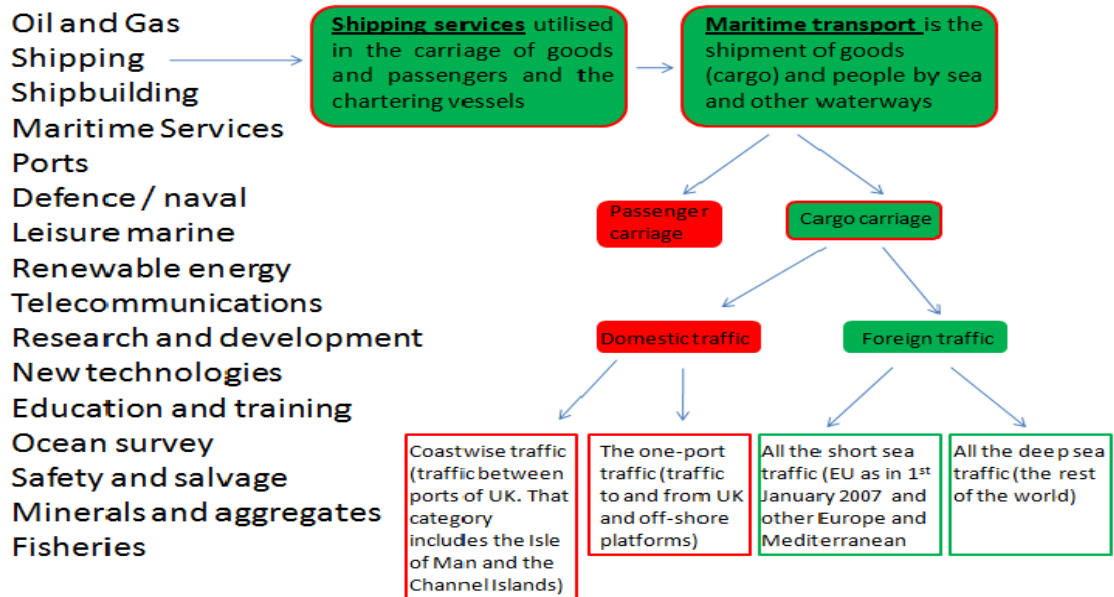


Figure 2-2 Divisions of UK maritime sector and shipping services definitions

Source: Adopted from Department for Transport (2011a); GFPTT (2011); Sea Vision UK (2011)

Maritime transport can be divided into two categories according to what a vessel carries. The first is the carriage of passengers and the second is the carriage of cargo. The cargo carriage category, which is of interest to this particular research, can be split into two subcategories in conformity to the geographical classification of the cargo traffic (Department for Transport 2011a). These classifications seek to categorise the cargo (goods) according to its last loading or next unloading at the end of the sea journey. The two traffic categories are domestic traffic and foreign traffic. Foreign freight consists of: 1) all the short-sea traffic (EU as in 1st January 2007 and other Europe and Mediterranean); and 2) all the deep-sea traffic (the rest of the world). Domestic traffic has two categories: 1) coastwise traffic (traffic between UK ports, including the Isle of Man and the Channel Islands); and 2) one-port traffic (traffic to and from UK ports and off-shore platforms). The Department for Transport counts the coastwise traffic twice; at the port of loading and at the port of unloading (Department for Transport 2011a). This research focuses on freight movements between the UK and China (as explained in Section 2.9); which occur once. Therefore, domestic traffic, including the Isle of Man and Channel Islands, has been excluded from this research. Thus, the UK, as stated by the Department for Transport (2011a), from which the researcher has extracted statistical data for this research project, is defined as Great Britain and Northern Ireland.

The Department for Transport includes all the non-freight-carrying units and commodities, such as passenger vehicles and trade motor vehicles (Department for Transport 2011a). The focus of this research and its definition for the shipping sector are provided in Figure 2-2.

Some additional definitions from the Department for Transport (2010) relevant to this research are:

- Ports that are classified as major ports are those which handle at least 1 million tonnes annually.
- All weights are expressed in metric tonnes (mt), including crates and other packaging. The tare weights of containers, road goods vehicles, trailers and other items of transport equipment (i.e. the unloaded weight of the vehicle or the equipment itself) are excluded.
- The vessels recorded by the Department for Transport are all the sea-going vessels of 100 GT (gross tonnes) and over. For this research, the data on vessels captured will be only for containerships of 100 GT and over.

As illustrated in Figure 2-3, shipping is a crucial part of the UK economy because it is the main transportation mode, in terms of volume, of UK imports and exports. It is also important from the perspective of the overall national economy. UK shipping is one of the mainstays of the national economy, as it is the 4<sup>th</sup> largest services earner (Chamber of Shipping 2011a). For example, shipping's turnover was still over £11 billion for 2010, in spite of it being the worst maritime recession in living memory. Its direct contribution to UK GDP remain above £6 billion (Chamber of Shipping 2011b).

The UK's seaborne trade has started to recover after the deep fall that occurred in 2009, as shown in Figure 2-4, which demonstrates the UK port traffic from 1981 to 2011. UK seaborne imports have displayed an increasing trend since 1981, while UK seaborne exports are stable. In 2009, the UK held 15.5 percent of the world's seaborne trade (in volume) (Clarksons 2011; Department for Transport 2011a). UK seaborne trade seems to have a high interaction with the UK real GDP, compared with the world seaborne trade, which has a looser interaction with the world real GDP. This can be understood from the impact that the economic crisis of 2008 had on seaborne trade (as illustrated in Figure 2-5 and Figure 2-6). That high interaction that the real GDP has with the seaborne trade for the UK can be explained by the fact that the UK is an island complex

and, thus, sea is the main method by which to transfer goods in and out of the UK. The container shipping industry demonstrated a fast recovery from the global downturn in 2008-09, which the IMF named the ‘Great Trade Collapse’. That downturn had an estimated overall cost of USD 19.5 billion on the maritime transport sector due to the severe slowdown in seaborne trade (Hellenic Shipping News Worldwide 2011a).

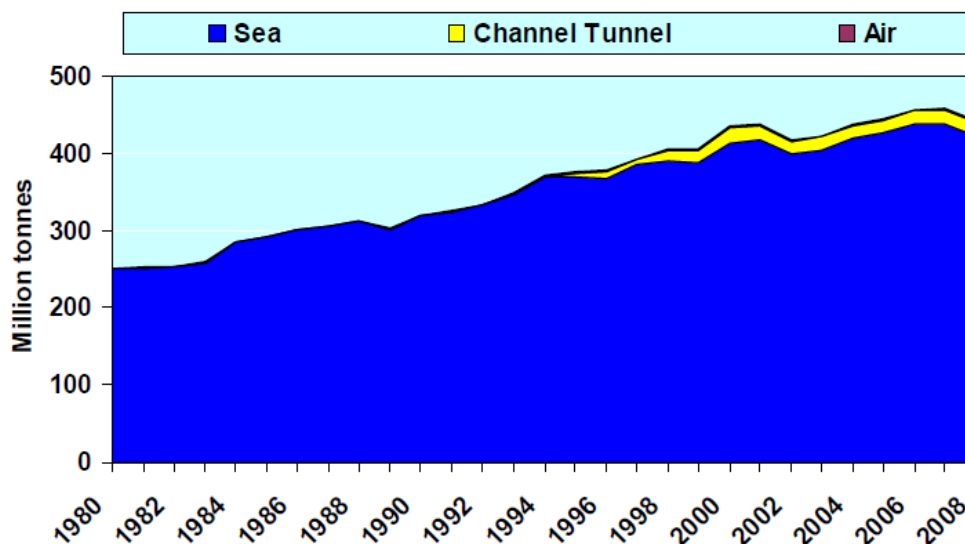


Figure 2-3 UK international freight lifted; 1980-2008 (million tonnes)

Source: Department for Transport (2010)

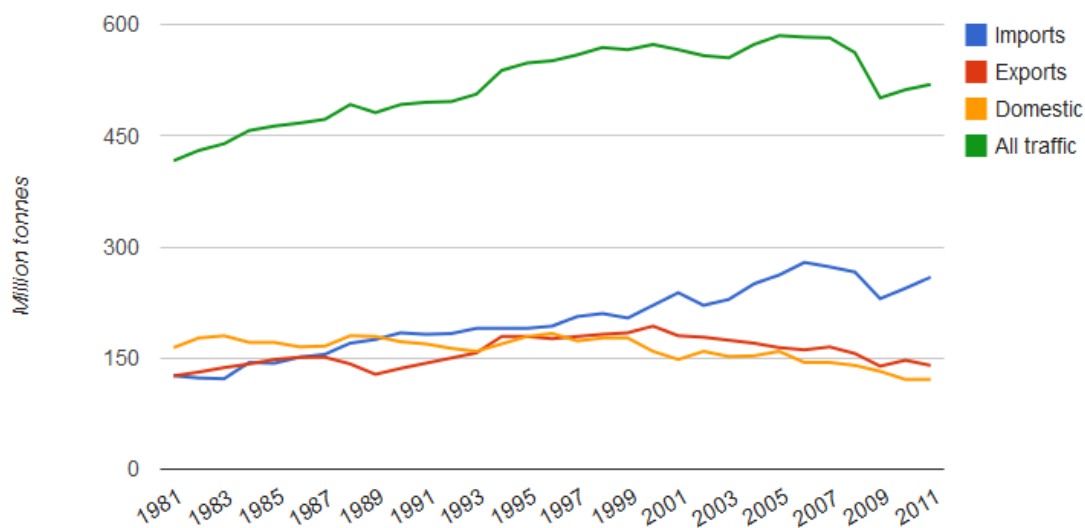


Figure 2-4 UK port freight traffic, imports, exports and domestic; 1981-2011 (million tonnes)

Source: Department for Transport (2012a)

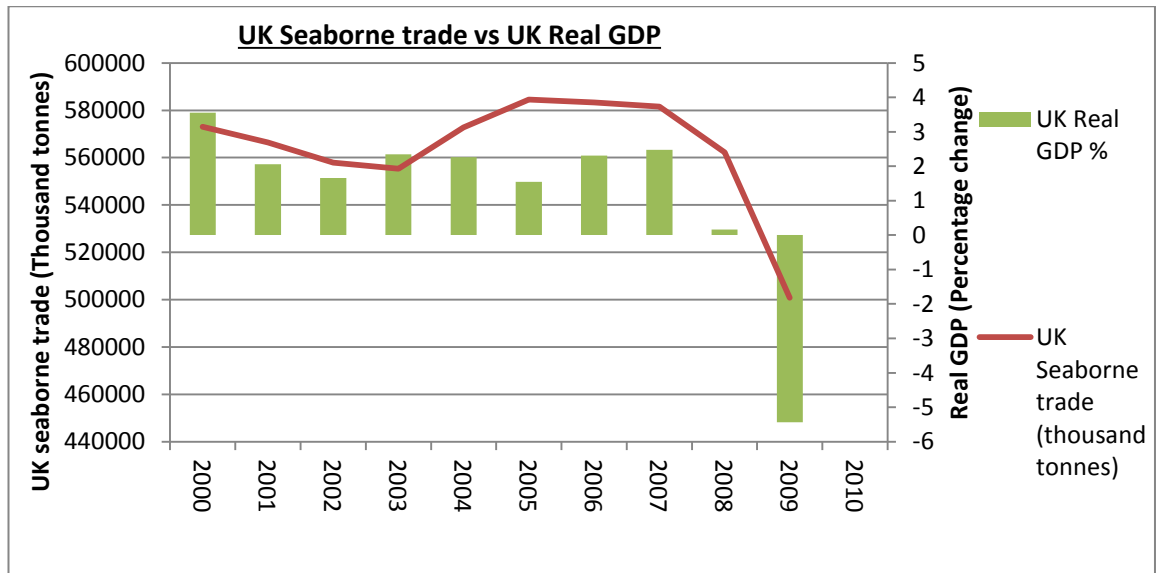


Figure 2-5 UK seaborne trade (in thousand tonnes) against UK real GDP

Source: Author, based on data from Department for Transport (2011a); UNCTADstat (2011a)

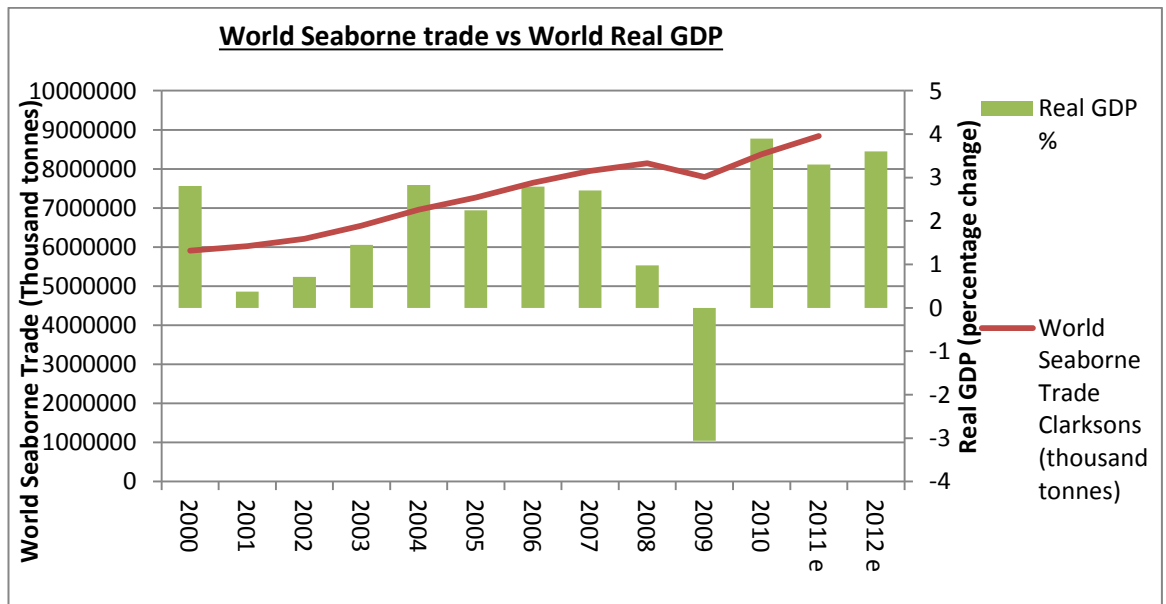


Figure 2-6 World seaborne trade (in thousand tonnes) against world real GDP

Source: Author, based on data from Clarksons (2011); The World Bank (2011); UNCTADstat (2011a)

From the data displayed in Figure 2-3 to Figure 2-6, it is clear that an improvement in maritime transport costs, connectivity and risk for the UK is important. If this can be achieved, the UK seaborne trade will prosper and flourish and, consequently, the real GDP could prosper as well. Real GDP can benefit from an increase in seaborne trade, because an increased trade volume leads to economies of scale, which, in turn, lead to

lower freight rates (Wilmsmeier et al. 2006). Thus, lower freight rates in a globalised economy, in a country which has a deficit trade balance as the UK does, leads potentially to an increase in GDP.

## 2.5 The UK's Maritime Transport Sector (Freight Cargo)

The maritime transport sector servicing the UK can be divided into four categories: liner, dry bulk, liquid bulk and specialised (Stopford 2009). The liner shipping sector can be divided into Lo/Lo (load on-load off) vessels and Ro/Ro (roll on-roll off) vessels. Containers can be described as the units (metallic boxes) carried by Lo/Lo vessels, while ship-borne port-to-port trailers and barges or rail wagons are described as the units (metallic boxes) carried by Ro/Ro vessels (Department for Transport 2009). This research focuses purely on the container sector. From 2000 to 2005, port-to-port trailers were considered incorrectly as Lo/Lo containers (Department for Transport 2009). Thus, if containerised data prior to 2005 is required, adjusted data will be used.

In conformity with the Department for Transport (2012a), for 2011 the 11.4 percent of the total inward and outward traffic was carried in containerised form via Lo/Lo vessels. Figure 2-7 illustrates the major UK port traffic in volume for combined inward and outward cargo; displayed according to cargo category for 2011.

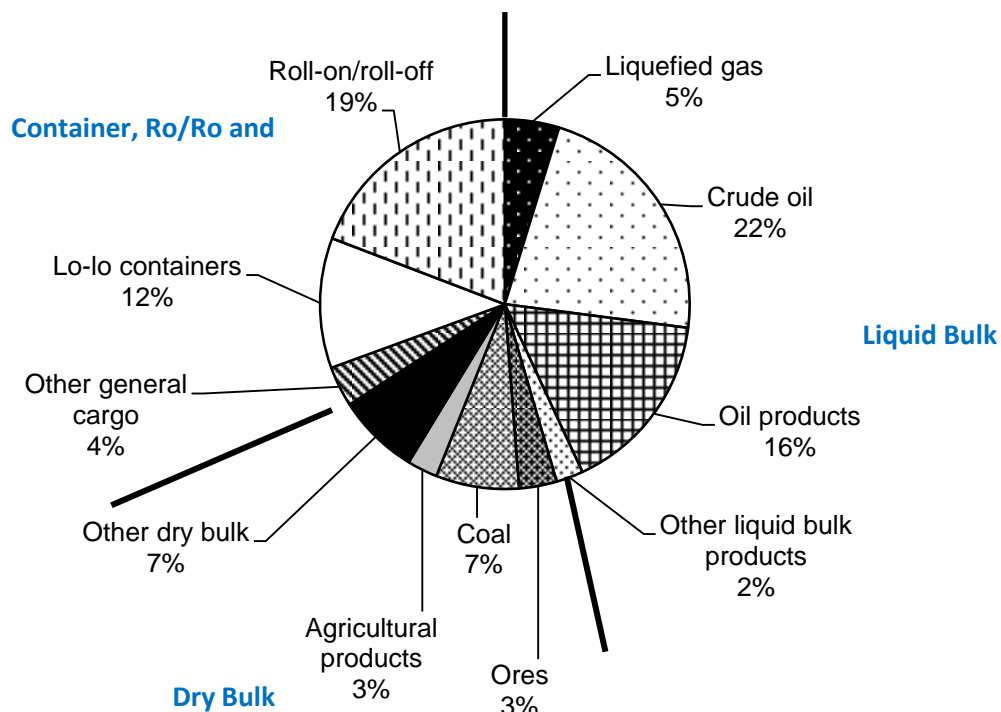


Figure 2-7 UK major port traffic, by cargo category; 2011 (gross weight)

Source: Department for Transport (2012a)

Figure 2-8 provides evidence of how the total volume of various types of cargo has changed between 1995 and 2011, while Figure 2-9 illustrates how the corresponding percentages of the total volume of various types of cargo have altered from 1995 to 2011. Liquid bulk (which is the major commodity carried through ports in the UK), along with total traffic, has declined over the years in terms of volume, while containerised traffic seems to have held steady from 1995 onwards. In other words, the percentage of container traffic has increased over the years, but not in volume or tonnes, as demonstrated in Figure 2-8 and Figure 2-9. The type of containerised loaded traffic entering and exiting the UK between 2005 and 2011 is described in Figure 2-10, in which the importance of the 40-foot and 20-foot containers against the other available container types is shown clearly.

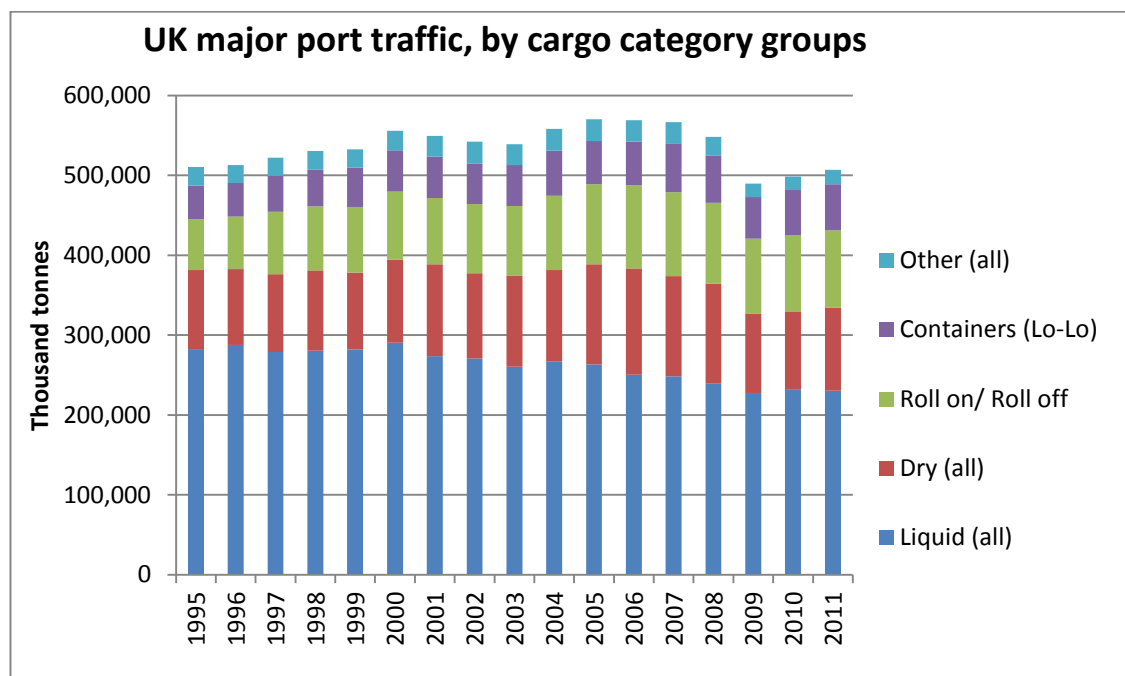


Figure 2-8 UK major port traffic, by cargo category groups; 1995-2011 (million tonnes)

Source: Department for Transport (2001; 2009; 2012a)

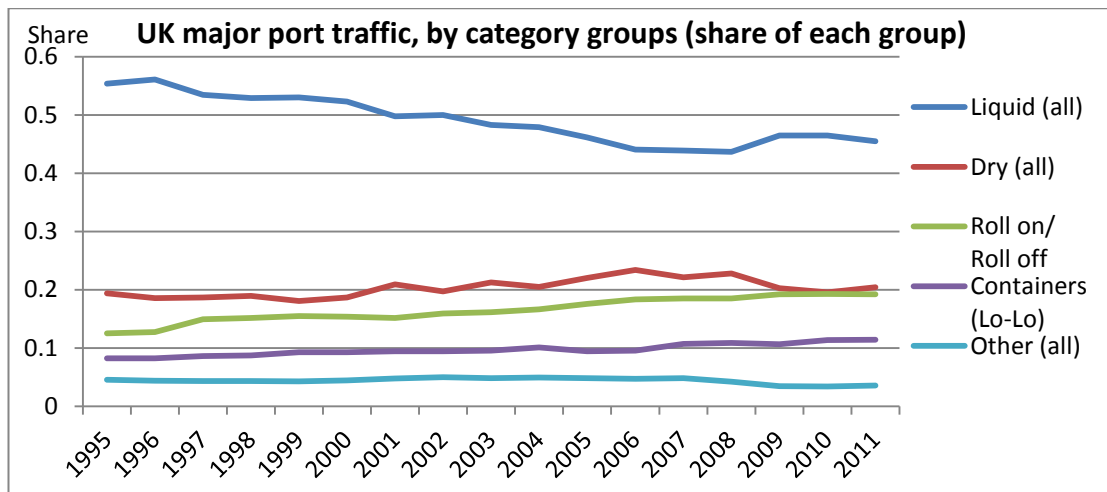


Figure 2-9 UK major port traffic, by cargo category groups; 1995-2011 (share of every category compared with the total traffic, in volume)

Source: Department for Transport (2001; 2009; 2012a)

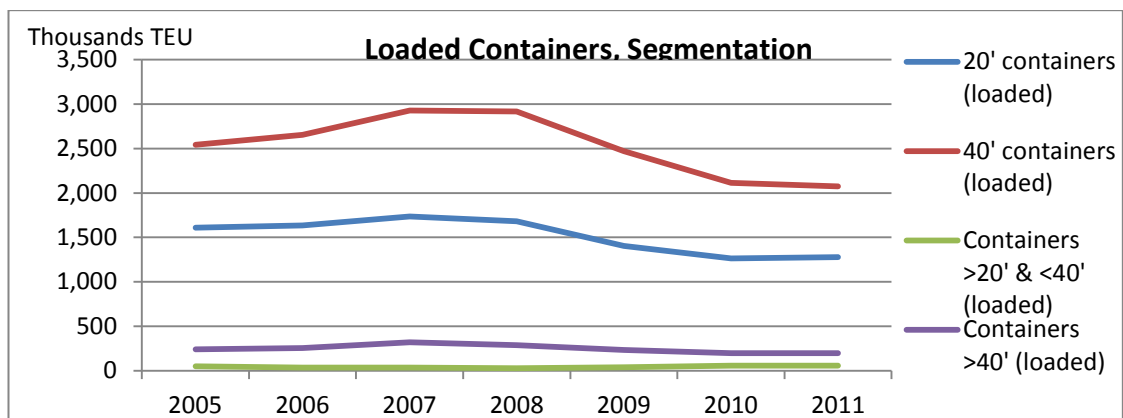


Figure 2-10 Full containers segmentation; 2005-2011 (thousand units; TEU)

Source: Department for Transport (2009; 2012a)

## 2.6 The UK Container Sector

The importance of the container sector in the UK has been discussed in Sections 2.3 and 2.5 with the use of traffic data from the Department for Transport. That importance is not demonstrated clearly by the data published by the Department for Transport, as it measures only freight volumes. Thus, many organisations, for example the UNCTAD, raise the importance of the container sector by measuring it in terms of value. As UNCTAD mentions, a containership carry 27 times more seaborne trade (in monetary terms) than a dry bulk carrier, if the ratio deadweight tonnage and value of cargo carried is compared (UNCTAD 2012). In 2010, the global value of seaborne trade was USD 9 trillion, from which the container trade comprised 60 percent (USD 5.6 trillion).

Moreover, the container trade consists of 37 percent of the monetary value of all global

trade (USD 15 trillion) (Lawrence et al. 2012). For the UK, as described in Section 2.3, 25 percent of the products (in terms of value) entering and exiting the UK by maritime transport methods are transferred by containerships. Although that figure demonstrates that the value of the UK containers is nearly half in comparison with the figure of the global value, it still illustrates the importance of the maritime container sector for the UK.

A rough calculation of the average value of contents of the global seaborne container equals USD 42,000 per TEU (Twenty-foot Equivalent Unit), as the global seaborne container trade is USD 5.6 trillion and the global seaborne container traffic is 140 million containers (Lawrence et al. 2012). Typically, a container could be shipped from the Far East to Europe for USD 1,000, which means that the freight rate equates to 2.38 percent of the value of the contents. This percentage is low, but it could be reduced further as some commodities that are transported by seaborne modes can reduce their shipping costs in comparison with the value of the product to within the range of two percent (Lawrence et al. 2012).

In the case of the UK, where the average value of a seaborne TEU is USD 29,329 [determined as UK seaborne TEU trade was USD 196 billion and the UK container port traffic was 6,706,854 TEU in 2009 (The World Bank 2012a)] and with a freight rate equal to the one described above (USD 1,000), this constitutes a larger percentage of the value of the contents, which was 3.4 percent in 2009. This means that, for the UK in particular, an index that would be able to monitor cost, connectivity and risk could achieve significant improvements.

It is worth highlighting the importance of the port of Felixstowe for the UK container sector. This port has the largest volume of container traffic in the UK. Through Felixstowe, 42.07 percent of the total UK Lo/Lo container traffic is distributed. Additionally, the Lo/Lo container transport sector comprises 92.01 percent of this port's traffic (Department for Transport 2011b). Most of its remaining traffic is Ro/Ro, which has similar characteristics in terms of volume per value. For that reason, where the absence of holistically UK data was observed, data solely from the port of Felixstowe was entered in the index as a good proxy for the UK.



## 2.7 Geographical Boundaries of the Research

As discussed in Section 2.4, the data used in this research from the Department for Transportation captures domestic traffic twice. That characteristic could potentially cause problems in this research and, consequently, domestic transport was excluded. The exclusion of the domestic data, which also excluded the Isle of Man and the Channel Islands, is to be noted. Politically, and for the purpose of this research, the UK is defined as Great Britain and Northern Ireland.

The exploratory variables that have been used in other research efforts to address transport costs and connectivity have used gravity models in order to study the following variables: 1) income of the country of origin and destination; 2) population of both countries; and 3) geographical distance between both points (Martinez-Zarzoso and Nowak-Lehman 2003). Frankel et al. (1995) also add the variable of trading countries sharing a common language. Therefore, to find a cost and connectivity for the maritime transport sector, it is necessary to have at least one homogenous country, such as the UK, from which the research can obtain data and compare like-for-like data from other countries. The question arising from this reasoning is: “Why should this research project focus only on the UK?” The answer is a result of the exploratory variables mentioned above by Frankel et al. (1995) and Martinez-Zarzoso and Nowak-Lehman (2003). The UK was selected for three reasons. First, because the researcher aims to contribute value to the UK economy; second, because the researcher is based in the UK, whereby it was easier to collect not only primary, but also the secondary data (most of the companies and organisations relating to shipping have their headquarters in the UK) needed for his research. However, this decision does not explicitly make its results applicable only to the UK. As Woo et al. (2008) suggest through a pilot study conducted for measuring port performance in South Korea, regional observations can be applied more widely due to fact that ports face similar challenges within the globalised logistics environment. So, as this research applies to container transportation, which is the fuel of the globalisation, the results found for the UK can be applied on a global scale. Finally, as the UK is a representative western country, according to the data described in Sections 2.2 and 2.3 and as the data can be generalised in accordance with Woo et al. (2008), it fulfilled the characteristics to become a ‘model’ country for a new measurement as the index developed.

## 2.8 Maritime Transport Sector Costs, with Focus on the UK

As many studies have shown, transport costs influence the volume, structure and patterns of trade, in addition to their relative advantage to a country (Hummels 1999b; Hummels 1999a; Limao and Venables 2001; Kumar and Hoffmann 2002; Hummels 2007). Increasing the transport cost of a country can slow the growth of its annual GDP (UNCTAD 2011); therefore, transport costs could be more important for countries that have a negative balance of trade in goods, as is the case with most western economies (UNCTAD 2011) such as the UK. Therefore, as maritime transport costs are an important determinant for the UK, a detailed analysis and explanation of the costs captured from this research is now provided.

Transport costs are the main elements of final 'trade costs' (Wilmsmeier and Hoffmann 2008). Trade costs have been defined broadly by Anderson and Van Wincoop (2004 p.691) as "all the costs incurred in order to get goods from producer to final user, other than the marginal cost of producing the good itself", while Rodrigue et al. (2009 p.97) define transport costs as "The monetary measure of what the transport provider must pay to produce transportation services and comes as fixed (infrastructure) and variable (operating). They depend on a variety of conditions related to geography, infrastructure, administrative barriers, energy, and on how passengers and freight are carried. Three major components, related to transactions, shipments and the friction of distance, impact on transport costs". Trade costs, as stated by Anderson and Van Wincoop (2004), are considered: 1) the transportation costs (both freight costs and time costs); 2) policy barriers (tariffs and nontariff barriers); 3) information costs; 4) contract enforcement costs; 5) costs associated with the use of different currencies; 6) legal and regulatory costs; and 7) local distribution costs (wholesale and retail). Trade costs are reported in terms of their *ad-valorem* tax equivalent (Anderson and Van Wincoop 2004). To summarise, Anderson and Van Wincoop (2004) emphasise the need for the establishment of better transport costs measures. These measures have to be used in order to expand the gravity models<sup>1</sup> and treat the endogeneity of the transport costs variable in this kind of equation.

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<sup>1</sup>Gravity model: It is called a gravity model because it has a similar formulation with the model which Newton developed for the gravity. The gravity model is the most common formulation of the spatial interaction method. The gravity model calculates the attraction between two objects and it is calculated proportionally to their mass and inversely proportional to their respective distance apart (Rodrigue et al. 2009). The type of the elementary formulation of the gravity model is the following:

Maritime transport costs are part of international transport costs, of which their determinants gain attraction as a topic in recent literature. Such an interest arises from the will to capture any existing opportunities for transaction cost reduction, which can occur from the better explanation of economic developments and international trade patterns (Wilmsmeier and Hoffmann 2008). A good start for the transaction costs reduction is the study of the maritime sector, as 77 percent (or 7,843 millions of tonnes) in 2009 of world merchandise trade was carried by sea, according to UNCTAD (2010a). Ships and ports are important points in global shipping networks. The negative impact of maritime transport costs on trade flow has been underestimated traditionally in the economic literature. However, Marquez-Ramos et al. (2005) proved that lower freight rates foster international trade and that maritime transport costs have a negative impact on trade flows. This negative impact is higher when the transport costs are considered an endogenous variable (Marquez-Ramos et al. 2005). Jonkeren et al. (2011) highlight that transport costs may be endogenous for various reasons; for example, “the unit shipping costs decrease with the volume of trade due to the presence of density economies” (Jonkeren et al. 2011 p.510). Jonkeren et al. (2011) also questioned previous studies by X. Clark et al. (2004), Marquez-Ramos et al. (2005), Wilmsmeier et al. (2006), Blonigen and W. W. Wilson (2008), because they considered the trade imbalance to be exogenous.

The physical cost of a shipment is just one part of the total trade costs, which are the total sum of costs to transfer a good from the producer to the final customer (Duranton and Storper 2008). Transport costs are the most important cost of trade within countries [Limao and Venables (2001); Sanchez et al. (2003)], and are considered effectively as artificial trade barriers, which are reduced to low levels as a result of increased trade liberalisation.

Hummels (1999a) suggests that, to some extent, import choices are made so that transportation costs can be minimised. As a consequence, many scientific articles use the data of importing goods to measure the transport costs and, by extension, the

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$$GF_{ij} = \frac{M_i * M_j}{D_{ij}} \quad i \neq j$$

The gravitational force ( $GF_{ij}$ ) between two objects  $i$  and  $j$  is equal to the direct proportional of the masses of the objects  $M_i$  and  $M_j$  and indirectly proportional to the distance between them  $D_{ij}$ . The gravity model is estimated in terms of natural logarithms. So the previous formulation of the gravity model is transformed to the following:

$$\ln GF_{ij} = \ln M_i + \ln M_j - \ln D_{ij} \quad i \neq j$$

The gravity model is the simplest model which expresses bilateral trade between countries  $i$  and  $j$  as a function of economic mass and which is inversely related to the transport route distance between them.

maritime transport costs (Sanchez et al. 2003; X. Clark et al. 2004; Wilmsmeier et al. 2006). To calculate the costs of the UK shipping sector, this research will adopt the definition of ‘import charges’ for the USA in order to express the needs of the research focusing on the UK. Using this definition, the researcher attempts to clarify the distinct areas of costs between a port-to-port transportation for cargo, which this research measures. The definition of ‘import charges’ provided by the USA Census is: “...the aggregate cost of all freight, insurance, and other charges (excluding USA import duties) incurred in bringing the merchandise from alongside the carrier at the port of exportation- in the country of exportation- and placing it alongside the carrier at the first port of entry in the US” (USA Census Bureau 2011). As it can be realised from this definition, import charges lie in the following three components: 1) costs associated with loading the freight and disembarking from the foreign port (cost of the foreign port); 2) costs connected with transportation between ports (cost of ocean freight); and 3) costs associated with USA port arrival (in this case, the UK port arrival) and unloading of the freight (in this case, the efficiency of the UK ports is high correlated with those costs). Thus, the shipping charges relevant to this research will measure and summate the costs related to: 1) the cost of ocean freight; and 2) the costs of discharging the cargo at the UK ports. Research that has measured shipping costs in line with the same philosophy is found in the study conducted by Blonigen and W. W. Wilson (2008). However, this research will not include the costs of loading at the foreign port, as it is focused only on the UK. Including costs at a foreign port could adversely affect the index, even if the other two cost segments (cost of shipment and cost of the cargo discharge at the UK ports) remain stable.

General port infrastructure has an impact on overall trade costs; however this research focuses on port-to-port measurements. The general transport infrastructure will be not considered in this research project, as Wilmsmeier et al. (2006) suggested that general transport infrastructure has no effect on the international maritime portion of trade costs.

## **2.9 Maritime Transport Sector Connectivity, with Focus on the UK**

The word ‘connectivity’ is defined by the Oxford dictionaries (2011) as: “The state of being connected or interconnected”. Connectivity is a relatively new construct in logistics and supply chain management (SCM) theory. Hoffman and Hellstrom (2008) have discussed the proposition that there is a need for further research on the topic and the creation of a widespread agreement of its definition. A good starting point could be

the development of a general definition of connectivity as improving communication between researchers and practitioners in logistics and SCM. Hoffman and Hellstrom (2008) also highlight the need for other future research at the level where any enabling factors can affect connectivity.

Rietveld (1995; 1997) attempted to define and measure the terms ‘connectivity’ and ‘interconnectivity’ as follows: “Connectivity is the existence of a connection between two points in a network” (Rietveld 1997 p.177). From this definition, the word ‘connection’ can be explained as links which are direct or indirect. Rietveld (1995 p.19) also defines the term ‘interconnectivity’ “as an attribute of networks and refers to the quality and costs to move persons and freight from an origin to a destination, by using various modes and nodes at a certain moment in time”. This research effort has focused only on port-to-port movements of freight; therefore, the above suggested definition of interconnectivity is rejected in favour of the term ‘connectivity’. An example of the use of the term ‘interconnectivity’ is evident in the research conducted by Notteboom (2008), in which he uses the term to describe the sailing frequency from a port. The term was used because Notteboom (2008) maps the interactions between the ports and the related hinterlands, and because various modes of transport are mentioned. Notteboom (2008) discovered that it is very hard, or possibly even not feasible/practical, to delimit the hinterland of a port as the hinterland transportation varies in relation to the commodity (e.g. bulk versus containers), the time (seasonal impact, economic cycles, technological changes, changes in transport policy, etc.) and transport mode (e.g. barge, rail, etc.).

Some maritime studies have tried to measure port connectivity by generating indices or equation models. McCalla (2003) has created a connectivity index that attempts to measure the complexity and redundancy of the total shipping network of ports in the Caribbean, with data yielded in 1994 and 2002. His connectivity index is obtained by dividing the number of links or edges of the network by the number of ports. The formula of the index is present in Equation 2.1.

$$\text{Connectivity Index} = \frac{\text{Links } (l)}{\text{ports } (p)} \quad (2.1)$$

As McCalla (2003) demonstrates, the connectivity index is not an explanatory variable, but explains over a third of the total TEU throughput in the region.

A measurement of connectivity, which has been developed by Rodrigue et al. (2006) and can be applied to the definition given in this research for maritime connectivity, is the gamma index. This index considers the relationship between the observed (actual) number of links and the maximum number of possible links that a network can contain.

Equation 2.2 presents the formula for the Gamma index.

$$\gamma = \frac{e}{\frac{v(v-1)}{2}} \quad (2.2)$$

where:  $e$ : the links of the network and  $v$ : number of nodes

The value of gamma is between zero and one, where a value of one indicates a completely connected network and is extremely unlikely in reality. The gamma index is a useful measure of the relative connectivity of the entire network (Scott et al. 2006).

Low et al. (2009) developed a more complicated equation for measuring the connectivity of every port. This derives from the port index of connectivity. The connectivity index of port  $i$ ,  $S_i$ , as a fraction of the total number of Origin Destination (O-D) pairs in the sample that is served by the port  $i$ . Equation 2.3 demonstrates the connectivity index of port  $i$ .

$$S_i = \frac{\sum_j 2(n_i+n_{ij})(n_j+n_{ij})}{\sum_j \sum_i 2(n_i+n_{ij})(n_j+n_{ij})} \quad (2.3)$$

where:  $n_i$  and  $n_j$  are the number of exclusive nodes [including the port itself, (This extra node is needed to account for the possibility of a direct shipping route starting from a common node and ending in the port itself (or vice versa) without going further to other exclusive nodes from port)] that can only be reached by port  $i$  and port  $j$ . There are also a number of common nodes, denoted as  $n_{ij}$ , that can be reached by using either port  $i$  or port  $j$ .

UNCTAD has also measured the connectivity between country pairs. It has found the existence of 17.7 percent of direct connections between country pairs, while a key trend observed that less direct point-to-point services are provided in hub-and-spoke networks (UNCTAD 2012).

Wilmsmeier et al. (2006), in order to measure the connectivity (or inter-port connectivity) of a port, have counted every direct services a port has with another. The connections a port has that are not direct (they need at least one transshipment) were also added on their model. That was the case, as the authors tried to avoid the problem of

having to take the logarithm of zero values. Of course, that can be used to demonstrate the option of having an indirect service with transshipment.

As Wilmsmeier et al. (2006) discuss, inter-port connectivity is not a feature of a single port, but more a point of reference of the level of services, and perhaps liner-shippping competition, between a pair of ports. They have measured the connectivity for the liner shipping services of various pair ports. The outcome revealed that, when the connectivity increases by 150 percent, the freight between the two ports decreases by 10 percent. The port connectivity reduces the transport costs because it enables economies of scale and increases the competition amongst the carriers (Wilmsmeier et al. 2006).

The Victoria Transport Policy Institute of Canada has developed a definition of roadway connectivity: “Roadway connectivity refers to the density of connections in path or road network and the directness of links” (Victoria Transport Policy Institute 2010). The Institute asserts that, as connectivity increases, travel distances decrease and route options increase; thereby allowing for more direct travel between destinations, creating a more accessible and resilient system.

With the application of the findings of the Victoria Transport Policy Institute of Canada, maritime transport connectivity can be defined in relation to this research as: “Maritime transport connectivity refers to the actual possible alternative connections which a port has, divided by the optimal connectivity (the maximum number of possible connections which a port could have)”. That connectivity needs to be normalised against a country’s population and the income of that country; it must also be defined carefully if it is going to be measured per country or per route. The normalisation maritime connectivity has to take place because large countries (in terms of population), with high per capita incomes, are likely to have more calls than those with minor populations (Rodrigue et al. 2006). Therefore, maritime transport connectivity has to be normalised against the gravity model when a comparison of the connectivity of various countries (which have many differences) has to be made. As only the UK connectivity is calculated in this research effort and the result will not be compared with other countries, the parameters of the gravity model will not be considered.

If maritime transport connectivity is going to be defined as per country, every country has to be considered as a node. In that case, the research has to take a measurement of one country against 162 coastal countries (nodes). If maritime transport connectivity is

going to be defined against the routes that are available between country pairs, all of the possible routes which a coastal country can have, have to be measured. The actual number of those routes for pair countries is 13,041 (Hoffmann 2010). As this research effort captures the influence of 68 factors, only the country nodes will be captured as data does not exist in such detail to sufficiently cover all routes. Even for some countries, data that could capture the 68 factors does not exist presently. Consequently, due to the fact that most of the data is not readily available to use, this research focused only on the principal trade transactor in terms of TEU for the UK, which is China. As is illustrated in Figure 2-11, China holds the first position in the overall traffic transported to and from the UK in terms of TEU, in 2010. China holds 24 percent, ahead of the Netherlands with 8 percent and Singapore with 5 percent. As illustrated in Figure 2-11, China represents one-quarter of the total UK container traffic, so the monitoring of that country could provide a good indication for this index. Furthermore, if it is considered that this research is capturing only foreign traffic, then the Chinese percentage increases slightly to 26 percent.

An additional factor for choosing the UK-Chinese route is that it is included in the Asia-Europe trade, which is “one of the biggest (trade) in the global economy and a barometer of the world’s overall economic health” (Price 2012).

Of course, the definition of maritime transport connectivity cannot provide a number, or numeric measure of some form, of the real connectivity in the context of this research effort, especially for liner shipping connectivity. If this research aims to measure real liner shipping connectivity, precautions must be taken, according to Rodrigue et al. (2006). Sometimes, some countries may have a high number of ship calls, but those calls may not have bear any relevance on the countries’ connectivity, as they are using the port only for transshipments. Of course, the service exists for exporters and importers to use. Another characteristic of the maritime transport connectivity, in conformity with J. S. L. Lam (2011), is that a higher level of maritime transport connectivity represents higher economies.



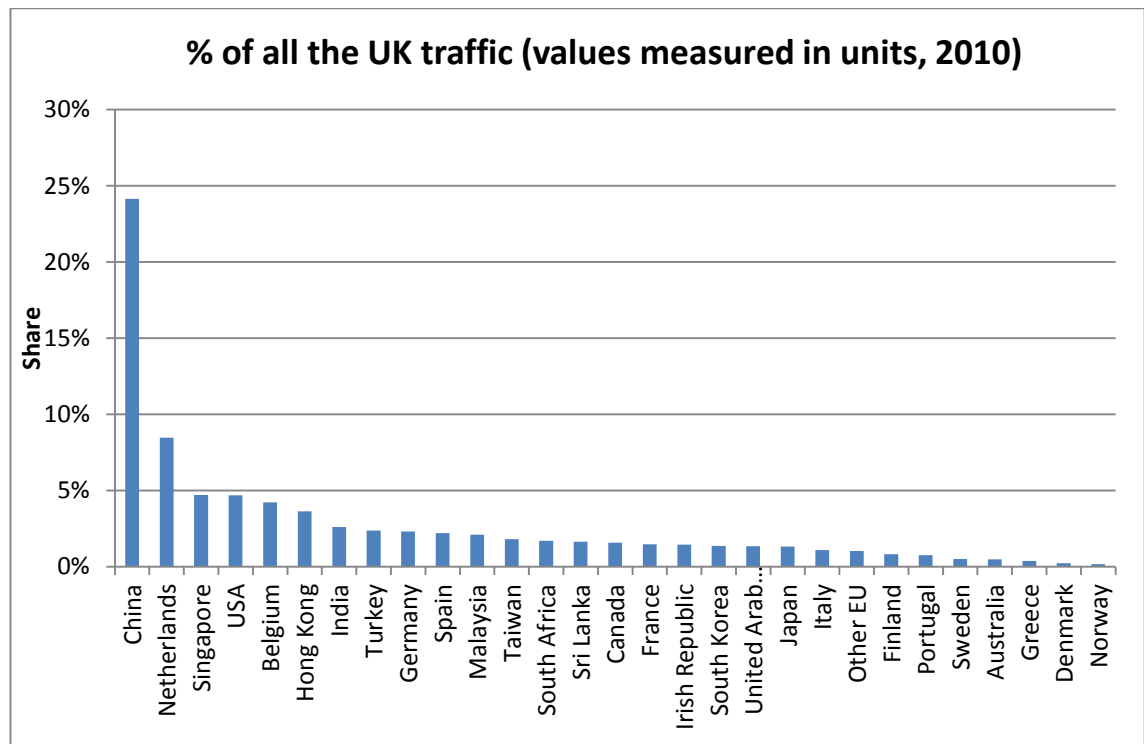


Figure 2-11 Percentage of all the UK containerised traffic according to countries traded (TEU units, 2010)

Source: Department for Transport (2012b)

According to various quarterly newsletters published by UNCTAD (UNCTAD 2005; UNCTAD 2006; UNCTAD 2009c), maritime transport connectivity is related closely to higher trade volumes and lower transport costs. Thus, enhancing a country's connectivity contributes to improving its trade competitiveness, while simultaneously, higher trade volumes will usually also lead to improved connectivity and lower transport costs (ibid).

The liner shipping companies with their services create a global maritime transport network; by which all the coastal countries are connected with each other. The level of 'connectivity' of each country with the global maritime transport network is measured by the Liner Shipping Connectivity Index (LSCI). The LSCI is a measurement created from UNCTAD in 2004, in order to measure the level of connectivity of various coastal countries (UNCTAD 2010a). The LSCI is formulated from the following five components:

- Number of ships deployed
- Their container-carrying capacity
- The number of companies

- The number of services provided
- The size of the largest vessels that provide services from and to each country's seaports (UNCTAD 2010a).

The index is generated as follows. For each of the five components, a country's value is divided by the maximum value of that component in 2004 (which is the baseline year for the index), and for each country, the average value for each of the five components is calculated. This average is then divided by the maximum average for 2004 and multiplied by 100. In this way, the index generates the value 100 for the country with the highest average index of the five components in 2004 (UNCTADstat 2011b).

The LSCI aims to assess a country's level of integration into the global liner shipping network by measuring the specified country's liner shipping connectivity. The higher the index for a country, the easier it is to access a high capacity and frequency of the global maritime freight transport system and, thus, participate effectively in international trade. The LSCI has been generated annually for 162 countries since July 2004 (UNCTAD 2010a).

This research will add more factors to the above LSCI, which, according to industry experts, are important for capturing the connectivity for a country. However, they will also assign weights to each factor, as will be discussed in the following sections.

## **2.10 Maritime Transport Sector Risks, with Focus on the UK**

There is a plethora of literature on the topics of risk and risk management in the shipping industry and how it can be measured; however, there remain varying perspectives of how to define this highly complex and critical aspect of the sector. One of the most widely-cited definitions of risk in the international shipping sector takes the view that risk is a negative factor influencing phenomenon and is the “measurable liability for any financial loss arising from unforeseen imbalances between the supply and demand for sea transport” (Stopford 2009 p.101). This definition has been developed from that of Downes and J. E. Goodman (1991 p.380), who recognised the mutual exclusivity between risk and uncertainty: “risk is the measurable possibility of losing or not gaining value. Risk is differentiated from uncertainty which is not measurable”. The fundamental difference between these authors' points of view lies in Stopford's inclusion of the term ‘measurable’. To further extend the discussion on risk, Waters (2007 p.17) suggests that “Uncertainty means that we can list the events that

might happen in the future, but have no idea about which one will actually happen or their relative likelihoods”, while “Risk means that we can list the events that might happen in the future, and can give each a probability”. The key difference between risk and uncertainty, according to Waters (2007 p.17) and which is aligned with Stopford’s thoughts, is that “risk has some quantifiable measure for future events, and uncertainty does not”. Therefore, risk is centred on uncertainty and measurability.

If one subscribes to the philosophy that risk can be measured or quantified in some way, the time-honoured conclusions of Harrington (1991 p.82) can be drawn upon: “If you cannot measure it, you cannot control it. If you cannot control it, you cannot manage it. If you cannot manage it, you cannot improve it”. Risk management is defined as “the process whereby decisions are made to accept a known or assessed risk and/or the implementation of actions to reduce the consequences or probability of occurrence” (Brindley 2004 p.22). Therefore, risk management is a key determinant of an industry, such as the shipping sector, which is dominated by cycles of rates and prices (Kavussanos and Visvikis 2006). Risk management for shipping is defined by Syriopoulos (2011) as “the process by which various risk exposures are identified, measured and controlled”.

In order for the volatility and vulnerability experienced in the maritime container sector to be reduced, all risk management capabilities within shipping organisations need to be strengthened. In addition, existing risks and likely future risks must also be identified (Cardona 2004). Consequently, many of the risks that are relevant to cost and connectivity within the maritime transport sector for the UK are addressed in this research.

## **2.11 Conclusions and Overview**

This chapter provided a summary of relevant information for the UK maritime transport sector. The first section provided a brief introduction to the UK and its interconnections with the global economy, followed by a section focusing on the UK containerised trade. An overview of the maritime sector was provided in terms of the UK, while its importance for the UK and the world was explained through several figures. A clarification was provided of some terms that are relevant to this research and to the UK maritime freight cargo. The geographical boundaries of the research were given in response to the question: “Why does this research effort focus only on the UK?” which was subsequently answered. A demonstration of the nature of maritime transport costs

was attempted (again with a focus on the UK) while, simultaneously, many techniques and sources for measuring the maritime transport costs were proposed. The second aim of this research was defined with the assistance of some existing definitions of connectivity. The final component of the proposed index, namely risk, was clarified through a demonstration of various definitions that have been proffered by experts within the transport and maritime transport sectors. The next chapter will provide a literature review relating to the factors affecting costs, connectivity and risk, and the nature and structure of indices. It will also demonstrate a content analysis conducted and information related to container transportation.

### **Chapter 3. Literature Review**

*“Ships are the perfect way for moving goods, only when they are fully loaded”.*

David Charlesworth, Shipping Consultant, Drewry Maritime Research

(East Coast Modal Shift Forum, 19 October 2010)

### **3.1 Introduction**

This chapter considers the boundaries established in Chapter 2 and attempts to extract from the existing literature the background knowledge that will determine the factors affecting maritime transport costs, connectivity and risks. In this chapter, the literature will also be explored to acquire deep knowledge and understanding of the nature and structure of indices that exists in the maritime transport sector. The chapter concludes with an exercise of mapping a container journey.

The conventional worldwide transport systems are related closely to socio-economic changes. Since the advent of recognising modern economics, through the works of economist and philosopher Adam Smith (1776) and his book ‘The Wealth of Nations’, the literature has been developed concerning the association of living standards with the increase in trade. Adam Smith (1776), in his discussion of specialisation and the extent of the market, stresses the relationships between wealth, trade and nations.

Since the the second World War, many countries adopted a development strategy emphasising integration with the global economy, in order to increase the nature and level of trade among and between them. Such integration led to a reduction of both tariff and non-tariff barriers to trade. Through that reduction in artificial trade barriers, the importance of transport costs has increased, as a remaining barrier to trade. Therefore, most countries have seriously considered transport costs. Thus, they endeavour to reduce their transport costs in order to increase their integration into the overall trading system (Limao and Venables 2001; X. Clark et al. 2002).

The maritime transport sector needs to be under constant scrutiny for the reduction of overall transport costs. This sector is the backbone of international worldwide trade and globalisation, with 77 percent (or 7,843 million tonnes, in 2009) of world merchandise trade being carried by sea, as stated by UNCTAD (2010a). Hence, there is a need to identify and, subsequently, reduce the various factors that result in high transportation costs. These factors can boost connectivity in the maritime transport sector and mitigate risk by helping the overall economy, both global and local, to prosper.

Such an identification of factors can be carried out through a detailed review and evaluation of the academic and commercial literature. The combination and calculation of these factors, allocating a specific relative weight for each of them according to their relevance to the research topic, can lead to the creation of an index that will aid in

monitoring subsequent changes. Of course, the monitoring of the factors affecting the costs, connectivity and risks for the maritime transport sector will be easier with the evolution and creation of an innovative and sophisticated index. Such an index will be useful not only for the policy makers who aim to reduce those factors, but also for everyone who is interested in all aspects of the maritime transport sector and attempts to facilitate improvements.

After monitoring the trend of changes, policy makers can make the most appropriate decisions to reduce those fluctuations, by taking specific and targeted actions. Traders and suppliers of transport services can do little against the fluctuations in freight costs. However, as UNCTAD's research has shown, policy makers can enhance their countries' connectivity and trade competitiveness, largely in the areas of transport infrastructure and trade facilitation, and in assuring local competition among service suppliers. Moreover, economies of scale have been shown to be important determinants of trade costs (UNCTAD 2008b) (for example, Figure 3-1, shows lower transport unit costs for larger containerships).

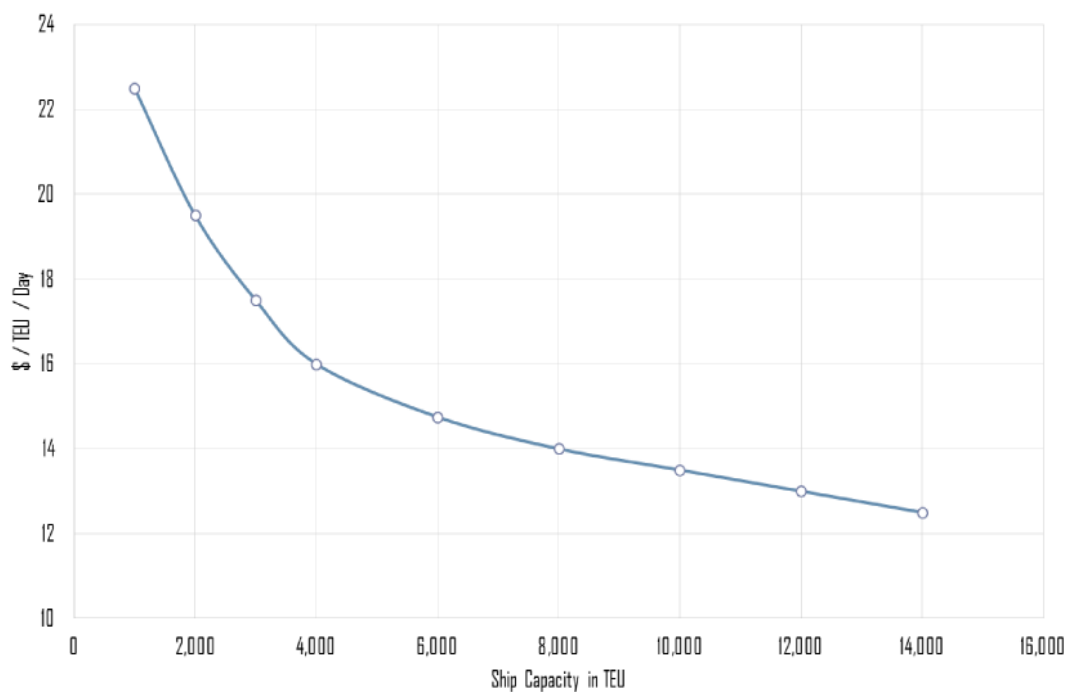


Figure 3-1 Transport cost by containership size (daily operating expenses in USD for containership per TEU)

Source: Rodrigue et al. (2013)

### **3.2 Critical Factors Affecting Maritime Transport Costs, Connectivity and Risk for the UK<sup>2</sup>**

For this research, the various factors affecting the maritime costs, connectivity and risk were separated into four groups according to: 1) factors affecting the maritime transport cost only; 2) factors affecting the maritime transport connectivity only; 3) factors affecting both maritime transport costs and connectivity; and 4) factors affecting maritime transport risks. That separation was conducted, as some other studies include in their models the same factors twice; for example Wilmsmeier et al. (2006). Thus, these factors can have a double impact on a model. The factors affecting cost, connectivity and risk for the maritime container transport sector are assigned as they were found in the literature. Therefore, the level of importance for each factor discussed in this section is irrelevant to the level of importance of the factors found in this research effort.

#### ***3.2.1 Maritime transport costs***

Marquez-Ramos et al. (2005) determined that the so-called gravity model does not have an effect on maritime transport costs, as, when a population is growing with an increase in its income, the level of trade also increases. The only problem is that when the income in a country increases, after a certain level is reached then the population will tend to begin to buy high added-value goods. These goods, according to Kumar and Hoffmann (2002), are often transferred by air freight (conversely, products with a relatively lower per tonne value tend to be transferred by ships). So, the portion of freight transferred by sea is shifting between carriers and, ultimately, the sea freight component is shrinking (in comparison with the total freight) when the income of a population increases. Additionally, Martinez-Zarzoso et al. (2003) suggest that greater distance and poor partner infrastructures increases appreciably maritime transport costs. Hummels (1999b; 2001) and Hummels et al. (2001) assign a willingness to pay for the saving of time for the shipment of manufactured goods. That willingness is combined with the decline of the international transport costs over time and he introduces the factor time as a form of trade barrier. One of his concluding points (Hummels 2001 p.25)

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<sup>2</sup> Initial findings of Sections 3.2 and 3.3 have been published in: Karamperidis, S., Mangan, J. and Jackson, E. 2010. Developing an Index of Maritime Costs and Connectivity for the UK. In: Whiteing, T. ed. *15<sup>th</sup> Logistics Research Network (L.R.N.) Annual Conference 2010, Towards the Sustainable Supply Chain: Balancing the Needs of Business, Economy and the Environment, 9<sup>th</sup>-10<sup>th</sup> September 2010*. Harrogate: The Chartered Institute of Logistics and Transport (UK), pp. 341-349.



is that: “each day saved in shipping time is worth 0.5 percent *ad-valorem*, approximately 30 times greater than costs associated with pure inventory holding”.

Marquez-Ramos et al. (2005) have developed a trade equation, in which the maritime transport costs are included as an explanatory variable and the estimated results have been analysed. The estimated results of the equation are considered an endogenous variable by Marquez-Ramos et al. (2005), while Anderson and Van Wincoop (2004) suggest likewise for transport costs.

Cargo traffic increases with the draught and trade volume, but decreases with port turnaround time and charges. Port charges are the least influential factor in determining the traffic at a port as they represent a tiny proportion of the total transport costs (Low et al. 2009). Hence, the port choice decision is not affected by the port charges, but by other significant indirect costs of transport services, as listed below.

### **Factors affecting maritime transport costs:**

#### Transport cost sensitivity

For physically heavy, low-value products, shipment is more expensive than for the physically lighter, high-value products (Mangan et al. 2012). Wilmsmeier et al. (2006) found that a one percent increase in the unit value of products leads to an increase in freight costs of 0.34 percent.

#### Bilateral trade (volume exported)

Wilmsmeier et al. (2006) found that an increase of one percent in bilateral container trade between two countries leads to a reduction of trade costs of 0.0065 percent (e.g. an increase of containerised trade between two countries from 1 million tons to 10 million tons leads to a cost reduction of 1.5 percent).

#### Containerisation

X. Clark et al. (2004) and Blonigen and W. W. Wilson (2008) have shown that containerisation has a positive impact on the reduction of costs for high-value per unit products, while the heavier products are not affected as much. The development of the containerised transport system has been an important technological change in the transport sector over the last few decades, which has had a positive effect on reducing transport costs according to X. Clark et al. (2002). The same study revealed that containerisation reduces the total transport costs by approximately four percent.

Containers have allowed large cost reductions in cargo handling and in increasing cargo transshipment; therefore, national and international cabotage [‘Cabotage’ is the transportation between two terminals, (a terminal of loading/embarkment and a terminal of unloading/disembarkment) located in the same country irrespective of the country in which the mode providing the service is registered]. Cabotage is often subject to legal restrictions and regulations. Under such circumstances, each nation reserves the right for its national carriers to move domestic freight or passenger traffic (Rodrigue et al. 2006). In turn, this increase in cabotage has resulted in the creation of hub ports that allow countries or regions to take advantage of an increasing return due to scale (X. Clark et al. 2002). The creation of hub ports has benefited from the invention of containers. According to Stopford (2011, pers. comm., 16 March), the benefits in terms of money yielded from containerisation are enormous. This is why containers are transferred frequently from, for example, Newcastle to Felixstowe by truck rather than by ship, which is an economical way of transporting freight over long distances. These benefits are delivered by the savings of labour arising from the use of containers. The old system involved spending an enormous amount of money on labour and handling time, relative to which container shipping is now gaining.

An example of how containerisation helped to increasingly result in cost reductions, especially labour costs and the time required for a ship to load and unload its cargo, is discussed by Peters (2000): “I talked to an old London dockhand some time back. He allowed as how in 1970 it took 108 guys about five days to unload a timber ship. Then came containerisation. The comparable task today takes eight folks one day. That is, a 98.5 percent reduction in man-days, from 540 total to just eight”.

#### *Load of the container*

As shipping companies charge their customers according to container freight rates, the most economic way of shipping goods is by having fully-loaded containers. It is, therefore, more efficient for consignors who are not able to fill a container to consider consolidating cargoes, so they could pay by weight or volume, depending on which option offers the better tariff (Business Link 2011).

#### *Containership loading*

The loading of a containership is crucial for a liner shipping company; if it is not designed and executed properly, there is a real threat of wasting valuable space and time.

To manage this risk, various software has been developed to help container companies maximise loadings and, thus, achieve higher profits with the added bonus of reducing of CO<sub>2</sub> levels per container (Hellenic Shipping News Worldwide 2011d).

### 100 percent container scanning

The USA planned to X-ray all containers for the possible presence of Weapons of Mass Destruction (WMD) ingredients before loading at a foreign port by July 2012. This proved to be controversial in conformity with many industry representatives, customs organisations, government officials and entities, both outside and within the USA. Criticism was expressed regarding its effectiveness, viability and the implementation costs (UNCTAD 2010b). According to British International Freight Association (BIFA) (2011), “As BIFA has said repeatedly, the Department of Homeland Security (DHS) has consistently underestimated the enormity of the task in hand relative with the costs both to the USA Government and those of foreign governments, as well as, importantly, the limited ability of contemporary screening technology to penetrate dense cargo, or large quantities of cargo in shipping containers”. For that reason, the DHS has decided to postpone implementation until July 2014 (UNCTAD 2010b). The World Customs Organisation (WCO) expressed concern in 2007 that 100 percent container scanning would be detrimental to world trade, economic and social development, and could lead to unreasonable delays, port congestion and international trading difficulties (UNCTAD 2010b). Figure 3-2 and Figure 3-3 illustrate the X-ray scanning of a truck and of a train loaded with containers, respectively. The scanning takes place so the containers and their contents comply with the C-TPAT (Customs-Trade Partnership Against Terrorism) principles.



Figure 3-2 X-ray scan of a container loaded in a truck



Figure 3-3 X-ray scan of a container loaded in a train

Source: USA Customs and Border protection (2011)

### Surcharges

Surcharges may be higher than the freight rates negotiated with the shipping lines, which is not a distinct issue in the literature (Slack and Gouveral 2011). Surcharges are levied by shipping companies and/or ports, in order to cover the costs of particular regulatory regimes (Business Link 2011). The number of surcharges applied by carriers to shippers has increased over time; they are highly variable and add significant extra costs (Slack and Gouveral 2011). As Figure 3-4 illustrates, in many cases the surcharges are greater than 100 percent of the total freight cost. It can be also seen from Figure 3-4 that surcharges are more important for some trade lines than others. Carriers are increasing the list of surcharges by encountering new costs, which are then passed directly to shippers (Slack and Gouveral 2011). Slack and Gouveral (2011) capture and examine only three surcharges, namely; Terminal Handling Charge (THC), Bunker Adjustment Factor (BAF) and Currency Adjustment Factor (CAF). Of course, as stated in their research, some surcharges apply only to one port, but others are levied on several markets. Some examples of surcharges that are used and are found in the literature are described below.

One example is the war-risk surcharge, which was introduced by Cosco Container Lines for all shipments from the Indian subcontinent and the Far East to ports in Libya. The surcharge was set at USD 200/TEU (Hellenic Shipping News Worldwide 2011c).

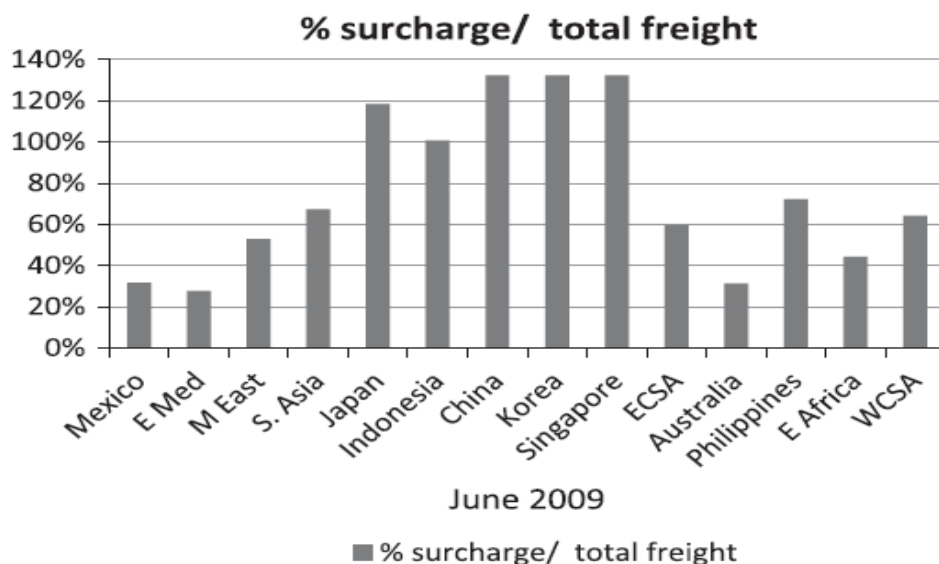


Figure 3-4 Surcharges as a proportion of total rates from the European Northern range, June 2009

Source: Slack and Gouveral (2011)

A peak-season surcharge has been applied by Cosco Container Lines on the westbound trades from the Far East (including Japan) and the Indian subcontinent to both Northern and Western Europe and to the Mediterranean. That peak-season surcharge was USD 200/TEU and was launched on the 1<sup>st</sup> of June 2011 (Hellenic Shipping News Worldwide 2011c). The surcharge applied only to the peak-season period. A piracy risk surcharge of USD 70/FEU was introduced by Maersk on the 1<sup>st</sup> of June 2011 for containers shipped between India and the Middle East Ocean region (The Journal of Commerce 2011e). Maersk also plans to introduce a surcharge for its customers, which could be called 'load protection fees'. This surcharge could apply to shippers that book a service but miss the sailing (The Journal of Commerce 2011d). According to Maersk's former CEO, Mr. Eivind Kolding, such customers comprise 30 percent of the total clients' portfolio. Only 41 percent of Maersk customers have 100 percent product delivery with their commitments agreed, while 56 percent have 90 percent product delivery (with 90 percent considered as a logical figure from Maersk's CEO). Therefore, 44 percent of Maersk customers do not deliver the goods they have been promised (The Journal of Commerce 2011d). Maersk's CEO also mentions that nearly one out of every two containers arrives on time (The Journal of Commerce 2011d). This knowledge provides impetus to the development of surcharges aiming to minimise the possibility of product delivery failures. Those charges could be USD 100 per dry container and USD 500 per reefer (Fairplay 24 2011c). In contrast, ocean carriers are not always on time; indeed, Maersk is ranked second in terms of container service reliability. The main reasons why companies do not meet their service reliability targets is caused one-third of the time by weather conditions and two-thirds by terminal issues (The Journal of Commerce 2011d). As a result, companies such as Maersk are considering compensating companies when their containers are not loaded on time, as agreed by the associated shipping company (Fairplay 24 2011c).

Surcharges do not always have the same level of impact. A good example is the CAF surcharge, which was applied in June 2009 and set at 7.87 percent. However, in absolute terms, the additional charge per container was €22 for Saudi Arabia or the United Arab Emirates and €128 for East Africa trade (Slack and Gouvernal 2011). The most important characteristic of surcharges, as illustrated in Figure 3-5, is that they are revenue generators for the shipping lines when the freight rates are low. Of course, as stated by Slack and Gouvernal (2011), 2009 (which was the year from which the data

were extracted) was not a typical year, but they wonder if such a thing as a typical year exists for the liner shipping industry. As evident from the freight rates fluctuations, the market is naturally volatile.

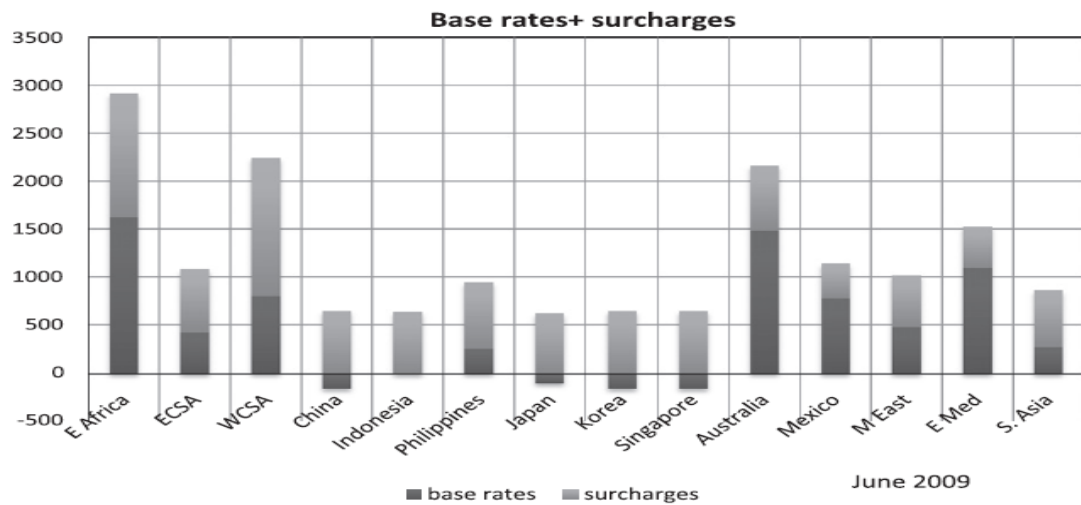


Figure 3-5 Total freight rates, base rates plus surcharges in USD, June 2009  
 Source: Slack and Gouveral (2011)

### Cost of labour

Many ports are facing dramatic increases in labour costs. For instance, the terminal operators in Los Angeles and Long Beach have increased their box handling fees (mitigation fees) by 20 percent, in order to cover the increases (the mitigation fee has increased from USD 50/TEU to USD 60/TEU and from USD 100/FEU to USD 120/FEU after the 4<sup>th</sup> of July 2011) (Fairplay 24 2011b). The mitigation fee has, however, been applied to shippers of box cargo only during the day time. The reason for doing this is to encourage the shippers to use the port gates during night shifts when there is less traffic. Of course, from the terminal’s perspective, the labour cost during the night shifts is higher than that of the day shifts (Fairplay 24 2011b). According to the terminal operators of the Los Angeles and Long Beach ports, the labour costs have increased by 31 percent since 2006 (Fairplay 24 2011b).

### Trade imbalance

Imbalances between exports and imports impact on transport costs. Trade imbalance has been measured with various models in the literature. The model demonstrated from Wilmsmeier et al. (2006) (imports divided by exports of trade between the trading partners) is the most commonly used. The impact of trade imbalance is particularly

noticeable in container transportation, because the shipping companies have to reposition the empty containers. In that repositioning activity, the extra cost of moving the empty containers has to be considered (Rodrigue et al. 2009). The impact of the trade imbalance affects the liner shipping companies more than the bulk carriers (J. Korinek 2011, pers. comm., 25 March). If the trade imbalance was 50 percent less, the shipping cost for containerised goods would fall with a reduction ranging from 57 percent to 62 percent. In contrast, the shipping cost for the bulk sector would fall by nine percent. These results differ substantially from the findings of Wilmsmeier et al. (2006), who found that an one percent increase in the coefficient imports/exports leads to an increase of freight costs by 0.00049 percent. This percentage is low and, hence, does not affect the trade imbalance of freight rates.

The trade imbalance is generally treated as exogenous (X. Clark et al. 2004; Marquez-Ramos et al. 2005; Wilmsmeier et al. 2006; Blonigen and W. W. Wilson 2008), while Jonkeren et al. (2011) are the first to consider it as endogenous in relation to transport costs.

Typically, empty containers ('empties') account for about 21 percent of the volume of global port handling (Boile et al. 2006). These empties present a logistical challenge to both the maritime and inland segments of freight distribution; thus, they are an issue of high importance as, at any given time, about 2.5 million TEU of containers are stored empty and waiting to be used. Figure 3-6 demonstrates the degree to which continents' trade imbalances are noticed, while Figure 3-7 illustrates the increasing trend in trade imbalances. Jonkeren et al. (2011) identified that a one standard deviation equivalent increase in the trade imbalance from region A to region B decreases transport prices from A to B by about eight percent.

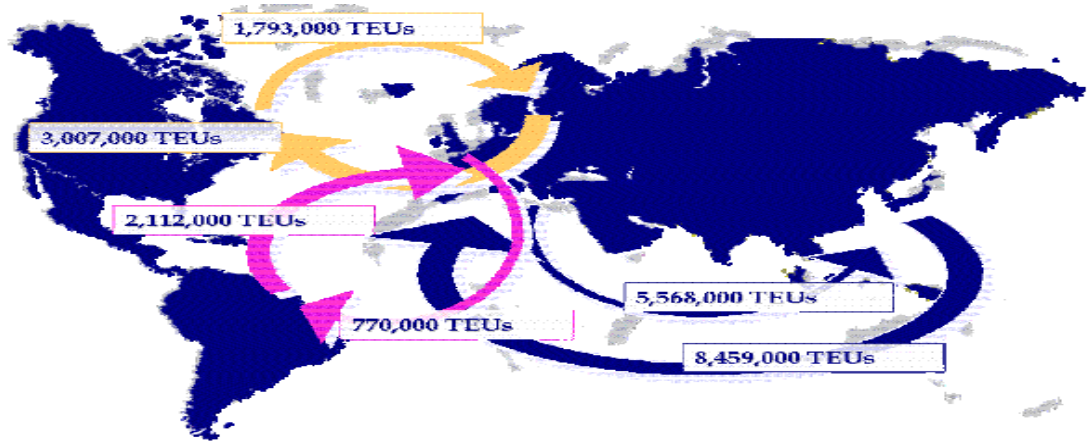


Figure 3-6 Imbalances in containerised seaborne trade to and from Europe (TEUs, 2004)

Source: Marquez-Ramos et al. (2005)

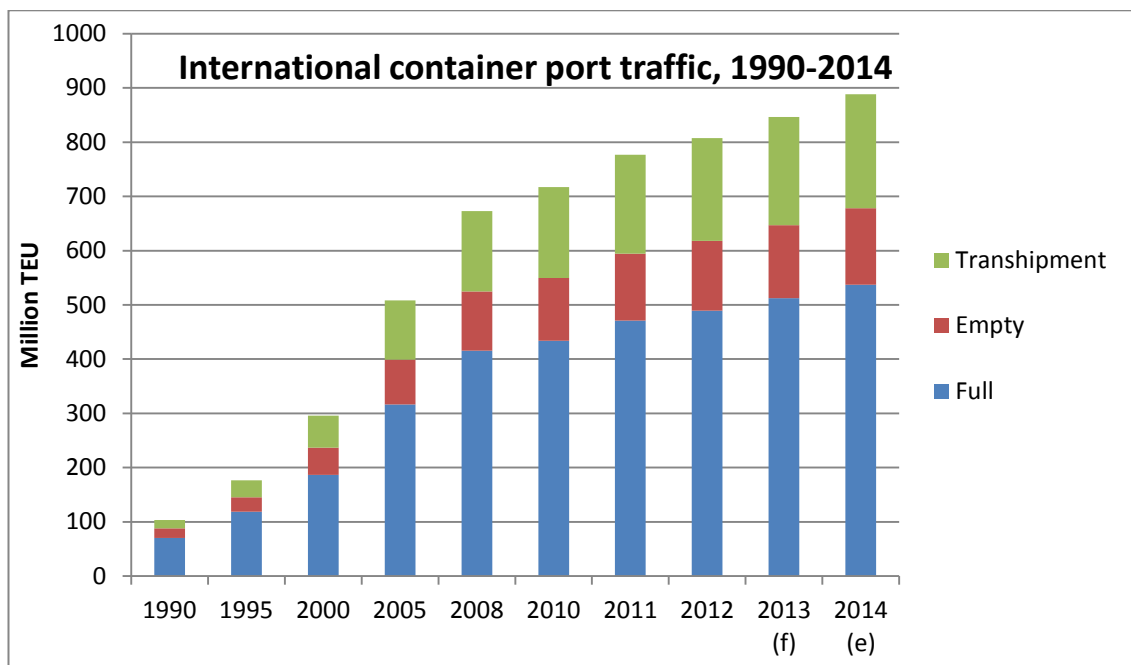


Figure 3-7 Development of container traffic and analysis of container traffic components throughout the years [1990-2014 (e)]

Source: Author, based on data provided by Drewry Maritime Research in the *Drewry Annual Container Market Review and Forecast*

Some carriers transport waste paper and metals for recycling at relatively low costs (i.e. USD 200 from USA to China) in order to reduce the trade imbalances. However, this tends to extend the turnaround time because the containers have to be cleaned after their journey (T. Fuller 2006). Some carriers choose to ship empty containers because “it is more lucrative to steam back quickly and unencumbered than to take on cheap and unprofitable cargo” (T. Fuller 2006). In March 2012, due to containerships idling, some



liner companies faced issues concerning trade imbalance. Maersk, which is the largest company in the Far East to Europe trade line with a market share of 27 percent, recently (March 2012) stopped taking cargo bookings on eastbound sailings, for at least one month. Consequently, other companies are applying an imbalance surcharge of USD 100 per 20-foot and 40-foot container to all cargoes, including those carrying waste materials, on sailings from Northwest Europe, including the UK, Scandinavia and Russian Baltic ports (Hellenic Shipping News Worldwide 2012k).

An interesting point on trade imbalance is made by Gouvernal and Slack (2012) to demonstrate that large shippers can achieve better deals for their freight rates, by striking a balance between exports and imports in a specific destination.

#### Number of shipping lines

Competition between shipping lines has resulted in alternatives being offered, for the same maritime transport service at a specific port. This phenomenon is new to the shipping sector, because after the early 1990s the shipping conferences started to decline (J. Korinek 2011, pers. comm., 25 March). The ports that are serviced by a large number of lines tend to have lower shipping costs (Rodrigue et al. 2009). Jane Korinek (2011, pers. comm., 25 March) has found that the level of competition and transport costs have an inverse correlation. Hummels (2007) found that one in six importer-exporter pairs in 2006 was served by a single liner service, while, simultaneously, the lines servicing more than half of the routes numbered three or fewer.

#### Flag of registry

Tolofari (1989) estimates that the operating costs for an open registry ship are 12 to 27 percent lower than for traditional registry fleets as a result of savings arising from manning (labour) expenses. Wilmsmeier and Martinez- Zarzoso (2010) calculated the benefits of having an open registry flag and found that costs for exports carried by ships with open registry flags are three to four percent lower than those carried by ships with other flags.

#### Economies of scale (vessel capacity)

The development of bulk and containerised maritime transportation has been influenced strongly by technology (Pinder and Slack 2004) and is evolving continuously, as demonstrated in Figure 3-8. Economies of scale have been achieved through the design

and construction of progressively larger ships; thereby impacting on optimum shipment size, vessel routes and port selection.

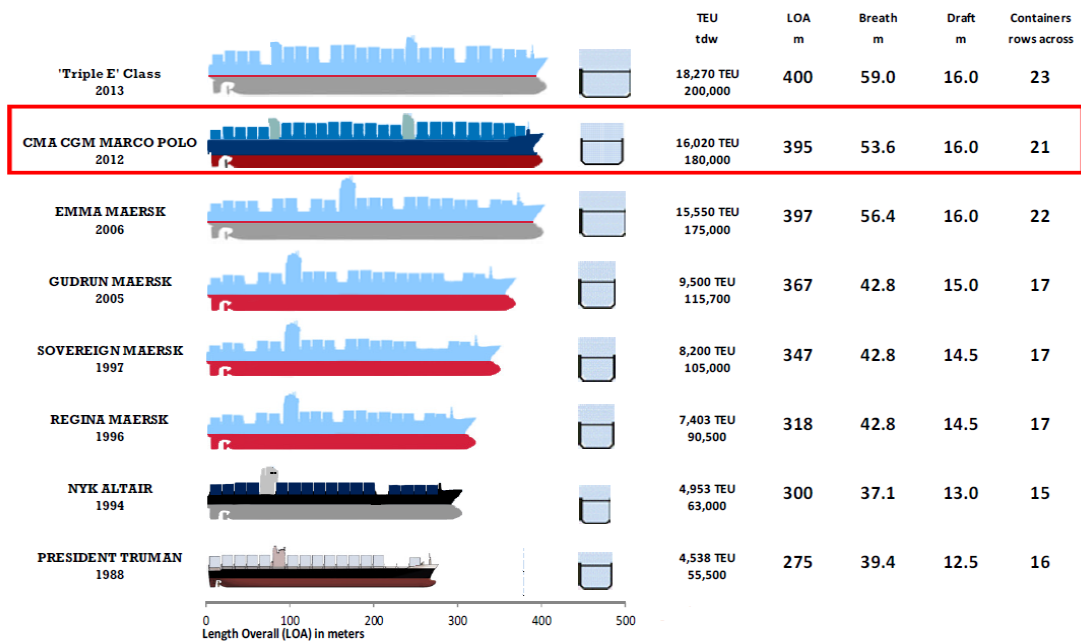


Figure 3-8 Evolution of the world's largest containerships; 1985-2013

Source: Alphaliner (2012a)

Wilmsmeier et al. (2006) found that, when the total volume of containerisable trade (in tonnes) increases by one percent, the freight cost is reduced by 0.0847 percent. Jane Korinek (2011, pers. comm., 25 March) demonstrates that various recent studies have yielded different percentages, in which the economies of scale seem to have influenced the maritime transport cost reduction. These different percentages, according to J. Korinek (2011, pers. comm., 25 March), result from the omission of relevant factors from the mathematical model created by each author, and/or from the use of restricted samples in terms of country or product coverage or coverage over time.

The set of figures quoted most frequently to demonstrate the impact of economies of scale are those generated by Stopford (2009), who calculated that the slot cost for a 14,000-mile round trip could vary between USD 648 for a 1,200 TEU vessel to USD 360 for an 11,000 TEU vessel. Figure 3-9 illustrates the vessel operating costs in Euros per container for vessels with a capacity ranging from 800 to 7,500 TEU. Some recently-reported data for economies of scale achieved from the larger vessels are provided by Alphaliner. Alphaliner estimates that slot costs of 13,000 TEUs ships are

about USD 150 per TEU lower than those for 8,500 TEUs ships on the Far East-Europe route (The Journal of Commerce 2011a).

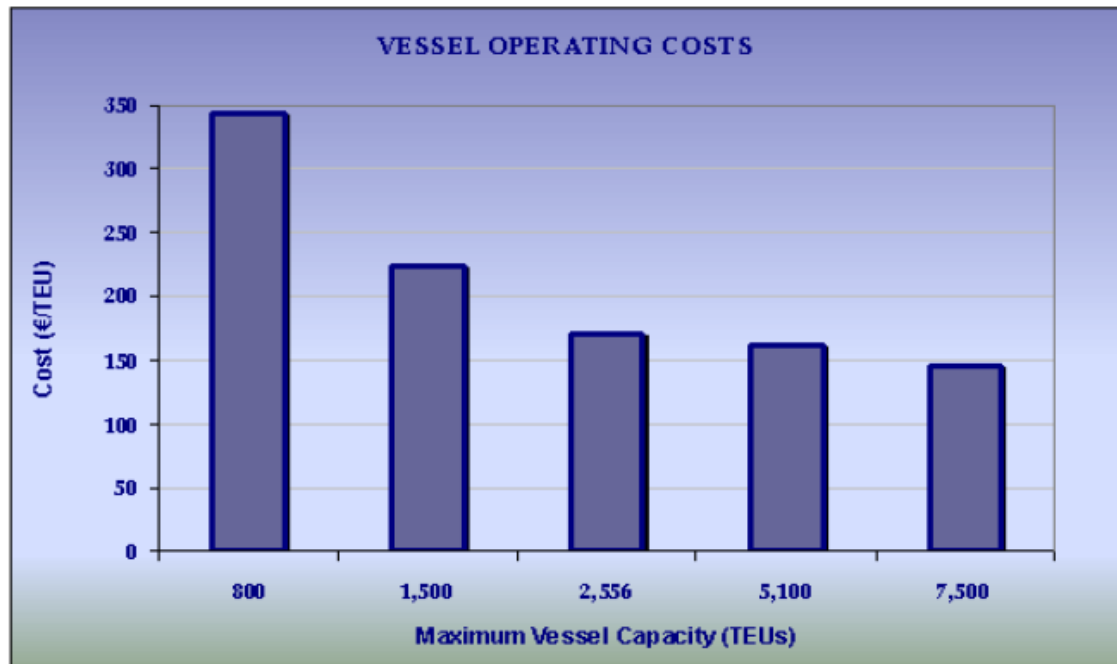


Figure 3-9 Operating costs for vessels with a capacity under 7,500 TEUs (Euros per TEU)

Source: Marquez-Ramos et al. (2005)

As can be concluded from the figures above, economies of scale can offer large savings to carriers. Therefore, liner companies are more focused more on Ultra Large Container Ships (ULCS) (vessels above 12,500 TEU), as Figure 3-10 illustrates. Moreover, this culminated in a 7.6 percent increase (in TEU) of the total fleet in 2011, compared with the figures for 2010. The Panamax sector had a year-on-year increase of 5.5 percent, which is miniscule in comparison with the ULCS (10,000- 12,499) and the ULCS (12,500- 15,999), signifying increases of 37.5 percent and 86.5 percent respectively (Lloyd's List Intelligence 2012, pers. comm., 19 January).

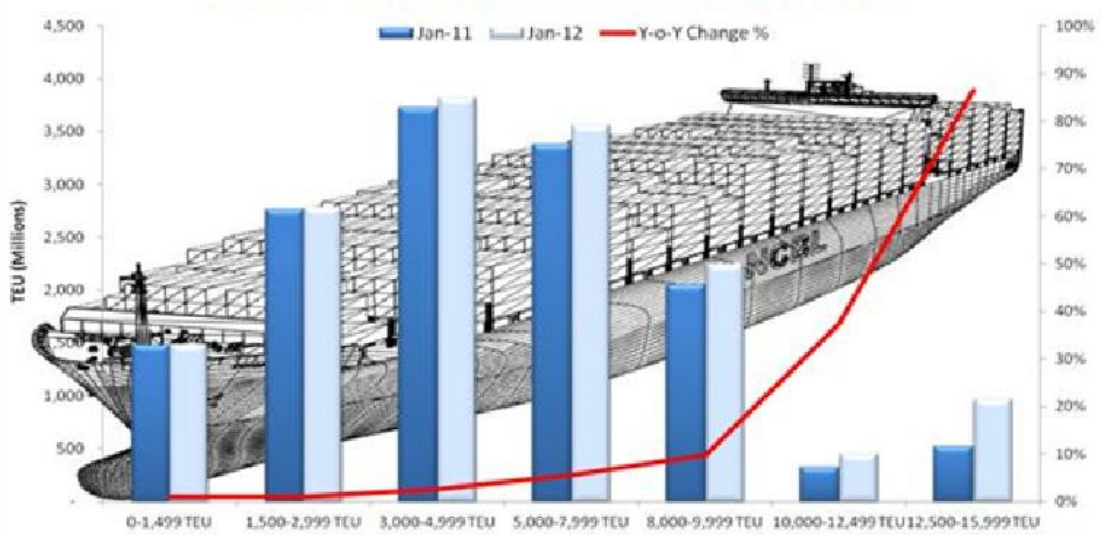


Figure 3-10 Container fleet development: Y-O-Y comparison

Source: Lloyd's List Intelligence 2012, pers. comm., 19 January

During 2011, all main carriers took deliveries of new vessels in all sectors. MSC and Maersk had the largest number of ULCS delivered, with 14 and 9 vessels each respectively (Lloyd's List Intelligence 2012, pers. comm., 19 January). As illustrated in Figure 3-11, most of the 'big' companies focused on ULCS. This trend will continue as companies compete for the market share and try to offer low slot costs. Of course, how far the companies will challenge the competition, in terms of vessel size, is an unknown, and hard to anticipate, quantity. Many experts in the field have tried to predict the size of new vessels for the next 10 years only to be proven wrong; for example, Notteboom (2004) declared that vessel size will not increase above 9,000 TEU within the next 10 years. However, only two years after this declaration, the first ship over 10,000 TEU, Emma Maersk, was delivered (Alphaliner 2012b); thereby heralding a new generation of vessels above 10,000 TEU. Recently Fairplay (2011b) reported that only the alliance of MSC/CMA CGM will control, in 2012, 78 vessels larger than 10,000 TEU.

The figures published by Fairplay have been cross-checked against those provided by Clarksons (see Figure 3-12). According to Clarksons (2012a), the VLCS (+8,000 TEU) provided 11 percent of the capacity for the Far East-Europe trade route at the beginning of 2006, while only four years later (August 2010) they were providing 53 percent. By August 2012, this number rose to 76 percent of the total capacity.



Figure 3-11 Vessel deliveries for 2011 according to liner company and vessel sector  
 Source: Lloyd's List Intelligence 2012, pers. comm., 19 January

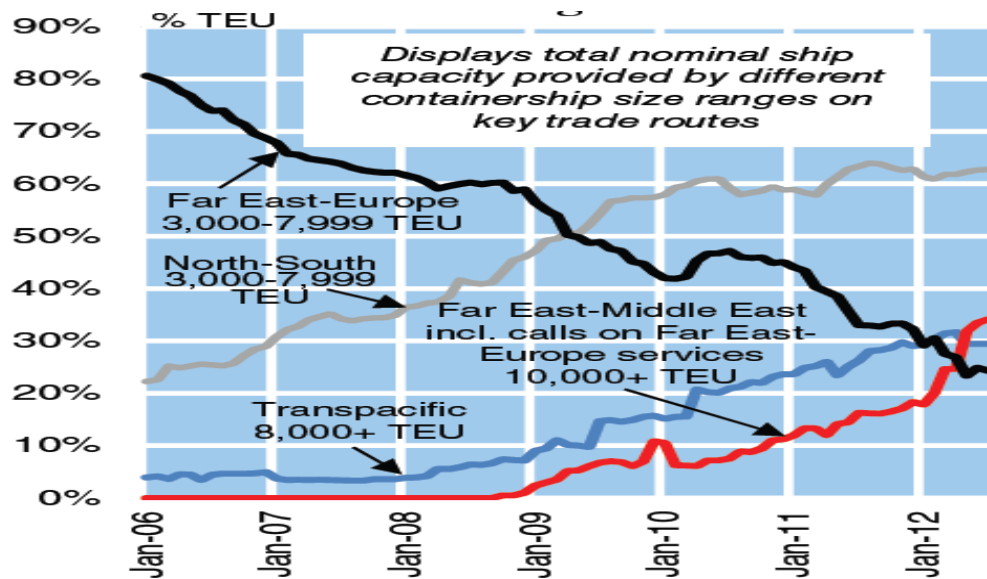


Figure 3-12 Percentage of various containership sizes (in TEU) on key trade routes between January 2006 and August 2012

Source: Clarksons (2012a)

Thus, it can be highlighted that the increases in vessel size are driven by the savings offered by the economies of scale. In an attempt to determine if ship size will continue to grow, a question regarding vessel sizes in 2050 has been put to industry experts

during the Delphi survey validation of the index (Phase 3b)<sup>3</sup>. However, as discussed previously, it is very difficult to predict the future and, more specifically future vessel sizes. Thus, the Delphi survey was applied as, according to the literature, it is a well-established method for forming a consensus among industry experts and generating forecasts (Helmer 1968).

Industry experts confessed they do not think that the vessels will exceed the 21,000 TEU capacity level, even though the technology will be available to design and power these vessels. Their doubt is related to the available port infrastructure and the trade factors in Northern Europe, which are unable to support these vessels. Traditionally, the North Europe location leads the way in terms of innovations in vessel size. Ultimately, carriers and ship-owners must consider not only the port limitations before placing new orders, but also their current and projected needs. This is because, in many cases, they build their vessels and tend to assume that the port will expand to facilitate their ULCV operations.

However, the use of larger ships will not lead necessarily to savings through economies of scale if the vessels do not have a high utilisation rate. Industry experts believe that utilisation rate of above 85 percent is required for vessels to generate profit. As Figure 3-13 illustrates, the utilisation rate for the Asia-Europe trade line was at 85 percent in June 2012.

The low utilisation rate was caused by the weak need for transport observed during the specified period (June 2012) along with the oversupply of vessels to the market. Figure 3-14 demonstrates the low need for transport, while Figure 3-15 demonstrates the vessels' availability through the idle containerships. A good indication of the market conditions is the statement made by Maersk's CEO in September 2012. According to Nils Andersen, Europe will take a couple of years to recover from the current financial crisis, the impacts of which are evident in shipping volume in the Asia-Europe trade line falling by eight percent in June 2012 and 14 percent in July 2012 (Hellenic Shipping News Worldwide 2012i).

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<sup>3</sup> Results of the Delphi are presented in: Mangan, J., Lalwani, C., Gibbs, D., Feng, M. and Karamperidis, S. 2012. The Relationship between Transport Logistics, Future Ship Design and Whole System Efficiency. In: *2<sup>nd</sup> International Conference on Technologies, Operations, Logistics & Modeling for Low Carbon Shipping (L.C.S)*, 11<sup>th</sup>-12<sup>th</sup> September 2012. Newcastle-upon-Tyne.

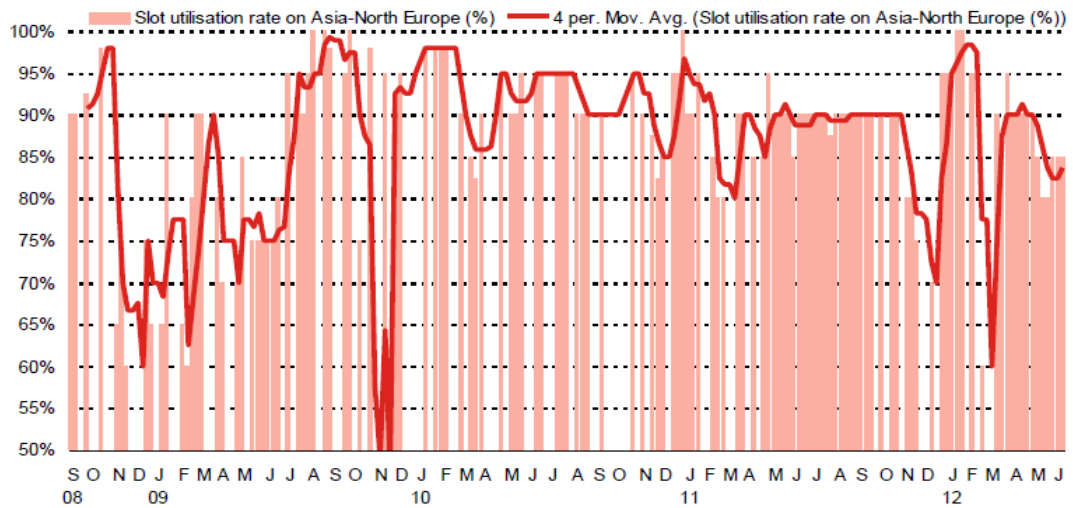


Figure 3-13 Slot utilisation rate on the Asia – North Europe trade route (in percentage)  
 Source: Hoe (2012a)

Anderson’s view concurs with the revised data published by the World Trade Organisation (WTO). As the WTO observes, the anticipated expansion of global trade has been downgraded from 3.7 percent to 2.5 percent for 2012 (World Trade Organisation 2012). This means that the world merchandise trade will expand at lower rates than initially expected, and the need for goods transport will be less than initially projected. An indication of this is illustrated in Figure 3-14.

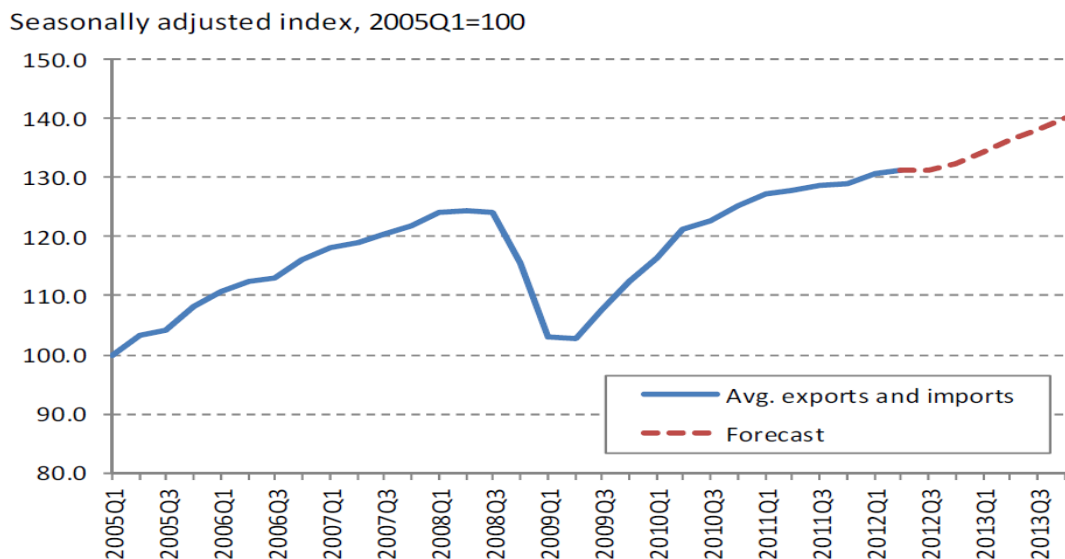


Figure 3-14 World merchandise trade volume; Q1 2005 – Q4 2013  
 Source: WTO (2012)

Furthermore, the oversupply of new vessels during previous years leads to an overcapacity in the market (Figure 3-15), which had a knock-on effect on the available vessel's utilisation as the market demand, due to the financial and economic crisis, did not increase. That low level of utilisation will lead many companies to redesign their business models in order to calculate the savings that should arise from using the economies of scale.

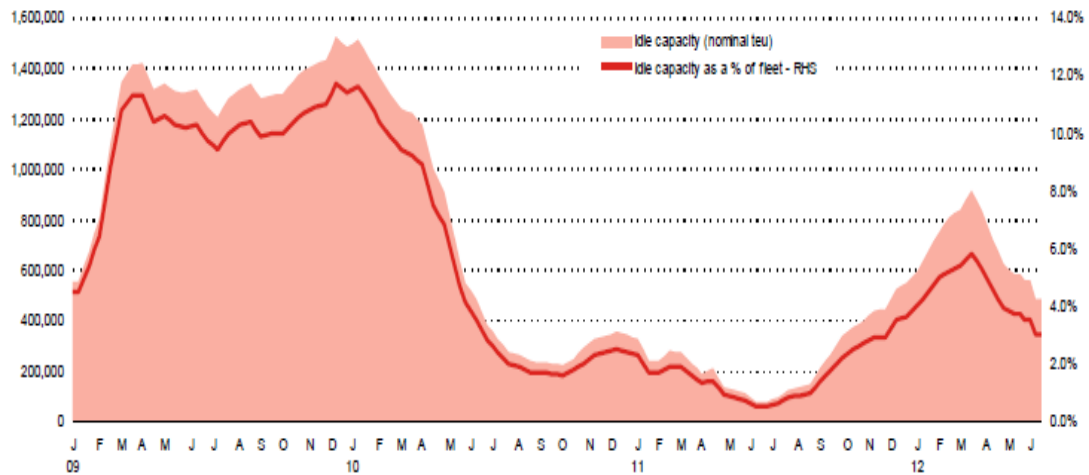


Figure 3-15 Idle containership fleet evolution between January 2009 and June 2012  
Source: Hoe (2012a)

As Alphaliner reported recently, since 2008 vessels have been upsized in all trades for two reasons: dictation of the order book by large ships, and the need to counterbalance the impact of higher fuel costs through a reduction of slot costs (Fairplay 24 2012b).

The average containership size has increased by 24 percent since 2008; from 2,610 TEU to 3,250 TEU, with average vessel sizes rising across all trade lanes as (see Figure 3-16). While the total number of containerships rose by only eight percent over the last four years to 4,965, their aggregate carrying capacity has increased by 35 percent over the same period to reach 16.13 million TEU by August 2012, according to Alphaliner's records. The upsizing trend will continue as new vessel deliveries are skewed towards larger sizes. The Far East-Europe trade line has taken most of the largest vessels due to the efforts of the carriers to reduce the impact of the high bunker costs by applying economies of scale (Alphaliner 2012c). Around 90 percent of the 138 containerships above 10,000 TEU delivered during the last four years have been deployed in the Far East-Europe trade line (Alphaliner 2012c).



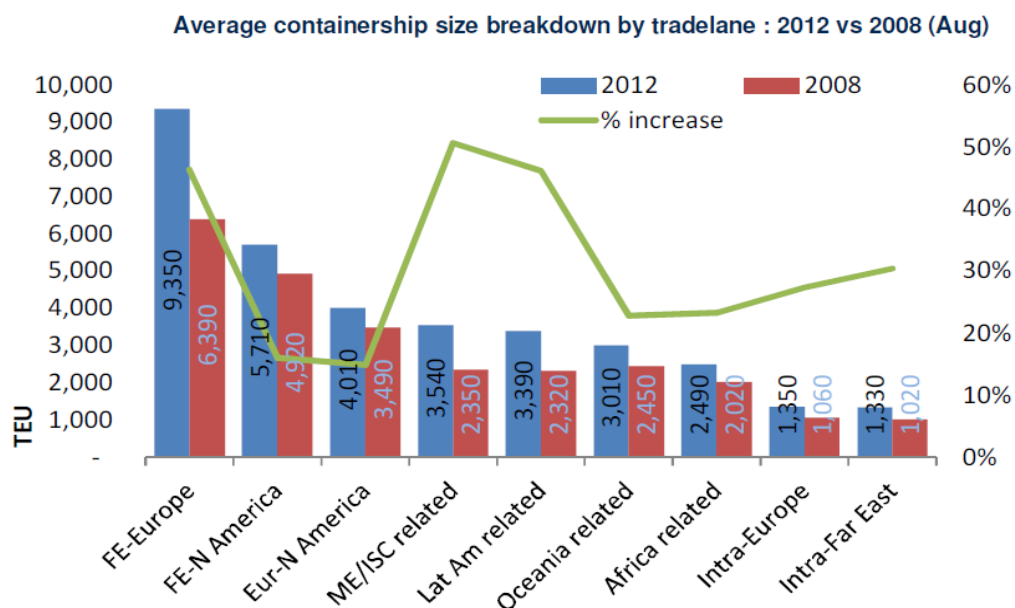


Figure 3-16 Average containership size breakdown by trade lane; 2012 vs. 2008 (Aug)  
Source: Alphaliner (2012c)

According to X. Clark et al. (2004), an additional saving, which sometimes can spring through the use of large vessels, is the seaport level savings. For example, the Port of Buenos Aires charges USD 70 per container for a vessel which carries 200 TEU and USD 14 per container for a vessel which carries 1,000 TEU to use an access channel.

In conclusion, one additional input that ship-owners have to consider when ordering new vessels is that cargo routing, ultimately, is a function of a shipper's supply chain optimisation, rather than the ocean carrier's line haul economics (Prince 2012).

#### Frequency of services

Limao and Venables (2001) believe that there is a link between transport costs and trade-freight volumes. They estimate that the elasticity of trade flows regarding the transport cost factor is around -3. These inferences are summarised in Table 3-1 and it should be noted, for example, that with a doubling of transport costs (from the median value) the trade volume is reduced by 45 percent.

When the freight volume is high, it is relatively easy for two trading regions to achieve economies of scale and have relatively frequent services. The frequency of a service is relevant to the volume of the freight being shipped over that route. For the maritime transport routes with low trade volumes, these are covered by tiny capacity vessels and vice versa (X. Clark et al. 2002). This occurs in order to fulfil the economies of scale for

the vessels servicing that route. Figure 3-17 presents the top 10 container routes recorded for 2010.

Transport cost factor, $t$ , selected values	Predicted change in trade volume from median
1.11 (25th percentile)	+53%
1.14	+42%
1.28 (Median)	0
1.56	-45%
1.83 (75th percentile)	-66%

Table 3-1 Predicted effects of transport cost factor on trade volumes,  $\tau = -3$

Source: Limao and Venables (2001)

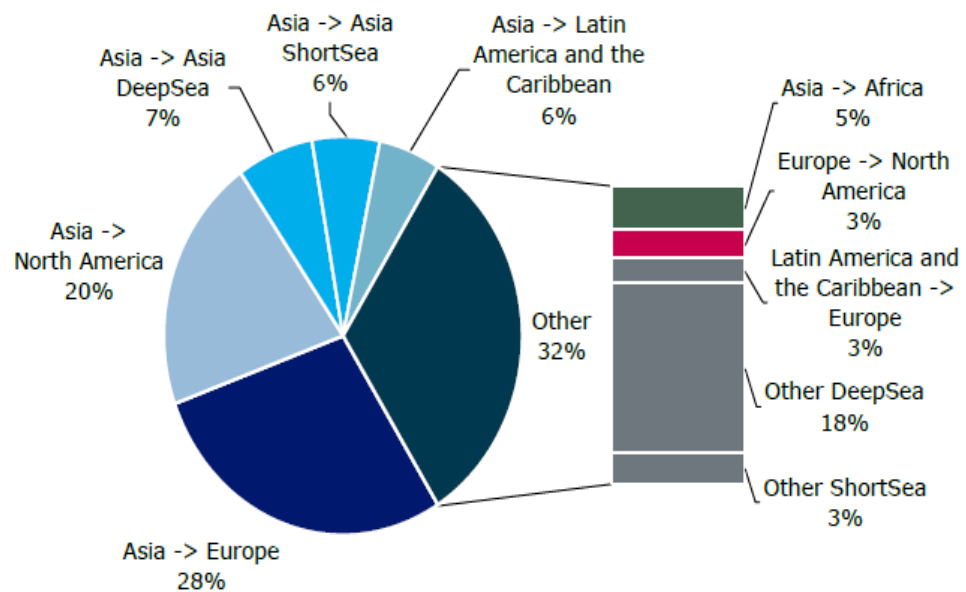


Figure 3-17 Top 10 container routes in 2010 (measured in TEU / nautical miles)

Source: Rex et al. (2011)

### Port privatisation

Wilmsmeier et al. (2006) discovered that, overall, privately-operated ports apply higher charges than public ports. This is because, when a private port needs money to improve its infrastructure, then has to take out a loan, which must be repaid with interest; in contrast, public ports generally receive some funding from local governments. Usually, the exporting port has the highest impact on freights. Of course, some ports (e.g. private ports) are regarded as more expensive than others (e.g. public ports), but that does not make them less attractive to shippers and carriers as it may allow them to generate savings elsewhere due to faster and more reliable services offered (Wilmsmeier et al.

2006). So, port privatisation may be more expensive in first instance, but reduces the maritime transport costs.

### Refrigerated cargo

According to Marquez-Ramos et al. (2005), refrigerated cargo needs special treatment; therefore, the corresponding maritime transport costs are increased. As a result, refrigerated ships are disappearing from the shipping market; moreover, refrigerated containers are easier to handle and have fewer operational costs. Of course, the refrigerated containers are more expensive to run because they consume electricity (both on board and on shore).

### Time spent at sea (number of days between service departures)

Apart from slow steaming, time was mentioned by Hummels (1999b) as a barrier to trade. According to J. Korinek (2011, pers. comm., 25 March), if the transit time of cargo from the port of origin to the destination could be halved, the maritime transport costs could be decreased by six to 21 percent. For example, one extra day spent at sea for an average sea voyage of 26 days adds 0.4 percent to the cost of the average goods, while other factors remain equal (J. Korinek 2011, pers. comm., 25 March). Similarly, Djankov et al. (2006) found that each additional day in transit was equivalent to an increase in distance of 70 kilometres.

In contrast, savings from slow steaming seem to overcome losses due to time constraints. Some ship owners and operating companies have introduced, after the 'Great Trade Collapse', the slow steaming concept. With slow steaming, ships run slower, so they consume less fuel while simultaneously increasing the fleet utilisation, as more ships are needed for the carriage of the containers. Figure 3-18 compares the fuel consumption of two types of ships (8,000 TEU and 6,000 TEU) with their operational speed (in knots), while Figure 3-19 illustrates the fuel consumption of six different vessels in a speed range of between 17 to 25 knots.

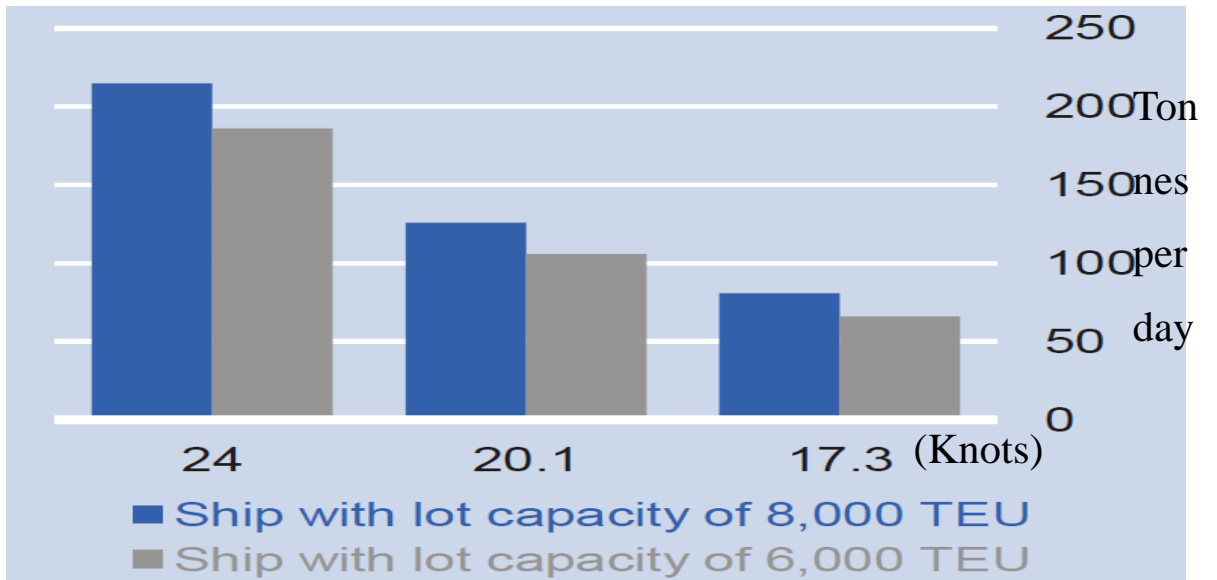


Figure 3-18 Fuel consumption (tonnes per day) vs. speed (knots)

Source: Heymann (2011)

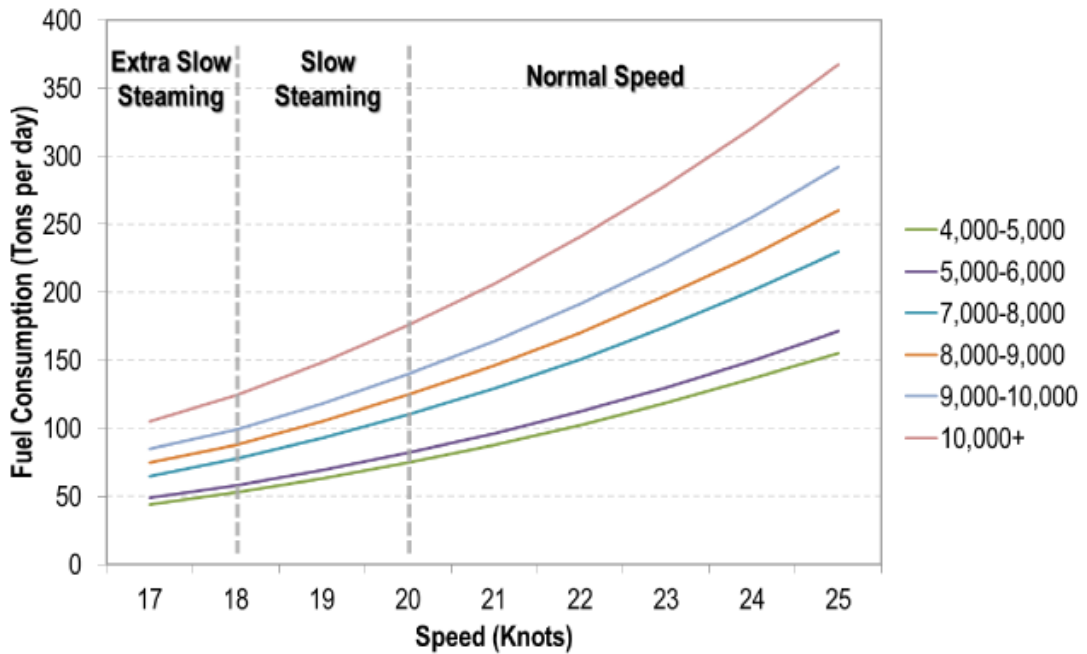


Figure 3-19 Fuel consumption (tonnes per day) vs. speed (knots)

Source: Rodrigue et al. (2012)

In 2010, the container fleet utilisation was greater than 100 percent with the help of slow steaming, which had absorbed the overcapacity (see Figure 3-20). Slow steaming seems to be a future solution for vessel overcapacity as, in 2010, it absorbed 10 percent of the idling container fleet (R.S. Platou 2011).

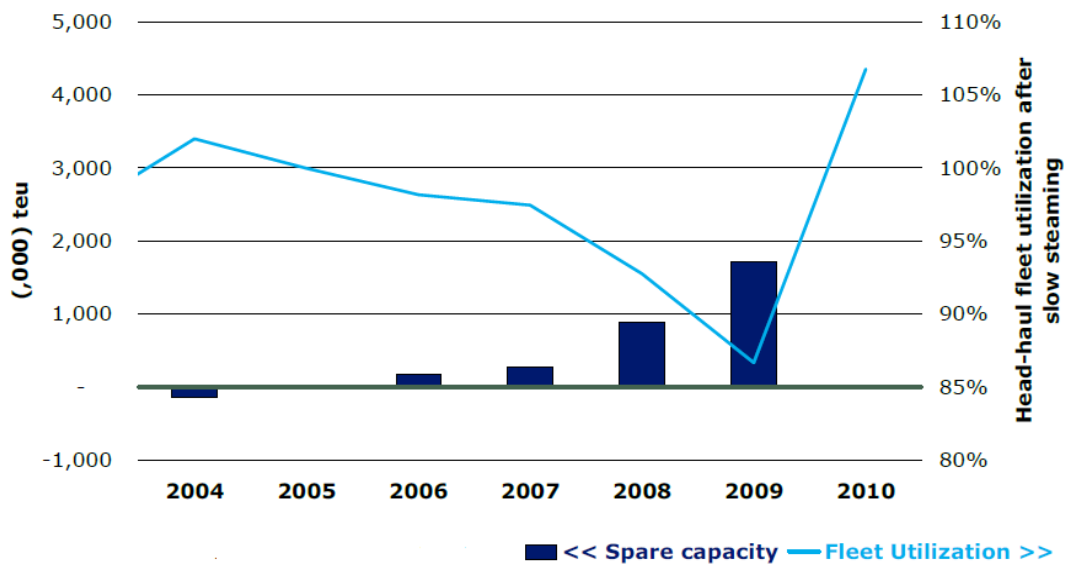


Figure 3-20 Spare capacity in thousands TEU against fleet utilisation

Source: Rex et al.(2011)

2010 is considered a good year in terms demand for container transport due to the fact that container traffic peaked; increasing the world GDP growth by 2.7 times (R.S. Platou 2011). Historically, global container traffic increased by between 2.2 and 2.7 times the world GDP (R.S. Platou 2011). De Langen et al. (2012) found that the actual annual growth of container traffic for the Hamburg-La Harve ports was 7.6 percent for the period 1990-2000 and 6.6 percent for the period 2001-2010. In their study, they also predicted that the lowest growth for 2010-2020 would be 2.2 percent and the highest growth scenario for the same period would be 4.2 percent. The same scenarios for the time period 2020-2030 provide annual growth rate ranges of 1.8 percent and 3.8 percent respectively. With these in mind, it is easy to predict that carriers will try to increase the level of slow steaming in order to absorb the idle fleet, to achieve higher utilisation ratios and higher savings in fuel consumption.

Consequently, some companies have introduced extra-slow steaming (speed of service 17-18 knots), which absorbs the surplus of tonnage capacity and provides extensive fuel costs savings (R.S. Platou 2011). The total capacity absorbed by 2012 as a result of the extra-slow steaming approach was estimated at 3.5 million TEU, while 3 million TEU capacities entered into service in 2012 (Rex et al. 2012). Figure 3-21 illustrates the effects of slow steaming into three different scenarios; 21.7 knots, 18.7 knots and 17.2 knots which exist since 2010.

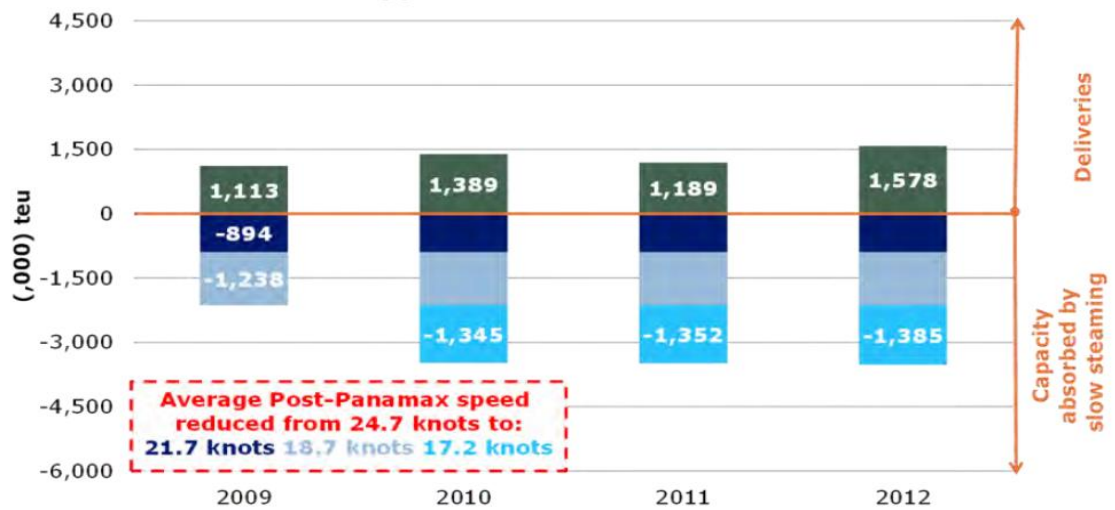


Figure 3-21 Absorbance of the TEU oversupply with slow steaming

Source: Rex et al. (2012)

Recently (September 2012), the appearance of super slow steaming has been reported (Hellenic Shipping News Worldwide 2012l). Super slow steaming has a speed of 14 knots and below. With these speed levels, the carriers are doing anything possible in order to absorb the capacity (Hellenic Shipping News Worldwide 2012l). According to Alphaliner, the extra slow steaming has absorbed 930,000 TEU during the first eight months of 2012, which is equal to the 5.7 percent of the total container fleet (Alphaliner 2012d). The evolution of extra and super slow steaming and bunker prices are illustrated in Figure 3-22.

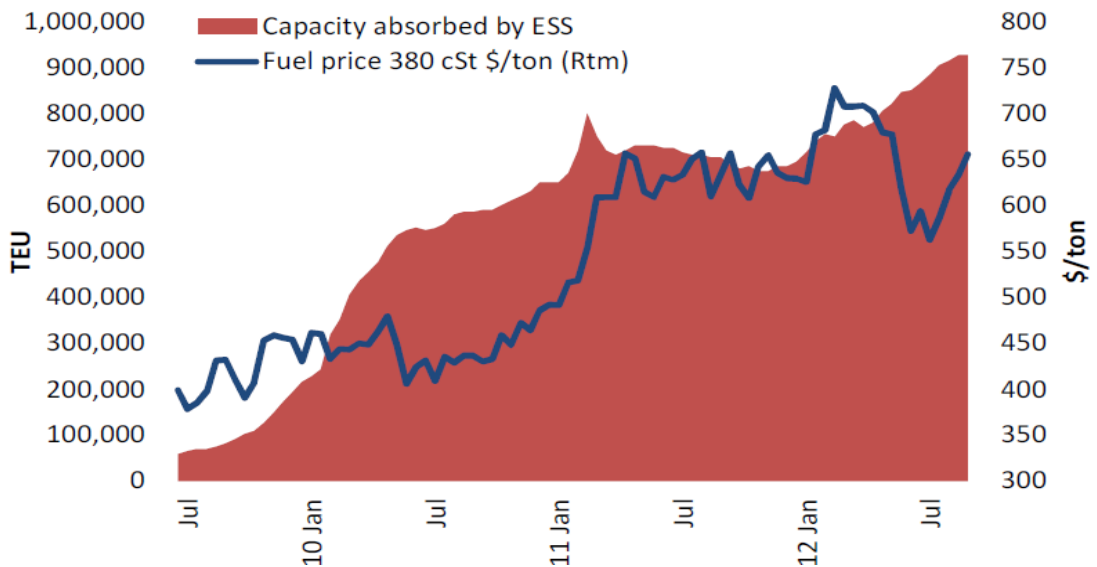


Figure 3-22 Capacity absorbed by Extra/Super Slow Steaming; July 2009-Aug 2012

Source: Alphaliner (2012d)

The average speed of vessels adopting the slow steaming is currently (September 2012) 10.44 knots. This is 10 percent lower than the average speed a year ago (Hellenic Shipping News Worldwide 2012c).

However, slow steaming (or extra-slow steaming) is not always beneficial, especially for the container sector, as it hides some additional important costs. These include the cost of leasing containers, which will increase in the near future, and inventory-holding costs. Presently, container companies own about 60 percent of the entire container fleet, but their share will probably deplete as the older boxes have an average lifespan of 14 years. This is due to the 'Great Trade Collapse' when shipping companies spent more money buying new ships rather than new boxes. Therefore, if a ship spends more time at sea, the shipping company will have to pay more money to lessors for their boxes that are being used (Kowalski 2011).

Slow steaming (or extra-slow steaming) results in extra transit time between two points. Transit time is one of the most important factors influencing shipping costs, in accordance with the World Economic Forum (Lawrence et al. 2012). The same report declares that, when the shipping time is prolonged, shippers will have additional inventory-holding costs-financing costs for the goods and the associated need to hold buffer stocks. Moreover, there are also depreciation costs (Lawrence et al. 2012). Many industry experts seem to agree with these findings; for instance, Mr. Jason Keegan, Head of Logistics of Marks and Spencer (M&S), states: "In my view, slow-steaming is not an innovation, as it costs M&S a lot of money in working capital" (Containerisation International Online 2012). Another statement was made by the instructor and consultant, Mr. Rogeria Correia: "The extra time in the transportation pipeline is costing shippers large sums of money. Surely it is time the lines and their customers put their heads together and came up with rates-to-transit time packages that everyone can live with" (Weir 2012a). Due to slow steaming, the average length of a loop journey between the Far East and Europe has increased by 28 percent since 2007. As Alphaliner demonstrates, the average rotation of the Far East-North Europe loop in 2007 was 8.2 weeks. This increased to 10.5 weeks in mid-2012 (Alphaliner 2012d).

#### *Container service (schedule) reliability*

Container schedule reliability is monitored through two reports published by Drewry Maritime Research and SeaIntel. Drewry Maritime Research prepares a quarterly report

entitled the “Schedule Reliability Insight”, while SeaIntel prepares a monthly report, the “Schedule Reliability Report”. Both reports detail container service reliability. Overall container service reliability fell to 51 percent for the first quarter of 2011, compared with the fourth quarter of 2010 when it stood at 55 percent, according to Drewry Maritime Research (Hellenic Shipping News Worldwide 2011b). The transpacific trade remained the most reliable of the three major east-west routes in conformity with the report. Its score was 55 percent for the first quarter of 2011, in comparison with 64 percent for the fourth quarter of 2010, as reported by Drewry Maritime Research (Hellenic Shipping News Worldwide 2011b). The large decline in container schedule reliability represents a sharp fall in freight rates, according to the report, as a synchronisation of freight rates with reliability has existed since the first quarter of the last year 2011 (Hellenic Shipping News Worldwide 2011b). The main reasons for not achieving container service reliability for the first quarter of 2011, in line with MOL, are: the New Year holiday, bad weather and berth congestion due to the recent Japanese earthquake (Hellenic Shipping News Worldwide 2011f).

The World Bank, through its report “Connecting to Compete” (Arvis et al. 2012), demonstrates that the lack of reliability and unpredictable attendant delays could cause more damage in the supply chains. This is especially relevant to low-income and many middle-income economies. Many industry experts have addressed the importance of reliability in the maritime container sector. Maersk’s CEO commented that their Daily Maersk concept was successful for their customers and managed to achieve direct savings on logistical costs (Maersk Line 2012a). These savings have risen with the service’s punctuality, which is helped by slow steaming: “Slow steaming is making the network more reliable... Most customers willingly accept slightly longer voyage transits in exchange for guaranteed door-to-door arrival times” (Hoe 2012b).

### Pipeline stocks

According to Saldana et al. (2009), pipeline stocks are typically more than four times the quantity of safety stocks. The most common reasons for this are: i) customs clearance; for example, in the USA containers must reach the port-of-departure at least two days before the booked vessel is scheduled to arrive (Saldana et al. 2009). Full-body scanners are the latest security measures in airports and millions of containers may soon need to be scanned before they are loaded onto ships (IMO 2010a); thereby



leading to additional delays; ii) port congestion, which, in the worst case, can reduce the benefits of highly sophisticated in-port logistics facilities (OECD/ITF 2008).

Inefficiencies in the non-ocean segments of the overall supply chain can also limit efficiencies of the supply chain and dilute the otherwise beneficial influence of superior ocean transit-time performance on the total transit time (Saldana et al. 2009) and; iii) dwell time, which is the time needed to import a container at a port. In other words, the average delay between unloading the container and exit from the port. This factor is a key indicator for international logistics, as suggested in The World Bank report, “Connecting to Compete” (Arvis et al. 2012).

A benefit of the ‘Great Trade Collapse’ is that port congestion has not existed at container terminals in recent years, with the exception of some hotspots (Hellenic Shipping News Worldwide 2012h). However, potential port congestion is still an important factor, which according to industry experts will rise when trade increases, especially in countries that have a bad infrastructure.

### Tariffs

Tariffs are another factor affecting maritime transport costs. Hummels (2007) found that, if a tariff is doubled, e.g. from five percent to 10 percent, the maritime transport costs will increase by 1.3 percent.

### Port efficiency

De Neufville and Tsunokawa (1981) and Notteboom et al. (2000) have measured port performance and efficiency. With the use of the Bayesian stochastic frontier technique, Notteboom et al. (2000) were able to pool individual results measuring port efficiency of each port. Port efficiency was addressed by the following characteristics: container traffic in TEU (loadings and unloading), terminal quay length in metres, terminal surface in hectares, number of container gantry cranes used on the terminal, the average number of workers per crane, the centrality index of the terminal (the index provides insight, in the way ports are strategically located with respect to production and/or consumption centres in hinterland), the diversion distance from the main trade route. After studying all the above port characteristics, Notteboom et al. (2000) found that hub ports perform better than feeder ports, as demonstrated in Table 3-2.

Efficiency level	0.60–0.65	0.65-0.70	0.70-0.75	0.75-0.80	0.80-0.85	Total number
Functional role of port						
Number of hub ports	0	2	1	10	6	19
percentage	0%	11%	5%	53%	32%	100%
Number of feeder ports	1	3	2	8	3	17
percentage	6%	18%	12%	47%	18%	100%
Total number of ports	1	5	3	18	9	36
percentage	3%	14%	8%	50%	25%	100%

Table 3-2 Grouping of pooled efficiencies according to functional role of a port and its efficiency level

Source: Notteboom et al. (2000)

Port infrastructures are not a fixed advantage, unlike the location, but a dynamic and changing characteristic affected by global economic developments and the capability of a port to serve various shipping networks (Marquez-Ramos et al. 2005). Martinez-Zarzoso and Nowak-Lehman (2003) have also found that port infrastructure affects the bilateral trade. Additionally, J. S. Wilson et al. (2003) found that port efficiency has a significant impact on bilateral trade flows in the Asia-Pacific region. Moreover, X. Clark et al. (2004) yielded the same result for the bilateral trade between the Latin American countries and the USA. The only probable disadvantage which the two mentioned studies may have is that they measure only a point in time and may lose other national economic characteristics that are not observed. Blonigen and W. W. Wilson (2008), in their research on port efficiency measures, also include time-varying measures that enable the control of unobserved country-level heterogeneity in trade flows. Jonkeren et al. (2011) discussed the fact that, in economies of density, they also affect port performance. As higher traffic density emerges on a route, carrier have the opportunity to use larger vessels and to operate more intensely the facilities. Such density has been captured by Jonkeren et al. (2011) in three trip-specific variables: vessel size, load factor and travel time. Sanchez et al. (2003) provide evidence that port efficiency has the same impact as geographical distance or the economies of scale on the international maritime transport costs. Wilmsmeier et al. (2006) demonstrate that if the import and export countries increase their port infrastructure by one percent, the freight will be reduced by 0.24 percent. While, if the port efficiency of importing and

exporting country increases by one percent, the freight charges will reduce by 0.38 percent. Generally, port improvements at the point of export appear to impact more strongly on maritime freight than those at the port of import. Finally, Wilmsmeier et al. (2006) demonstrate that if both ports of export and import double their efficiency, the international maritime transport cost will be the same as if the two ports were 50 percent closer. In other words, the distance between the two ports decreases by 50 percent when both ports double their efficiency.

X. Clark et al. (2004) believe that an improvement in port efficiency from the 25th percentile to the 75th percentile reduces shipping costs by more than 12 percent, or by the equivalent of 5,000 miles. Furthermore, X. Clark et al. (2004) suggest that, if China, Indonesia and/or Mexico improved their port efficiency to levels observed in countries such as France and/or Sweden, their transport cost reductions would be around 10 percent. Some larger ports in Europe, for example, Antwerp, are considered by shipping lines as a kind of safety valve for their schedule, in the sense that if a vessel is delayed in transit, very high terminal productivities can subsequently be achieved to bring a vessel back on schedule as quickly as possible (Notteboom 2006). The earlier findings have been verified by other research conducted by Lirn et al. (2004), who with the help of Analytical Hierarchy Progress (AHP), applied to industry expert extracts, with the help of weights, the most important characteristics of a port (the findings of the AHP are in Appendix A).

After examining six port characteristics, Wilmsmeier et al. (2006) found that efficiency and infrastructure are the most critical elements in determining port success. They also found that if two ports can double their efficiency and are involved in bilateral trade, the impact of that improvement in international maritime transport costs is the same as halving the route distance between the two ports. The following is a set of infrastructure variables that addresses port efficiency and performance:

- 1) Number of cranes (Marquez-Ramos et al. 2005)
- 2) Quay length (Marquez-Ramos et al. 2005)
- 3) Maximum draught (Blonigen and W. W. Wilson 2008)
- 4) Ocean/tidal movements (Blonigen and W. W. Wilson 2008)
- 5) Time to clear customs (Blonigen and W. W. Wilson 2008). Customs of the country which the product is exported do not impact on freight, while the

importing country has a positive impact of 0.0051 percent on freight when the customs clearance time is reduced by one percent (Wilmsmeier et al. 2006)

6) Labour relationships (Blonigen and W. W. Wilson 2008)

7) Port container throughput (Marquez-Ramos et al. 2005)

8) Storage area at origin and destination ports (Marquez-Ramos et al. 2005)

Various studies exist in the field of port efficiency suggesting that improvements could lead to maritime transport cost reductions. The level of the reductions varies according to the study and the data sets analysed by each researcher.

#### Level of organised crime

The level of organised crime is another factor affecting maritime transport costs. X. Clark et al. (2004) demonstrate that organised crime has an important negative impact on port services. This, in turn, impacts on increasing transport costs.

#### Vessel characteristics (vessel design)

Shipbuilding companies aim to reduce ship operating costs through improved vessel design. Innovations and developments focus, in particular, on areas such as hull design, vessel capacity and energy-efficient propulsion systems (a notable example being recent trials on the use of sails on large commercial vessels). In the container trades, vessel size in particular can have a significant effect on freight rates. Maritime transport is an industry that faces an increasing return to scale effects. Alfred Marshall (1920) succinctly commented: "... a ship's carrying power varies as the cube of her dimensions, while the resistance offered by the water increases only a little faster than the square of her dimensions". So, the ship-owners and shipbuilders aim to make use of the economies of scale with the construction of larger vessels. Bendall and Stent (1987) and Marquez-Ramos et al. (2005) consider the fact that vessels' significant characteristics as: a) the average capacity b) speed c) age of the youngest vessel in service x, can explain the positive effect of fleet performance on a service between two ports. Larger capacity, younger vessels with higher speeds will, therefore, help in the cost-reduction activities.

#### Exchange rates (money)

Martinez-Zarzoso and Nowak-Lehman (2003) found that currency exchange rates have a notable impact on maritime transport costs. In contrast, the correlation found by

Martinez-Zarzoso and Nowak-Lehman (2003) may be correct, but in reverse. As Figure 3-23 illustrates, the BDI influenced strongly the relationship of the Euro and USD. Due to the fluctuations in the exchange rates, shipping companies add a currency adjustment factor, which is an extra cost for the shipment of a container. Because exchange rates can fluctuate during the journey of a container, shipping costs are usually calculated in USD (Business Link 2011).

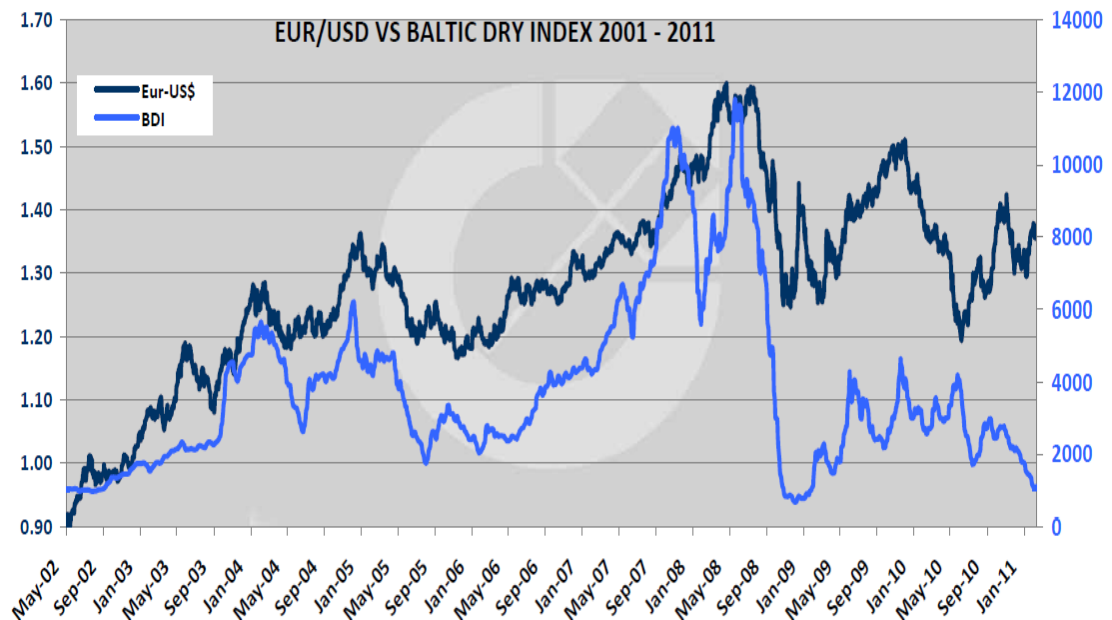


Figure 3-23 Trends of EUR/USD against the Baltic Dry Index (2001-2011)

Source: N. Contzias Shipping Consultants (2011)

### Insurance

The use of high-risk routes (such as those that pass through the Gulf of Aden, and the North East/North West passage) are more expensive in terms of insurance costs. This is because, when the vessel sails through these regions, there is a greater risk of it being damaged (Thomson Reuters 2011).

### Environmental issues

Some ports are attempting to charge an environmental tax on containers. For example, the local government of California wanted to charge every container that was transiting, loaded or unloaded in Californian ports at a rate of 30 USD per container. However, the governor of California had to reduce the fee (HighBeam Research 2011). Conversely, some European ports have announced that they would reward vessels that have good rankings in environmental indices (Fairplay 24 2010b).

### Corruption (institutional quality)

If the levels of corruption in Greece, Poland or Italy were to diminish to those of Denmark or New Zealand, this alone would reduce transport costs by nine percent (J. Korinek 2011, pers. comm., 25 March). Sometimes a shipper has to bribe the administrative officers of certain ports, the cost of which will be cascaded to their customers. The level of corruption in every country is captured by the Corruption Perception Index (CPI) published by Transparency International (2011).

SeaIntel Maritime has revealed a link between corruption and the likelihood of a container to arrive on time (Weir 2012b), although this is not the only reason. The absence of direct services and the shipment of a container with multiple transshipments or a poor infrastructure or even bad weather could contribute to delays (Weir 2012b).

### Regulatory framework

Jane Korinek (2011, pers. comm., 25 March) notes that the regulatory framework determines largely if the shipping industry will achieve the efficiencies it aims for and which it is hoped will be able to reduce the maritime transport costs. According to J. Korinek (2011, pers. comm., 25 March), elements that are affected by the regulatory framework include the following cargo reservation policies:

- 1) Openness of the cargo handling service industry. Workers in some ports are required to have a license in order to provide stevedoring services. These bring extra costs without providing any extra service.
- 2) If the docking services for ships are mandatory or not from a port.
- 3) Price-fixing carrier agreements.
- 4) Cooperative working agreements.

### Oil price

In the research conducted by Beverelli et al. (2010), a high positive correlation of 0.98 was found between the Brent oil prices and the bunker fuel costs. The maritime transport, as with other transport modes, relies heavily on oil for propulsion; thus, any escalations in the Brent price could have a significant impact on the maritime transport sector (Beverelli et al. 2010). It has been observed that during volatile and sharply rising oil prices, container freight rates also increase (Beverelli et al. 2010). The problem which the maritime industry has, according to M. Stopford (2011, pers. comm., 16

March), is that its models are based on relatively low oil prices. Therefore, the escalating price of fuel oil is certainly a significant factor that will affect the maritime transport cost (M. Stopford, 2011, pers. comm., 16 March).

As oil is becoming scarcer, its price will increase gradually year by year, as illustrated in Figure 3-24. Therefore, it could be predicted that the maritime transport costs will follow the trend of oil prices.

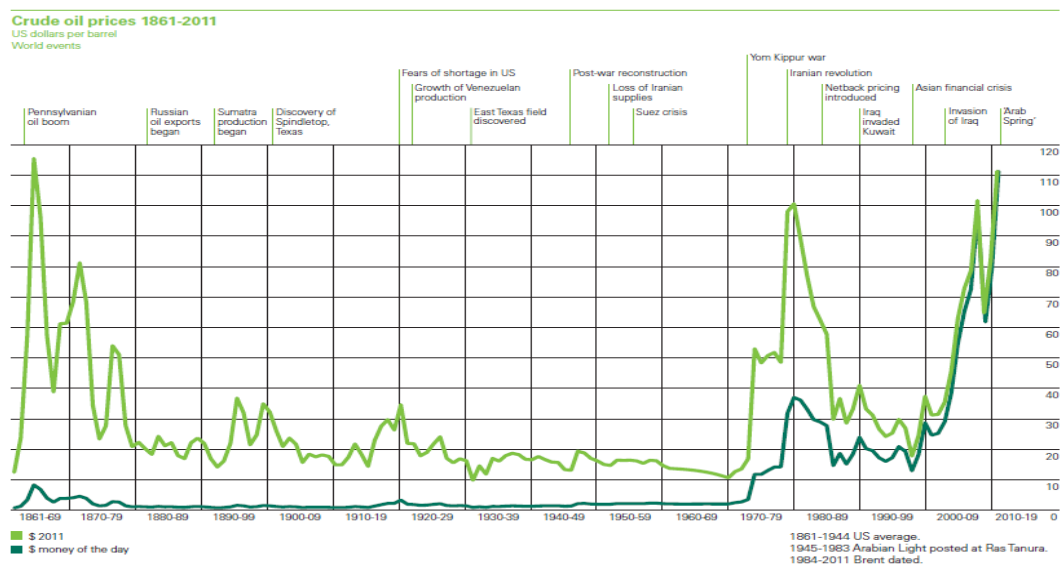


Figure 3-24 Crude oil price from 1861 until 2011 in USD per barrel

Source: BP (2012)

However, the increase in oil price is not always translated into higher freight rates for the container sector, as shown in Figure 3-25. Of course, when that is the case, shipping companies are faced with losses. Consequently, shipping companies have introduced surcharges, such as the Bunker Adjustment Factor (BAF), which is used to absorb any fluctuations in fuel prices (Business Link 2011) and to reduce the losses. It is then used as a revenue generator when the freight rates are low (Slack and Gouvernal 2011). That surcharge has evolved from the Far East Freight Conference (FEFC) before the abolition of the conferences on the 18<sup>th</sup> of October 2008 (Alphaliner 2011a). The BAF system was first introduced by carriers in 1974 in the aftermath of the first oil crisis. How those surcharges are added to the final freight rate is demonstrated in Section 3.6.1.

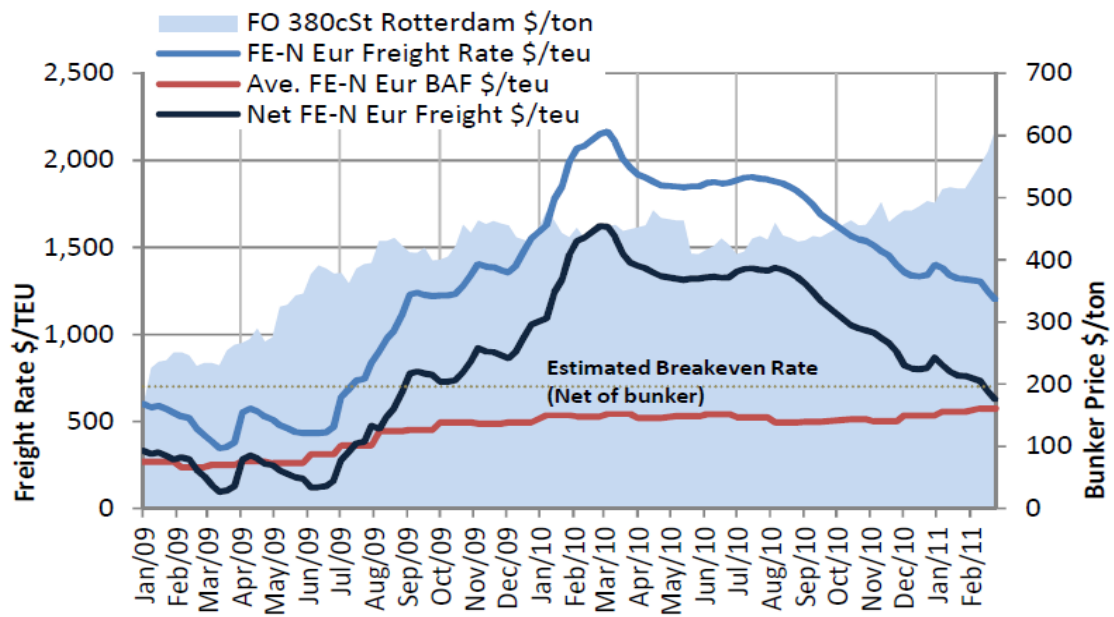


Figure 3-25 Freight rates USD/TEU vs. bunker prices USD/ton for the route Far East – North Europe, 2009-2011

Source: Alphaliner (2011b)

Freight rates cover basic bunker costs, while the BAF applies to changes above the base level. These have been calculated using various formulas and base rates and, as a result, they have been criticised by shippers as being opaque. The largest problem which shippers face with liner companies is that the savings from slow steaming and the use of more efficient ships are not passed on to them; therefore, some carriers have stopped charging the BAF and have instead introduced the all-in rates, while others have introduced the Emergency Bunker Surcharge (EBS) which is substantially lower than the official BAF (Alphaliner 2011a). According to Alphaliner (2011a), the BAF was USD 776/TEU on June 2011, as Figure 3-26 illustrates.

BAF and average bunker prices are regarded as having a close relationship according to Cariou and Wolff (2006), but the BAF covers responses to both the upward and downward movements of bunker prices. In contrast, Notteboom and Cariou (2009) demonstrated that divergences exist between the BAF and bunker prices, but these are dependent on the trade line. The Far East-Northern Europe trade line, for example, had the one of the lowest divergences (Notteboom and Cariou 2009).



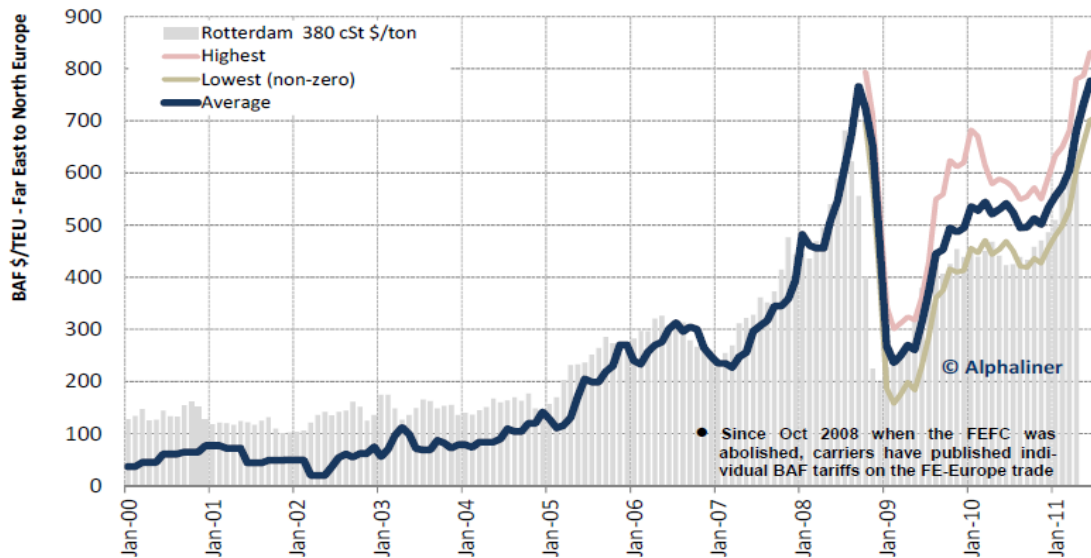


Figure 3-26 Bunker price and BAF on the FE-North Europe trade; 2000-2011

Source: Alphaliner (2011a)

Between 2008 and 2011, average fuel prices increased by 186 percent, while the average BAF charge to North Europe has increased by 227 percent. In conformity with UNCTAD (Beverelli et al. 2010), an increase in bunker fuel prices of 10 percent leads to an increase in container freight rates ranging between 1.7 and 3.4 percent. Those figures were generated after regressing the container freight rates on bunker fuel prices, so an elasticity was delivered ranging between 0.17 and 0.34. Of course, the analysis conducted by Beverelli et al. (2010) to calculate elasticity uses a model that excludes some important factors, such as distance. Thus, it may not capture accurately the importance of bunker costs.

According to Figure 3-27, which is generated from Clarksons (2012b), the bunker costs could comprise 85 percent of the total daily cost of a Panamax vessel, 4,400 TEU at 24.3 knots. These costs could be reduced if the vessel decreases its speed by 4.3 knots. With an approximate calculation for the 4,400 TEU ship sailing at 20 knots, the ship operator could gain USD 45,000 per day [consumption of 380cst (centistoke) bunker for a 4,400 TEU vessel at 24.3 knots is 145.4 tpd, while at 20 knots is 81 tpd. If the difference between the consumption and the price of the 380cst bunker, which is roughly USD 700/tonne (28 May 2012), is calculated, the savings are USD 45,080 per day] (Clarksons 2012b).

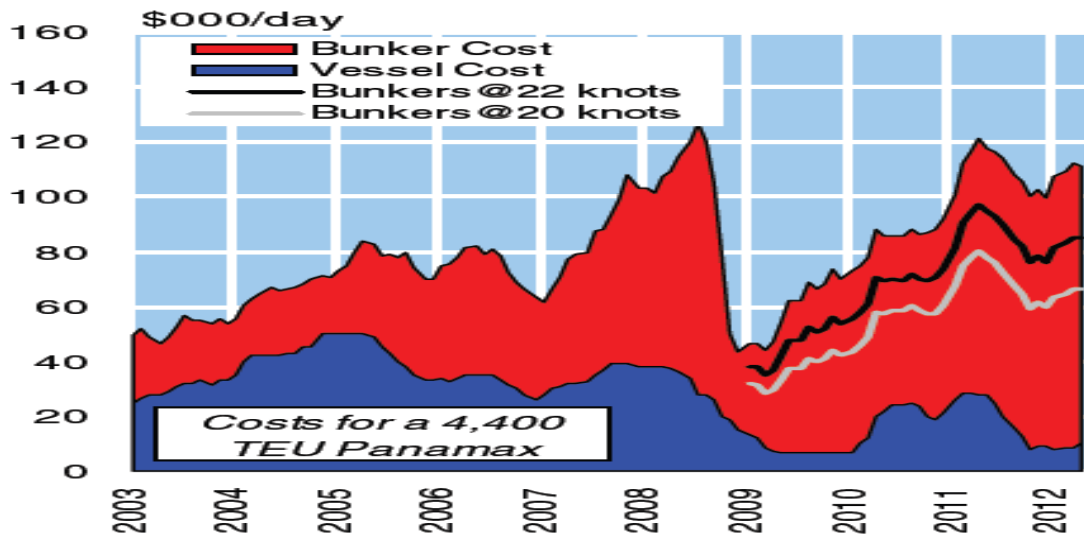


Figure 3-27 Bunker costs at 24.3, 22 and 20 knots for a 4,400 TEU Panamax vessel compared with the costs of the vessel since 2003

Source: Clarksons (2012b)

The increased price of bunkers arose from a situation relatively unique for the shipping industry. One example, which comes from the dry industry, demonstrates that is the first time since 1989 that bunker costs have surpassed the cost of hiring a vessel; illustrated in Figure 3-28. This fact demonstrates the current importance of the bunkering costs in shipping, which consists of 60 percent of the total coal transportation (Lawrence et al. 2012).

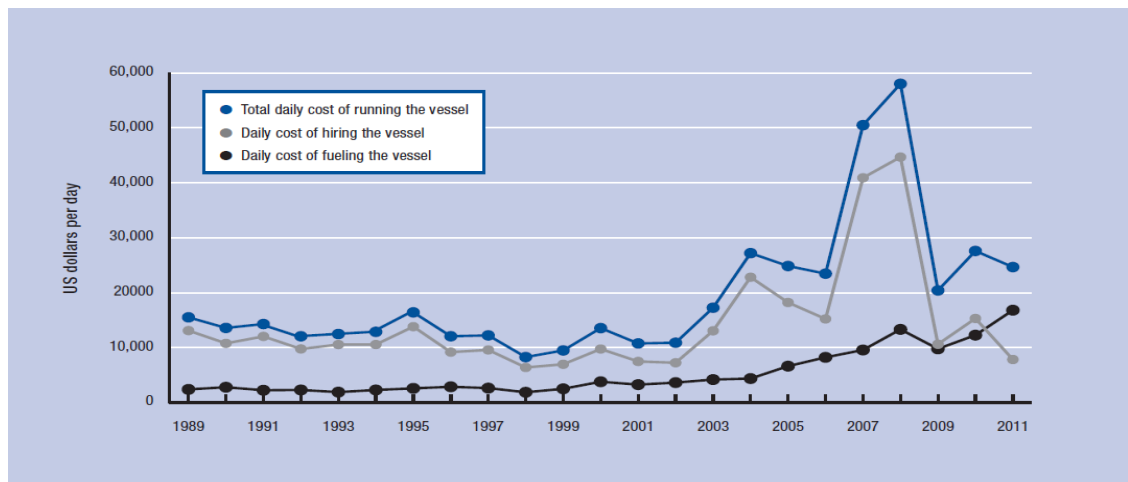


Figure 3-28 Daily cost of moving 65,000 metric tons of coal

Source: Lawrence et al. (2012)

A similar example is captured for the container sector, as Figure 3-29 illustrates.

Unfortunately, it was not possible to find data prior to 2002, but according to Clarksons

database the daily cost of fuelling a vessel surpassed the daily cost of hiring a vessel in 2008. Moreover, since then it has increased gradually to USD 50,000, while the cost of hiring a vessel remains below USD 20,000 for 2011. The daily fuel consumption has been calculated at 81 tonnes per day, which is a typical consumption of 380cst bunker for a 4,400 TEU vessel at 20 knots (Clarksons 2012b). The average speed of 20 knots is taken, even though slow steaming has generally been applied over recent years, due to the fact that the task is in trying to compare the fuel consumption rates since 2002. Therefore, an average speed for that time frame could be 20 knots, according to Clarksons (2012b).

The savings of slow steaming could be demonstrated by considering a 10,000 TEU vessel [which is roughly the average vessel sailing in the Asia - Northern Europe trade line (Beddow 2012a)]. According to Wackett (2013), a 10,000 TEU vessel sailing at 25-20 knots consumes 350 tonnes of 380cst bunker/day, while when it sails at 18-15 knots it consumes 100 tonnes of 380cst bunker/day. Using the same price for the 380cst/tonne as used previously (USD 700), a saving of USD 175,000 per day could be achieved.

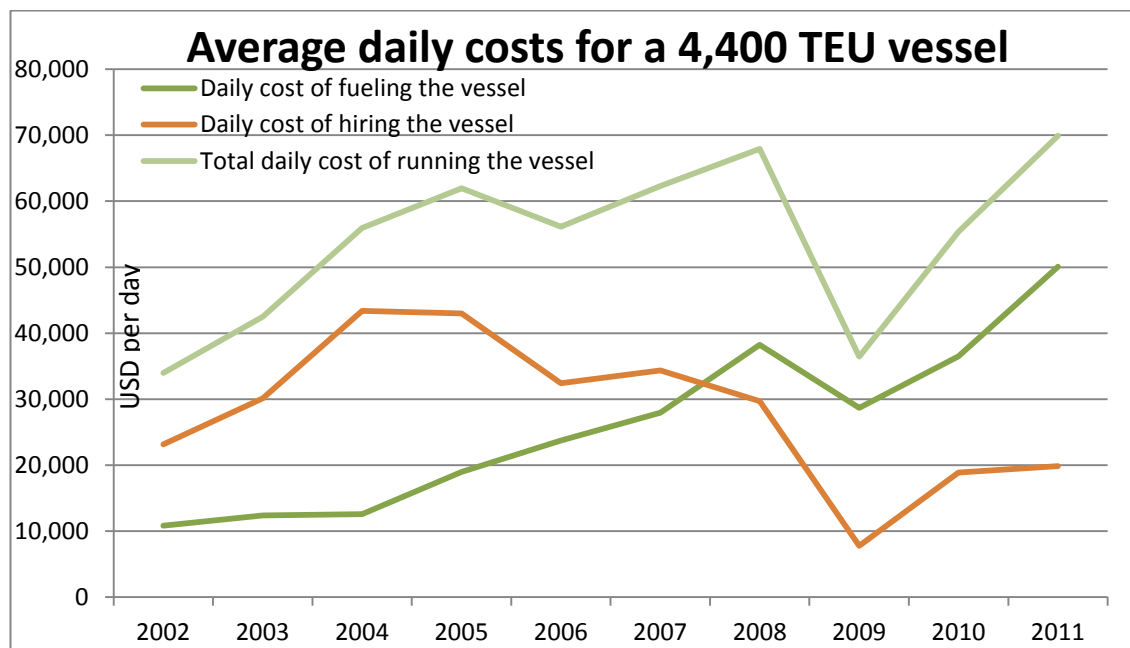


Figure 3-29 Average daily costs of a Panamax vessel (4,400 TEU)

Source: Adapted from Clarksons (2012d)

Another factor affecting the price of bunkering is the geographical location from where the shipping lines fuels are supplied. According to Drewry Maritime Research, there were some rumours that, due to the fact that the Singapore IFO (Intermediate Fuel Oil)

price was considerably higher than the IFO price in Rotterdam [as Figure 3-30, Figure 3-31 and Figure 3-32, and the data from the average bunker fuel prices from 1998 to 2008 collected from Beverelli et al. (2010) illustrates], the freight rates in the backhaul Europe to Asia trip might have been correspondingly influenced. This probably occurs because more lines were filling up their ships with cheaper bunker at Rotterdam port and, subsequently, were leaving behind some of the lower-contribution export freight; thus, making it more difficult for those shippers to secure on-board container space (Drewry Maritime Research 2012).

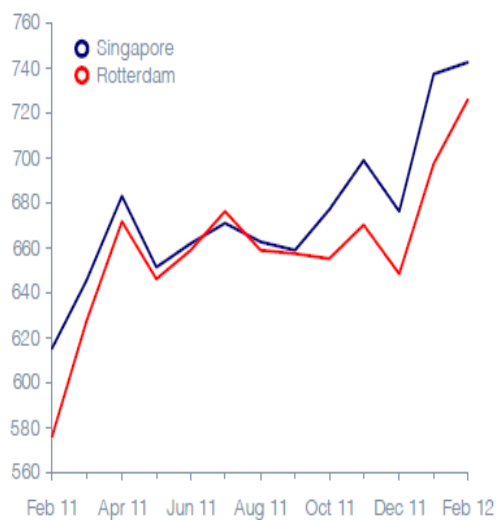


Figure 3-30 IFO bunker prices; Feb 2011-Feb 2012 (USD/tonne)

Source: Drewry Maritime Research (2012)

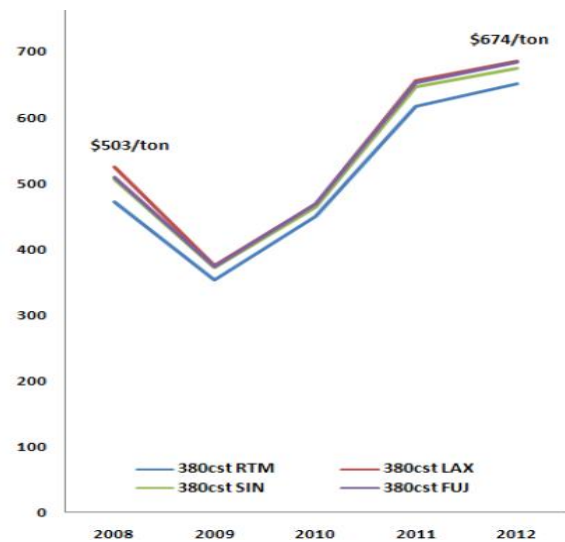


Figure 3-31 380cst average bunker prices; Jan 2008-Sept 2012 (USD/tonne)

Source: Morochartzis (2012)

In conclusion, the savings ship-owners/carriers can achieve through reducing their fuel consumption are vast. As Hoe (2012b) demonstrates, the fuel savings of a 9,000 TEU wide-beam designed containership with an optimum sailing speed of 18 knots, could be 70 tonnes per day. This saving could be the equivalent of USD 40,000 per day at current prices, which is lower than the USD 50,000 per day charter rate agreed by Evergreen for 10 13,800 TEU containerships (Hellenic Shipping News Worldwide 2012f); however, it is higher than the USD 35,000 per day charter price agreed by APL for the 8,530 TEU vessel, APL Zeebrugge (Fairplay 24 2012). Thus, some clever tactics in fuels management, such as slow steaming, could reduce the bunker consumption of the vessel to the levels the ship operator pays for hiring the vessel.

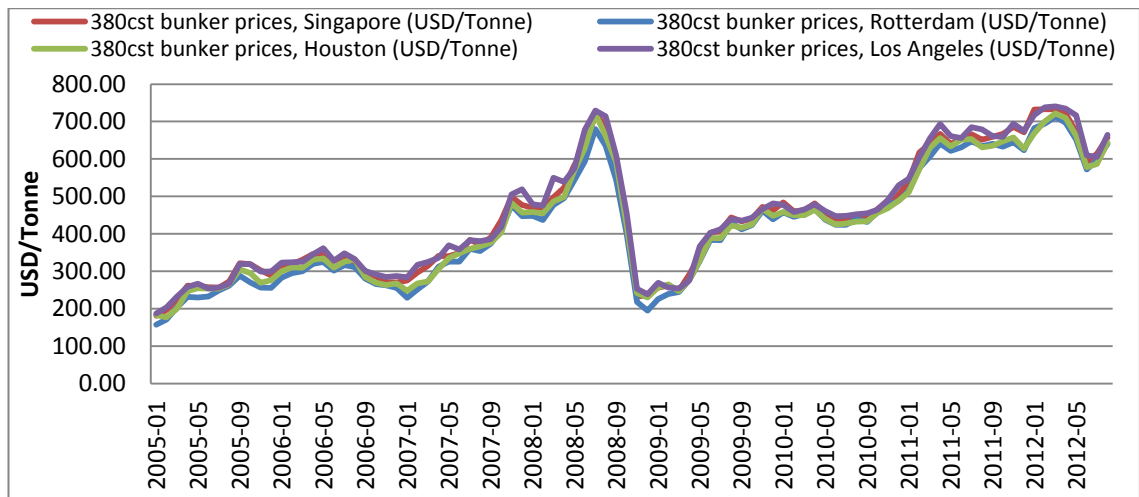


Figure 3-32 Evolution of 380cst global bunker prices; 1-1-2005 - 1-8-2012

Source: Clarksons (2012c)

Freight rates (Global supply/demand balance)

Usually, freight rates are the same for every container category in most of the trade lines, regardless of what the container carries and the quantity loaded on it; therefore, they are called Freight All Kinds (FAK) (Fakhr-Eldin and Notteboom 2012). Of course, rate differentiations exist amongst each container type; TEU, FEU, refrigerated, tank, etc. (Gouveral and Slack 2012). However, this takes place only in theory rather than in practice, as FAK tariffs are quite complex. What is actually captured for rates is that they can vary by customer, even for the same destination. This variation is determined by how important an individual customer is to the shipping line for that particular destination (Gouveral and Slack 2012). Academic literature on freight rates pays less attention to this, regardless of their importance (Gouveral and Slack 2012). Also, the industry has not, thus far, created enough systematic and reliable measurements for freight rates. Only a few indices exist that capture the actual freight rates. Furthermore, these indices capture data for only a few trade lines; therefore, this research has decided to use the Shanghai Container Freight Index (SCFI), which is the most commonly-used freight rate index in the container sector. Specifically, the North Europe-Shanghai freight rates of the index are used, as UK-Shanghai freight rates do not exist currently. Unfortunately, the UK also lacks a UK-specific measurement for freight rates. This is probably due to the fact that, in accordance with industry experts, the UK freight rates are only experiencing a tiny variation from the Northern Europe freight rates.

The exploitation of the economies of scale has helped to cause freight rates reduction. Notwithstanding, freight rates still fluctuate widely in response to numerous factors, such as fuel prices, operating costs and, most notably, the interaction of supply and demand, which is expressed by the utilisation rate of the vessels. The utilisation rate demonstrates the need for services compared with their availability. According to industry experts, an utilisation rate above 85 percent is profitable for ship operators. As Figure 3-33 illustrates, before the ‘Great Trade Collapse’, which has reduced the utilisation rate of the world merchant fleet, the utilisation rate was above 85 percent. During the last three years, the utilisation rate has been around 80 percent. This has been caused by factors relating to the continuous oversupply to the market with new vessels, while demand has fallen (Figure 3-33).

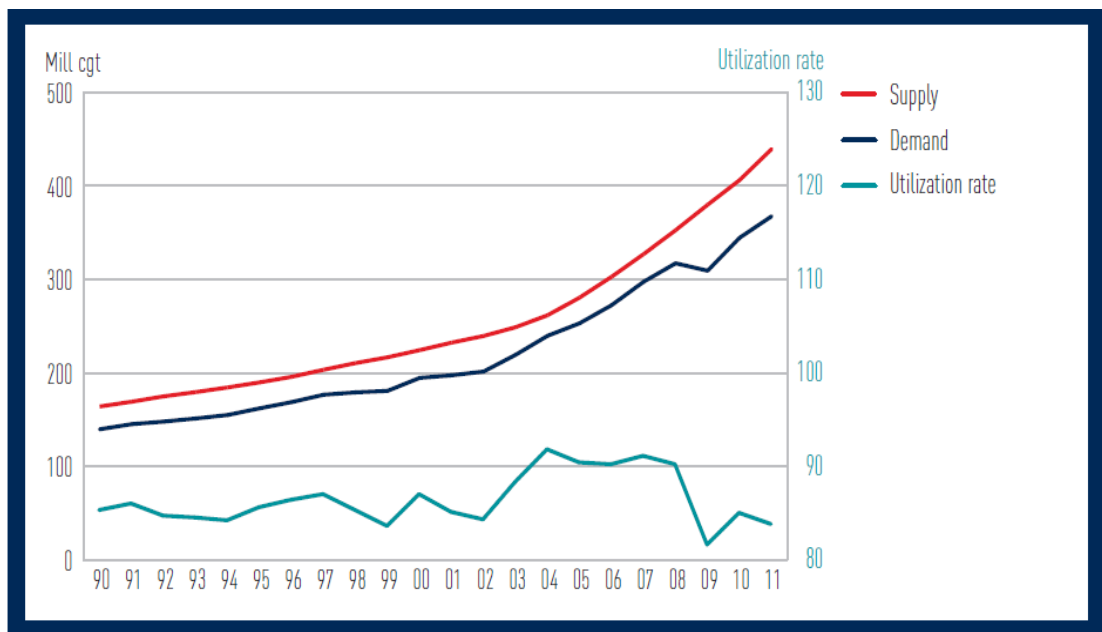


Figure 3-33 Supply, demand and utilisation rate of the world merchant fleet; 1990-2011  
Source: R.S. Platou (2012)

For example, in response to falling demand, some operators have recently resorted to ‘slow steaming’, which increases transit time but can lead to significant overall fuel savings (Notteboom 2006). The efforts of the industry to exploit economies of scale is seen in the design of ever-larger vessels; for example, the recent orders from Maersk for 10 container vessels, which can each carry up to 18,000 TEUs (Marinelog 2011). However, this efficiency presents a problem since only a limited number of ports can handle vessels of such a size; deeper ports and larger-capacity high lift cranes, for

example, are required to handle the volume of cargo from such vessels (Ting n.d.). The interactions between vessel supply, demand and the freight rates are observed following a comparison of the data in Figure 3-34 and Figure 3-35, which compare the idleness of containers and the time charter rates (the New ConTex Index). The same comparison has been attempted by Alphaliner in Figure 3-36, where the number of idle containers in relation to the Alphaliner charter rate index is conducted.

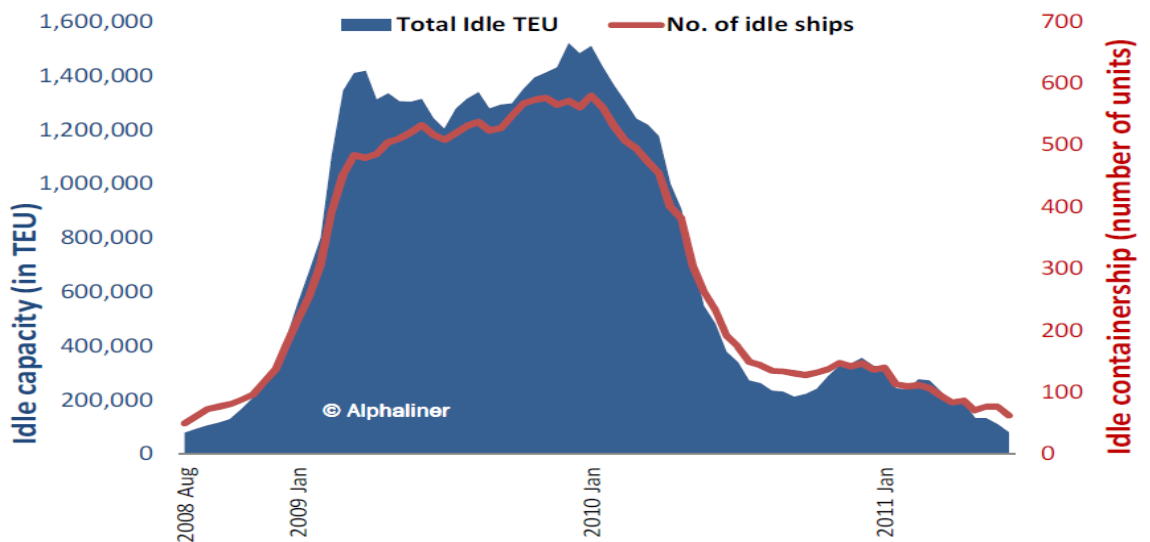


Figure 3-34 Idle containership fleet evolution; August 2008 until June 2011

Source: Alphaliner (2011c)

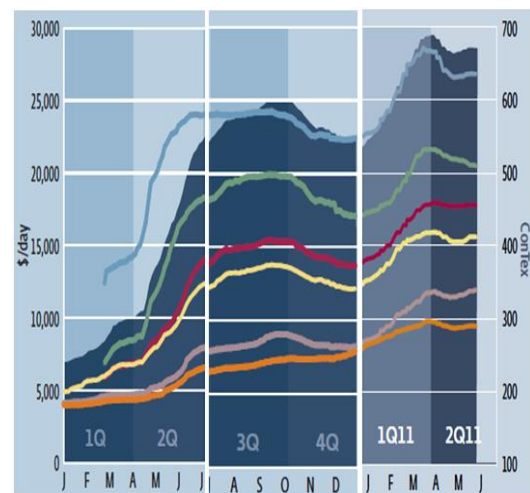


Figure 3-35 New Context Index; January 2010 until June 2011

Source: Fairplay (2010b); Fairplay (2011a)

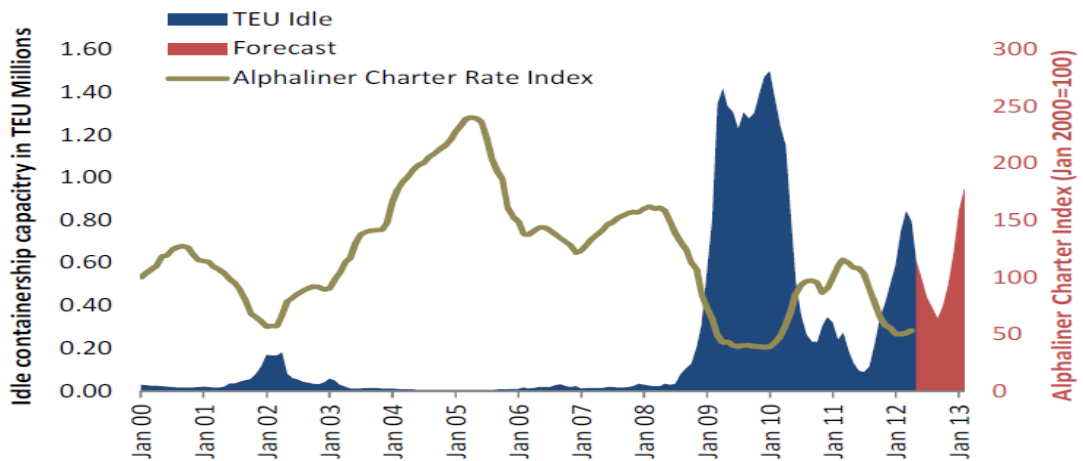


Figure 3-36 Containership idle capacity and Alphaliner charter rate index (2000-2012)  
Source: Alphaliner (2012e)

However, the most important factor for influencing the fluctuations of the freight rates in the Far East to North Europe trade line has been the conference repeal by the EU on the 18<sup>th</sup> of October 2008 (Alphaliner 2011d). According to an analysis of the CCFI rates conducted by Alphaliner (2011d), particularly for the North Europe and the Mediterranean line freight rates, the company found that the level of volatility in the freight rates had increased from 14 percent to 20 percent. An explanation of CCFI and how it works is provided in Section 3.3.3. Figure 3-37 below illustrates how the freight rates for the North Europe and the Mediterranean destinations have fluctuated before and after the repeal of the FEFC from the EU.

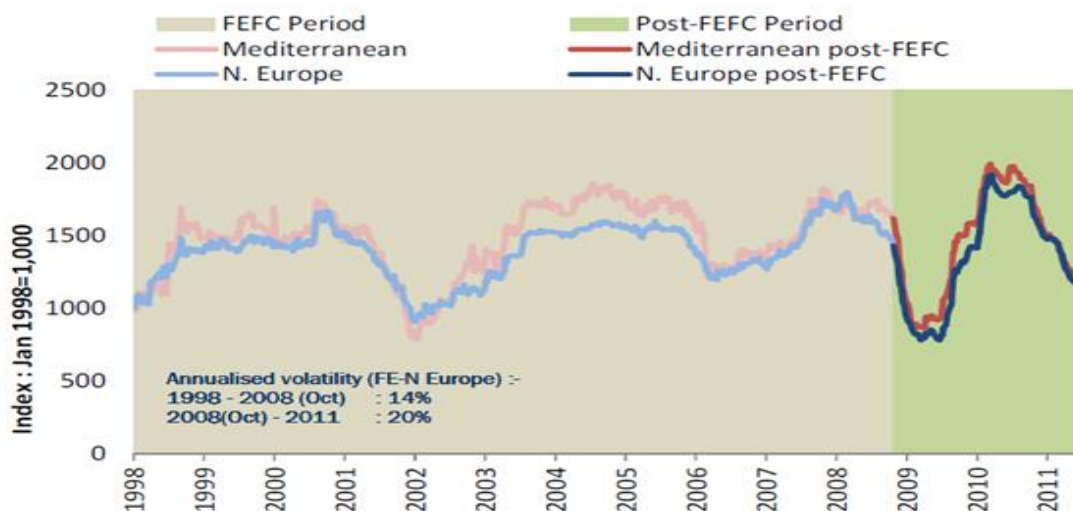


Figure 3-37 CCFI China-Europe Freight Index: FEFC vs. post-FEFC (period 1998-2011)  
Source: Alphaliner (2011d)



Conversely, Wilmsmeier et al. (2006) have not included in their analyses factors such as fuel prices or vessel charter rates. This is because, even though they have an impact on the transport costs, it can vary over time and does not depend on the chosen port or trade route.

Finally, freight rates are crucial to the viability of carriers and shippers. On the one hand, low freight rates mean that carriers will face the problems they encountered in 2011, while in contrast, high freight rates will create issues for shippers' supply chains with an easy solution of transferring the extra cost to their customers. According to ICAP, the breakeven point for carriers on the Far East Europe trade line is at least USD 1,200. While, in conformity with BIMCO which represents 65 percent of the global tonnage, the breakeven point for the most cost-efficient lines, which apply slow-steaming and larger vessels, is between USD 900 and USD 950 (Hellenic Shipping News Worldwide 2012a). With the projections for the freight rates falling below those levels, the carriers will try to stop some services in order to increase their utilisation and profitability. That of course will affect connectivity, which is discussed in detail in the following section.

### ***3.2.2 Maritime transport connectivity***

The factors affecting connectivity were evident in the literature, and most them were also found affecting costs. This is of particular interest to the importance of connectivity measures, as two countries may be distant geographically, but may be very well connected; the high degree of connectivity influences transport costs (Marquez-Ramos et al. 2005).

Connectivity has an important impact on maritime freight rates (Wilmsmeier and Hoffmann 2008). Increased connectivity, together with lower transport costs and trade facilitation, is also an important component of competitiveness and, thus, helps to explain future trade growth. Higher connectivity leads to lower transport costs, and lower transport costs lead to higher volumes of trade (Hoffmann 2007). The challenge for researchers, according to Hoffmann (2007), is to identify the mutual causalities between transport costs, transport connectivity and trade. When that challenge is addressed, the policy makers will be able to promote better and less costly transport services; thereby helping to promote trade which, in turn, will again encourage further improvements in transport services and costs (Hoffmann 2007).

## **Factors affecting maritime transport connectivity:**

### *Trade volumes (national trade volumes)*

Trade volume is one of the factors found in the literature that affect maritime transport connectivity. As both Hoffmann (2010) and Low et al. (2009) have found through their research, connectivity has a positive correlation with the increase in trade volumes.

### *Annualised Slot Capacity (ASC)*

J. S. L. Lam and Yap (2011) have found that the method of analysing ASC can reveal the degree of port connectivity in a systematic and quantifiable manner. So, according to these authors, a comparison of the slot capacity between ports can expose the level of each port's connectivity. ASC can be calculated by using Equation 3.1:

$$Y_t = \sum_{k=1}^n y_{ij}^{kt} \quad (3.1)$$

where  $Y_t$  is the total slot capacity of  $k$  shipping services for the time period  $t$ , deployed between port  $i$  and port  $j$  for  $k = 1, 2, 3 \dots n$ .

### *Port infrastructure*

Wilmsmeier et al. (2006) and Hoffmann (2010) demonstrated that improved port infrastructure has a positive effect on connectivity. As discussed previously in Section 3.2.1, when infrastructures improve maritime transport costs decline. This characteristic contributes to selecting a port service provider.

Of course, the maritime transport cost reduction may not be obvious. Wilmsmeier et al. (2006) highlight that an improvement in port infrastructure can lead to improvements in efficiency (in other words, improvement of port connectivity). However, that improvement hides an additional cost; for example, a port that improves its depth as a result of an investment programme increases its dues in order to source capital for the loan taken for the investment. Of course, shipping companies are willing to pay higher port charges if their efficiency allows them to generate more revenue.

### *Types of vessels deployed*

J. S. L. Lam (2011) discovered that the types of vessels being deployed have a positive impact on connectivity. This is because some ports lack facilities that allow some ships to load and/or unload. As a consequence, some containerships have on-board cranes for self-loading and unloading.

### GDP per capita in exporting country

According to Hoffmann (2010), the GDP per capita in an exporting country has a positive impact on connectivity.

### Service frequency

After analysing the slot capacity deployed by container shipping lines, J. S. L. Lam (2011) found that the frequency of a service has a positive impact on connectivity.

### Schedule of port calls (number of port calls)

According to various studies, the schedule, or number, of port calls has a positive impact on measuring connectivity (Marquez-Ramos et al. 2005; Low et al. 2009; J. S. L. Lam 2011). Fewer port calls lead to poorer access to more potential cargo catchment areas. Sometimes, adding a port call can generate additional revenue. If that revenue is greater than the additional cost of using the extra port call, the company increases its profitability (Notteboom 2006). Therefore, it can be concluded that an extra port call increases the connectivity between ports, as well as between countries. Of course, the more efficient a network (from a carrier's perspective), the less convenient that network may be from the shipper's perspective (Notteboom 2006).

### Collaborating partners

The existence of collaborating partners among the shipping lines, according to J. S. L. Lam (2011) has a positive impact on connectivity, which is obtained through the economies of scope.

### Depth of the port (ship draught)

The water depth of a port is a limiting factor for a shipping company that wants to achieve economies of scale and has large ships requiring deep water port facilities (Low et al. 2009). As illustrated in Figure 3-38, some ports cannot serve vessels which carry more than 2,000 TEU, such as Liverpool and Teesport. So, a shipping company, such as Maersk, will probably exclude those ports because it cannot help the company to achieve economies of scale. These are crucial for container companies such as Maersk, and consequently, the company recently placed orders for containerships that can carry 18,000 TEU.

Generation	1 <sup>st</sup> - 2 <sup>nd</sup>	3 <sup>rd</sup> - 4 <sup>th</sup>	Post-Panamax	Suezmax
Year From	1968	1972	1994	2006
TEU	1,000 - 2,000	3,000 - 4,700	4,700 - 9,000	~11,000 - 13,000
Containers across deck	11-13	13-15	15-17	17-22
Draft	10 - 11m	11.5 - 12.5m	13.5 - 14.5m	15-16m
Width	28m	32m	39-43m	58m

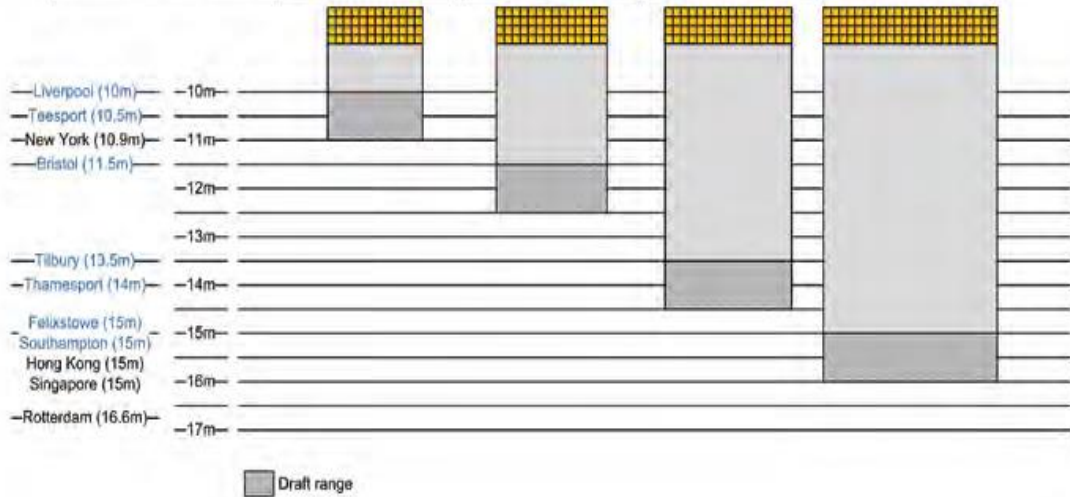


Figure 3-38 Depth of water in various ports compared with various characteristics of container ships

Source: Department for Transport (2011c)

### Port cargo traffic

With reference to port cargo traffic, Low et al. (2009) refer to the cargo throughput (measured in TEUs) of a port, including transshipment traffic. The research showed that port cargo traffic has a positive impact on connectivity.

### Total annual operating hours

The total annual operating hours has a positive impact on connectivity (Low et al. 2009). When a port has high score, shipping services are attracted as the companies want the ports to be open 24/7 throughout the year, in order to discharge their cargo when the ship is in port. It can then be hired for another journey once the discharge is completed.

### Average port charge per vessel

The average port charge per vessel has a negative impact on connectivity (Low et al. 2009). However, port charges are the least influential factor in determining the traffic at a port (Low et al. 2009). Low et al. (2009) demonstrate that port charges have minimal impact on port choice decisions and they discuss that port charges are a tiny proportion

of the total transport costs. Therefore, port choice is not affected by the port charge, but rather by other more significant indirect transport costs.

UNCTAD has calculated that the port charges comprise 10 percent of the total freight rate. In the same example, UNCTAD has calculated that if the port handling charges could be reduced by 50 percent, that alone could cause a five percent reduction of the total freight rate (UNCTAD 2012).

#### *Inter-modal transport capabilities in ports (inter-modal connections)*

Inter-modal transport capabilities in ports as defined by Low et al. (2009), or inter-modal connections as defined by Wilmsmeier et al. (2006), are the facilities ports have for handling containerised imports and exports. Better port handling facilities have a positive correlation with connectivity.

#### *Common political block*

The fact that two countries may be part of the same political block increases their connectivity. Wilmsmeier et al. (2006), however, dismiss this factor as it has no impact, according to their findings.

#### *General comment*

As can be interpreted from the mentioned determinants of connectivity and in accordance with J. S. L. Lam (2011), it is particularly important for ports to have a high connectivity as the economies of scope can be achieved for global shippers, manufacturers and traders. Thus, higher maritime connectivity improves the economic activity.

Marquez-Ramos et al. (2005) also use the performance and structure of vessels to define the connectivity between origin and destination in maritime transport. They also mention that port performance is crucial to the efficiency and effectiveness of the maritime network, and observe that the structure and network have a complex interaction that influences the cost of transportation between two countries.

Thus, many of these determinants affect the maritime connectivity as well as maritime costs. According to Hoffmann (2007; 2010), these can be measured by the following indicators:

- Per ships arriving

- Per total tonnes of cargo
- Number of services
- Number of shipping companies. [Wilmsmeier et al. (2006) introduce an indicator of competition for liner shipping services which could be found from the logarithmic number of liner services divided by the total bilateral trade volume. They also found that an increase of one percent in levels of competition between liner services can lead to a freight reduction of 0.1129 percent]
- The size of largest ships
- Average vessel size
- Fleet deployment (a larger number of ships is an indicator that a country's shippers have more opportunities to load their freight)
- Deployment of ship carrying capacity
- Deployment of ships per capita
- Deployment of ship carrying capacity per capita
- Liner services (for containers)
- Maximum vessel sizes.

UNCTAD (2010a) measures the level of connectivity at the country level for liner shipping using the LSCI. As discussed in Section 2.9, this index is formulated from five components: 1) number of ships; 2) container-carrying capacity; 3) the number of companies; 4) the number of services provided; and 5) the size of the largest vessels that provide services from and to each country's seaports.

In summary; it can be concluded that there is no agreed-upon definition of connectivity. This demonstrates that the term 'connectivity' and, specifically, 'maritime connectivity', is a subject that has not been rigorously studied. The factors that affect maritime connectivity have been addressed above. Additional factors affecting cost and connectivity, as found in the literature, are demonstrated in the following section.

### ***3.2.3 Costs and connectivity for the maritime sector***

Sections 3.2.1 and 3.2.2 have discussed factors that affect solely costs and the connectivity of the maritime transport sector. However, in the literature review, it was

found that some factors affect both costs and connectivity, as the two are interrelated. As Wilmsmeier et al. (2006) demonstrates, more liner services and higher cargo volumes (in other words, improved connectivity) can lead to reduced freight rates. The same outcome concurs with the Review of Maritime Transport 2012 report (UNCTAD 2012). Of course, lower transport costs boost the trade volumes, which lead to even more economies of scale and lower freight rates (Hoffmann 2010). UNCTAD (2007a) demonstrates that freight rates have fallen by 35.5 percent over a period of 25 years (1980 until 2005), as illustrated in Figure 3-39. In 1980, the maritime transport costs were eight percent of the final total costs, while in 2005 they were 5.9 percent.

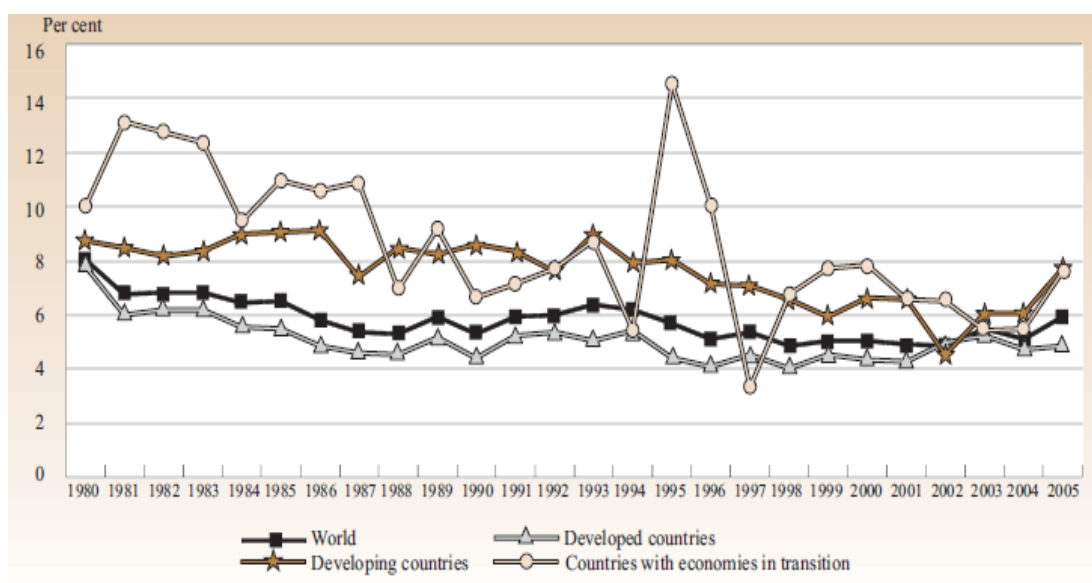


Figure 3-39 Freight costs as a percentage of value of imports: long-term trend (1980-2005) (Percentages)

Source: UNCTAD (2007a) (Data generating the graph are placed in the Appendix B)

For the purpose of index creation, the experts participating in the brainstorm session have separated the factors that affect costs and connectivity according to where they have higher representation (either cost or connectivity). More details on how the factors were separated are given in Section 4.4.

**Factors affecting maritime transport costs and connectivity:**

*Distance*

Distance is one of the most studied factors that influences maritime transport costs; however, distance also influences connectivity. Hoffmann (2010) found that distance has a negative correlation with connectivity as when the distance increases, the

connectivity between the two countries decreases. The study of distance takes place with the help of the gravity model. Wilmsmeier et al. (2006) found that an increase in distance of one percent leads to an increase of 0.37 percent of freight, which is lower than predicted by the gravity model. [Doubling the distance is not leading in a doubling of the freight, but only on an increase of 29.4 percent (Wilmsmeier et al. 2006)]. Wilmsmeier et al. (2006) also found that the elasticity of distance is slighter than that of port efficiency, and which, in keeping with their research, is the most important variable. Countries that are separated by a large distance will trade less, according to the gravity model (Linnemann 1966). Wilmsmeier and Hoffmann (2008) have found that distance for Caribbean countries has a positive correlation with the freight rates, as presented in Figure 3-40.

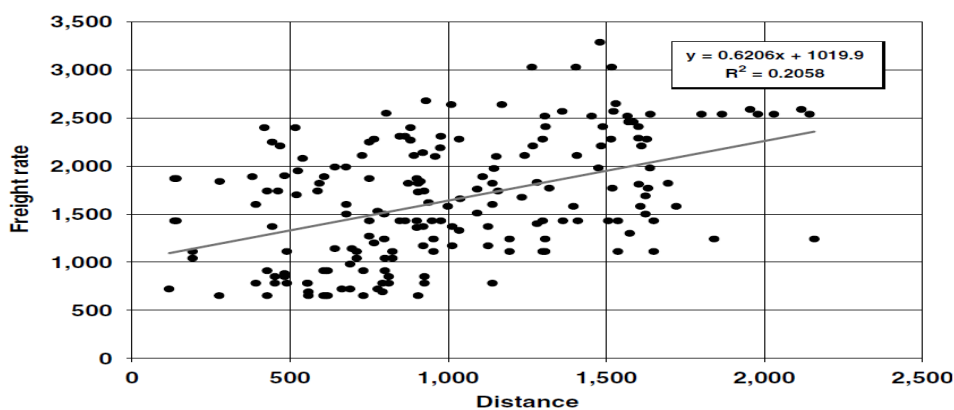


Figure 3-40 Correlation between freight rate (USD) and distance (km). Data extracted from the Caribbean region on July 2006

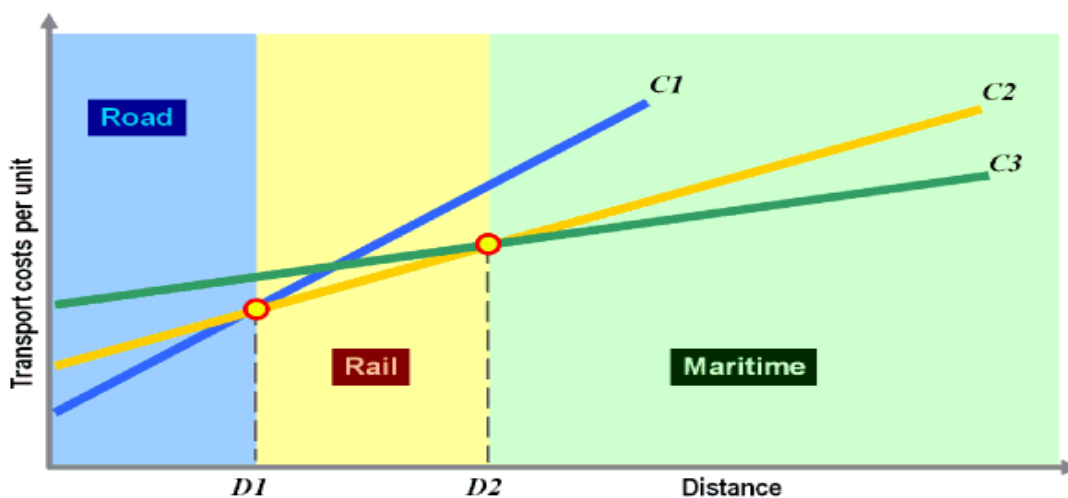
Source: Wilmsmeier and Hoffmann (2008)

The greater the distance between two markets, the higher the transport costs. For example, X. Clark et al. (2002) found that an increase of 100 percent in the distance of the bilateral trade between an export country and the USA increases the maritime transport costs by around 20 percent. This distance ‘elasticity’, close to 0.2 in this case, is consistent with the existing literature on transport costs (X. Clark et al. 2002). The problem with distance is that it is difficult to appear as a measurement. There is some evidence, from Hummels (1999a) and Rodrigue et al. (2009), that the effect of shipping distance on transport costs becomes less important for longer distances. This consolidates the observation that overall transport costs increase with distance, but less than proportionately when the goods are transferred by sea. Limao and Venables (2001) also found that using distance alone explains only 10 percent of the variations in



transport costs; this is much lower than the approximately 50 percent explained when infrastructure variables are included. The OECD indicates that transport costs can be influenced by many factors and state “the aggregate effect of distance on transport costs is, to say the least, complex” (Korinek 2011). While D. P. Clark (2007) states that: “Theorists should re-evaluate the role of distance in trade models and refrain from using distance as a proxy for transport costs”.

Rodrigue et al. (2009) attempted to calculate the various cost functions for road, rail and maritime transport mode, as presented in Figure 3-41. They found that road has the least cost function for short distances (between 500 and 750 km), while transporting goods by rail has the least cost only when the transported distance is between 500-750 km and 1,500 km. Transporting goods by sea is becoming the less costly solution when the distance is beyond 1,500 km.



Note: D1= 500-750 km and D2= 1,500 km.

Figure 3-41 Transportation costs of various modes for transporting goods, against distance

Source: Rodrigue et al. (2006)

### Access channels

Access channels to ports and canals often represent physical bottlenecks in the global maritime transportation system. Interruptions to port access come in various forms, ranging from unexpected waiting times due to irregularities in pilotage or towage services (e.g. low availability of pilots or tug boats), to unexpected waiting times caused by delays at sea locks or the morphology of the access channel in terms of tidal windows (Notteboom 2006). Maritime passages, such as the Suez Canal and the

Panama Canal, are the most crucial passages. The Suez Canal is crucial for container shipping, as it can be seen in Figure 3-42, as containerships currently account for 55 percent of the net tonnage and 38 percent of the total number of vessels transiting the canal (Alphaliner 2011e).

Of course, the canals themselves have some restrictions. For example, if a ship arrives late at the Suez Canal, it may have to wait up to 12 hours for the next convoy to pass through the canal in the required direction. One of the most famous restrictions of the Panama Canal is its limited dimensions, as a vessel has to fit its locks in order to pass through the Canal. The largest vessel that can fit the locks of the Panama Canal can have a draught no more than 12.04 metres, length of 294.13 metres and beam of 32.31 metres. The vessel has to also have an air draft less than 57.91 metres so it could fit below the bridges (Knowles et al. 2008). The dimensions described are equal to a containership of approximately 4,400 TEU, which is known as Panamax container vessel.

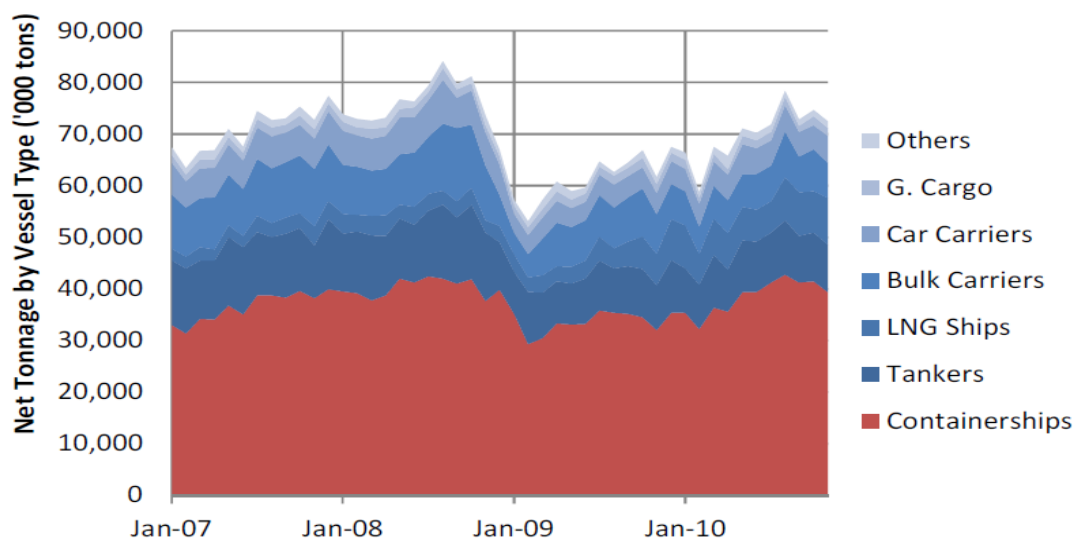


Figure 3-42 Monthly Suez Canal transit breakdown by vessel type (2007-2010 Nov)  
Source: Alphaliner (2011e)

Furthermore, ship size is a bilateral limitation factor for liner shipping companies using those passages. On the one hand, large vessels are not able to fit through the passages and locks, so shipping companies focus on smaller ships. For example, the largest vessel that can pass through the Panama Canal currently is a Panamax vessel that can carry 4,400 TEU. This limitation will be withdrawn soon, as the Panama locks are being

updated between late 2014 and early 2015. Once this has happened, the canal will be able to serve the New-Panamax sized vessels of 12,600 TEU (Fossey 2012c). In other words, ships with a maximum length of 366 m (up from 294.13 m), beam of 42 m (up from 32.31 m) and draught of 15.2 m (up from 12.04 m) will then be able to pass through the Canal (Prince 2012). Conversely, the tolls charged by Canal authorities are pushing the shipping companies to invest in larger ships, as they pay less per TEU when they transit through these passages. The Global Institute of Logistics cites an example, illustrated in Table 3-3, of the various ship sizes crossing the Suez Canal and the tolls being paid (Ring 2011). The toll per TEU for a 6,000 TEU vessel is USD 62.3; while for a 13,000 TEU vessel it is USD 50.3. Therefore, when a fully loaded 13,000 TEU containership is transiting through the Suez Canal, it pays 23.8 percent fewer tolls compared with a 6,000 TEU vessel. This is illustrated in Figure 3-43 and Table 3-4. Of course, liner shipping companies have to be careful when they buy containerships regarding the tolls, because, as presented in Table 3-5, the ratio of the ship size is moving in parallel with the ratio of the channel tolls. Therefore, a large containership with a low load ratio will be more expensive than a small containership with a high load ratio.

<b>Suez Canal toll according to ship size</b>	
13,000 TEU	USD 655,000
10,000 TEU	USD 537,000
8,000 TEU	USD 456,000
6,000 TEU	USD 374,000

Table 3-3 Suez Canal tolls per ship size

Source: Ring (2011)

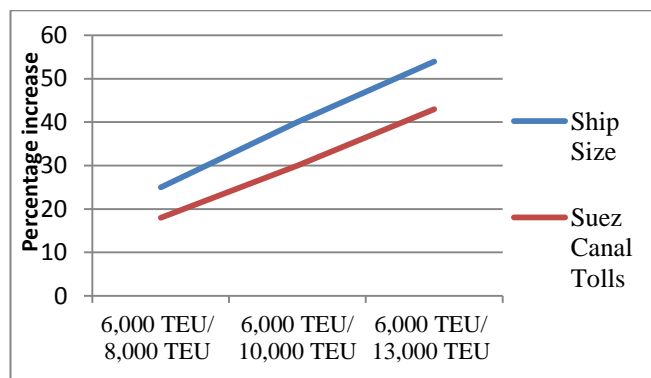


Figure 3-43 Percent increase of ship size and Suez Canal tolls of a 6,000 TEU vessel compared with other vessel sizes

Source: Ring (2011)

Ship size	Tolls
8,000 TEU / 6,000 TEU = 1.33 → +33%	USD 456,000 / USD 374,000 = 1.21 → +21.5%
10,000 TEU / 6,000 TEU = 1.6 → +66%	USD 537,000 / USD 374,000 = 1.43 → +43%
13,000 TEU / 6,000 TEU = 2.16 → +116%	USD 655,000 / USD 374,000 = 1.75 → +75%

Table 3-4 Percent increase of ship size and tolls. Baseline the 6,000 TEU and its tolls

Source: Adapted from Ring (2011)

Ratio of percentages			
Ship size	Ship size increase	Ship size	Tolls
10,000/8,000 TEU	66/33 = 2	10,000/8,000 TEU	43/21.5 = 2
13,000/10,000 TEU	116/66 = 1.75	13,000/10,000 TEU	75/43 = 1.74
13,000/8,000 TEU	116/33 = 3.5	13,000/8,000 TEU	75/21.5 = 3.49

Table 3-5 Comparison of percentages between ships and their increase in size and tolls

Source: Adapted from Ring (2011)

### Turnaround time

Turnaround time has a positive impact on connectivity (Sanchez et al. 2003). One of the characteristics of efficient ports is their short turnaround times, which are influenced by other factors, such as: a) the availability of up-to-date physical facilities; b) labour productivity; c) speediness in custom services etc. (Sanchez et al. 2003). The turnaround time factor has an impact on cost and connectivity: cost is affected by ports with long turnaround times, leading to a time ‘addition’ for freight transferring through them. The connectivity of a port can be affected by a long turnaround time due to the fact that shippers may exclude it when transferring their cargo; thus, the liner company calls will diminish, along with port traffic.

### Transshipment routings

Transshipments are an important characteristic of the liner shipping sector. According to UNCTAD (2009c p.10), “only 17 percent of pair countries are serviced by direct liner shipping services. For 62 percent of pairs of countries, shippers can find liner shipping connections that require only one transshipment; for 19 percent of routes two transshipments are necessary; and for 2 percent of connections traders would have to use a combination of services that require three transshipments”. For all those countries that

are served with transshipments, it is not to be implied that they possess a competitive disadvantage due to higher costs or slower services in comparison with countries that are served via direct services (UNCTAD 2007b). This is because it might be the case that high density routes may be connected with large vessels, achieving economies of scale. It may also reduce delivery times if frequencies to and from the transshipment points are higher than those with direct services (UNCTAD 2007b).

Conversely, a study conducted by Wilmsmeier and Hoffmann (2008) suggested that every transshipment has the equivalent impact on freight rates as an increase in route distance of 2,612 km between two countries.

An additional observation demonstrated in some reports, is the strong correlation between on-time container delivery and the presence of direct services; specifically, from China to various European ports (Beddow 2012c). Countries that have more direct services appear to have better on-time container delivery (Beddow 2012c).

The current UK container flow is composed of 70 percent direct and 30 percent indirect calls (De Langen et al. 2012). Unfortunately, the percentage of direct calls will probably decrease over the coming years, with some assumptions predicting that they will be 65 percent of the total container flow in 2020, and 60 percent in 2030 (De Langen et al. 2012). According to De Langen et al. (2012), this will be due to the following:

- The size of the vessels will increase resulting in a reduced number of calls to UK deep sea ports.
- The preference to shift to feeder services, in contrast to the container transportation through the UK road and rail systems.
- Redeployment of distribution centres to central UK regions, while the UK deepwater ports are located in the South. This provides an opportunity to the smaller ports (e.g. in the Humber area) to create 'port-centric' distribution facilities and attract more traffic (these ports are serviced by feeder vessels).

#### *New intercontinental routings*

The melting of the North Pole ice cap is creating new routing opportunities for shipping companies (Astill 2012b; Astill 2012a), while the widening of the Panama Canal will reduce transit distances for some services currently employing large vessels (Sabonge 2009). With regard to the former, the persistent cold temperatures and potential for continued ice presence may reduce the current effectiveness of numerous ship

components (such as, deck machinery, emergency equipment and sea suction); therefore, ship builders and operators are examining the suitability of assigning current and proposed vessels with their crews (after special training for such environmental conditions) to any new routes (IMO 2010a). These will reduce the distances between the East Asia and Western Europe ports by roughly a third (Astill 2012b); however, only ice-capable vessels can sail through the Arctic (Astill 2012a). Of course, the proposed use of the Northwest Passage and the Northern Sea Route (NSR), is still at an early stage, due to the many limitations and complex problems (Figure 3-44).

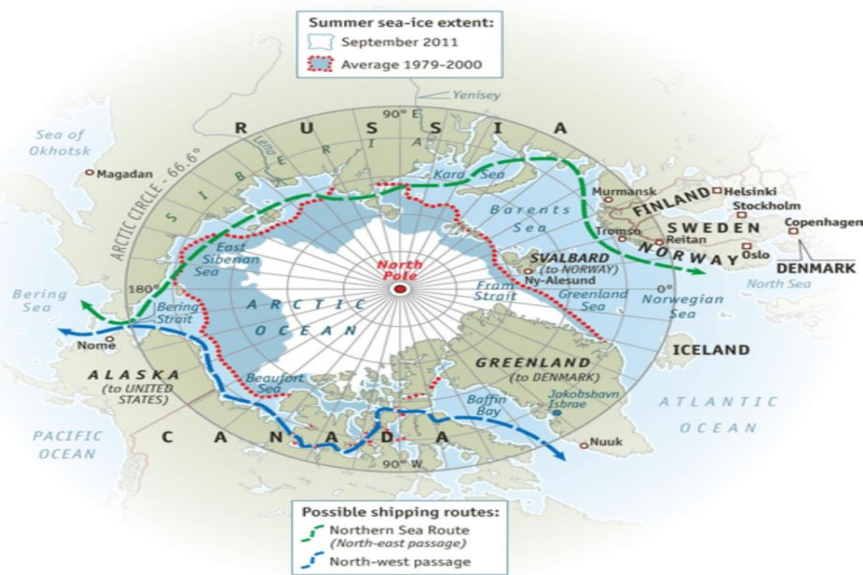


Figure 3-44 Northwest Passage and NSR

Source: Astill (2012b)

These difficulties are caused specifically by the normal limited availability of these routes, typically only few weeks, during the summer period in the Northern Hemisphere. However, in 2011 they were effectively open for four to five months during the year and, thus, attracted increased traffic. For example, in 2010 only four ships had used the NSR, while in 2011 the usage of the NSR had increased by 850 percent when 34 ships used the passage (Astill 2012b). According to data released by Gunnarsson (2012), the average area of the Arctic Sea that has been covered by ice each September since 1979, is diminishing hugely, as Figure 3-45 illustrates. In 2011, this helped 34 ships to use the passage in both directions; for example, tankers, refrigerated vessels carrying fish and a cruise liner (Astill 2012b). Those vessels in total carried 820,000 tonnes of cargo (Astill

2012a), while the vessel currently holding the world record for being the fastest and largest ever to cross the Arctic is the 160,000 dwt Suezmax tanker ‘Vladimir Tikhono’, which carried 120,843 tonnes of condensate gas and made the transit at an average speed of 14.0 knots (Gunnarsson 2012). By crossing via the NSR, the vessel reduced its voyage distance by roughly 40 percent, while the distance between Rotterdam and Shanghai could be reduced by 22 percent if the NSR was used (Astill 2012a).

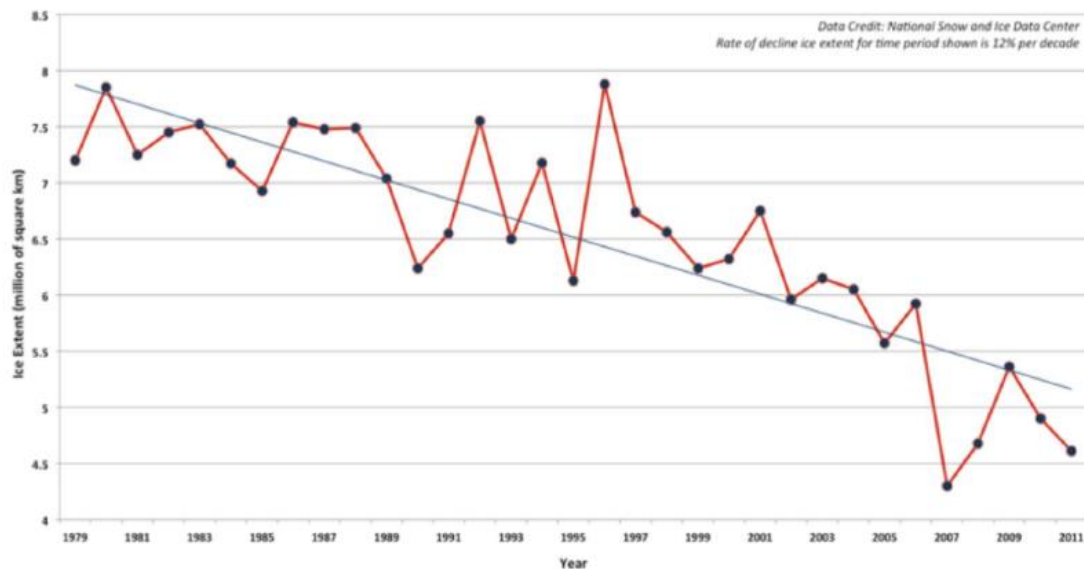


Figure 3-45 Average monthly arctic sea ice area extent for September; for years 1979-2011

Source: Gunnarsson (2012)

In other words, ships could reduce their service speed as they cover shorter distances, and the reduction of speed could save bunkers (Astill 2012a). Another benefit of using that particular route is that it is free from pirates (Astill 2012a), although the vessels require the escort of icebreakers. The ‘Vladimir Tikhono’ was escorted by two nuclear icebreakers in order to achieve the records mentioned above (Astill 2012a). Using icebreakers incurs additional costs; therefore, the benefits of the route can easily evaporate, or even become negative. Moreover, bureaucracy exists from the authorities in order to gain access to and use the routes (Lloyd’s Ship Economist 2010). However, the impact of these factors seems to have been reduced over the years due to the political will from Norway and Russia to support the usage of the route (Astill 2012a). The latter has announced that it will open 10 search and rescue stations along the NSR in August 2012. These will be the first stations of that kind (O’Dwyer 2012). Of course, the largest disadvantage of the NSR is that there is no rescue service in the Arctic and if

something goes wrong it could easily escalate into a disaster (Astill 2012a). One characteristic that makes the route unappealing for container shipping is that the industry is ruled by just-in-time deliveries schedule and the scarceness of the ice breakers will make it vulnerable to the exigencies of sea ice.

Port location (with respect to major trading routes)

The location of a port relative to major trading routes is a factor that affects cost and connectivity as it impacts freight rates. Ship availability affects the competitive advantage of a port area, so a port area along or close to a major trading route may enjoy lower shipping rates than one that is less favourably located (Binkley and Harrer 1981).

Common language between trading countries

The factor of sharing a common language between trading countries is a variable that affects cost and connectivity, but it cannot be considered a determinant of transport cost and connectivity (Marquez-Ramos et al. 2005).

Industry structure

The competitive structure of the maritime sector (in particular, ports and shipping companies) is a key influencing factor for maritime costs and connectivity. Consolidation among shipping companies is evident, allowing such companies to exploit economies of scale and to provide a broader range of services. Figure 3-46 illustrates the shares of the top 20 shipping lines and terminal operations in 1980 and 2007. Also, global port operators (such as PSA of Singapore and Dubai Ports World) have recently emerged and operate ports and terminals in multiple countries (see Figure 3-47).

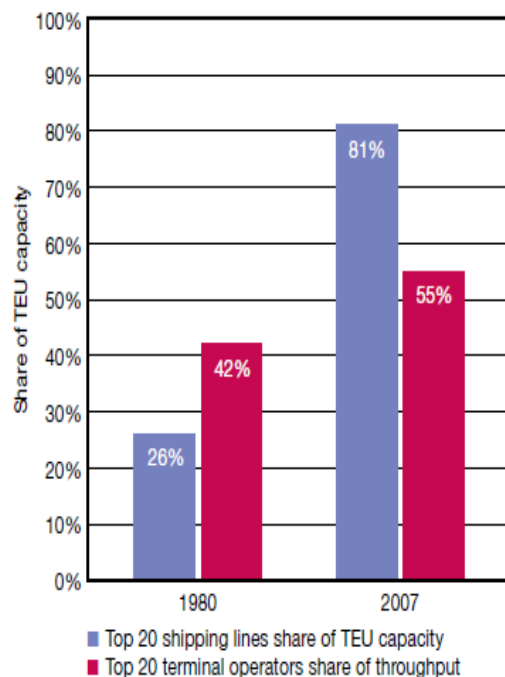


Figure 3-46 Consolidation in the container shipping industry

Source: Department for Transport (2011c)



Mergers and acquisitions mean that there are fewer carriers today than there were 10-20 years ago; however, the same major global carriers today continue to expand into new markets. As a result, the number of carriers providing services to a specific port has actually increased for the majority of countries (Wilmsmeier and Hoffmann 2008).

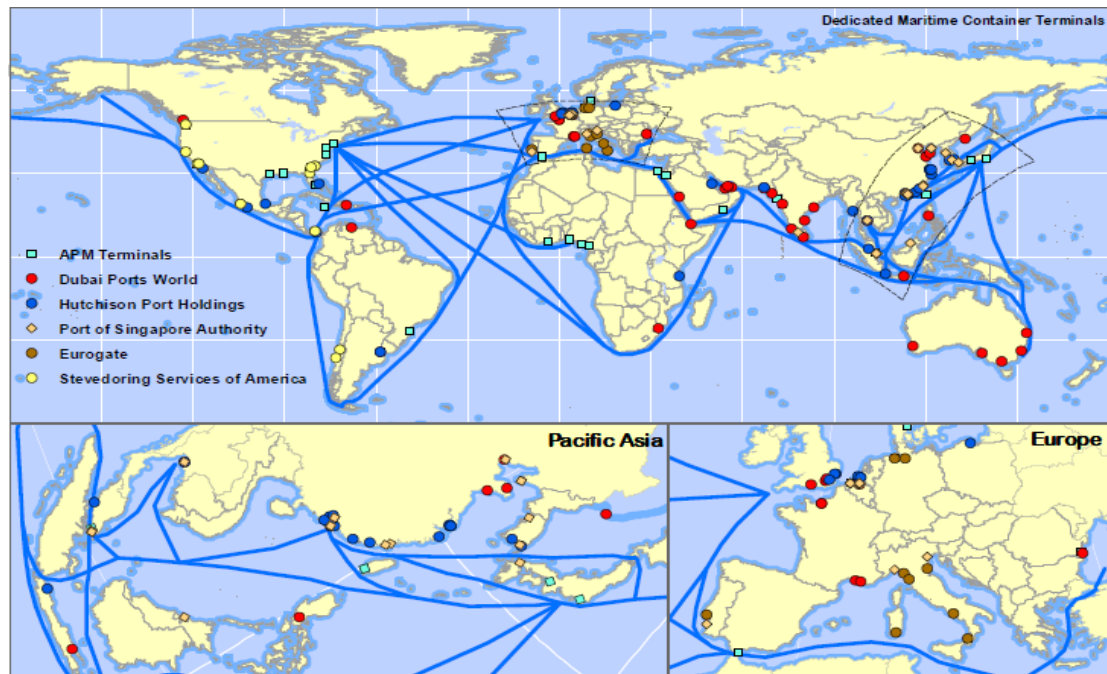


Figure 3-47 Major port holdings, 2007

Source: Rodrigue and Browne (2008)

National economic characteristics; high per capita income and country size

The UK has a relatively high per capita income (7<sup>th</sup> economy among the 27 EU states) (Eurostat 2010) and is the 9<sup>th</sup> largest economy in the world in GDP in terms of PPP terms (CIA 2011), while it is a substantial country in terms of population size (3<sup>rd</sup> among the European countries, 18<sup>th</sup> among the world) (Encyclopedia of the Nations 2010). However, these two characteristics are not catalysts, and, thus, they cannot help the country to reduce its transportation costs. Limao and Venables (2001) point out that a high per capita income has scarcely any impact on transport costs. While country size does affect transport costs, this is only through: 1) the volume of trade; and 2) economies of scale in shipping (X. Clark et al. 2002). After the economic recession of 2008, the volume of trade and the economies of scale in shipping have both fallen; therefore, the UK has lost the benefit that was reducing its freight costs.

Furthermore to these factors which affect maritime transport costs and connectivity, it is envisaged that consideration of the various aspects of risk will also be central to the research project. There is an increasing awareness of the economic impact arising potentially from various diverse risks, such as international terrorism or diseases like swine flu, bird flu and so on. Therefore, it makes sense, in the context of the impact of such developments on the maritime transport chain, to be aware of the level of vulnerability that exists in the UK import and export maritime transport chain. How such vulnerability can be mitigated needs to be understood and modelled in the proposed index.

#### ***3.2.4 Maritime transport risks<sup>4</sup>***

Due to the nature of the shipping business, risk plays an important role, while sometimes its effects could cause major disruptions. The forms of risk found through the literature review are reviewed in the section below. Some generic shipping risks are also demonstrated as each branch of the shipping business is ruled by the same forms of risk.

##### **Possible risks, relevant to cost and connectivity of maritime transport sector**

The UK maritime transport sector is part of the world maritime transport sector, which is composed of thousands of miles of shipping routes worldwide. This huge network is vulnerable to various risks; for example, weather conditions, such as the natural perils of fog, typhoons, blizzards, ice and rain. The risk caused by the weather can add extra costs to carriers, because, for example North Atlantic and North Pacific regions, are particularly affected by heavy waves during winter (Korinek 2011). In addition to causing speed to be reduced, these are pushing the ships to follow longer but safer routes, which are typically at lower latitudes. Of course, these actions increase the distance between two ports; hence, the time needed for the sea journey (time and distance are both factors which affect the cost and connectivity). Sometimes carriers try to avoid having to deal with adverse weather for example by using weather routing; thus, ships may be idling at portsides during extreme weather phenomena. All of the above mentioned actions mean extra costs, because the cargo and the ship have to be

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<sup>4</sup> Findings of this section have been published in: Jackson, E., Karamperidis, S. and Mangan, J. 2012. Perceptions of Risk in the UK Maritime Container Sector. In: Wilding, R. ed. *17<sup>th</sup> Logistics Research Network (L.R.N.) Annual Conference 2012, Go for Gold – Winning the Supply Chain Triathlon: Creating Social, Economic and Environmental Value, 5<sup>th</sup>-12<sup>th</sup> September 2012*. Cranfield: The Chartered Institute of Logistics and Transport (UK).

transported carefully and safely. Furthermore, this cost is passed eventually to their customers (Korinek 2011).

### Piracy:

In recent years, one risk factor that has risen astronomically in certain regions is piracy. In 2010, IMO (2011) reports that “there have been 286 piracy-related incidents off the coast of Somalia. They have resulted in 67 hijacked ships, with 1130 seafarers on board – whilst (in April 2011) 714 seafarers are being held for ransom on board 30 ships scattered at various points of the country’s extensive coastline”. Considering these figures, many carriers trading in the high risk area off Somalia internalise an extra surcharge to allow for the risk of piracy (Korinek 2011). Exporters and freight forwarders also purchase additional insurance for their cargo when it sails through these areas (Thomson Reuters 2011). This additional insurance raises the total maritime transport costs.

Pirate attacks in the world’s seas totalled 266 in the first six months of 2011, up from 196 incidents in the same period last year, as the International Chamber of Commerce (ICC) International Maritime Bureau’s (IMB) Piracy Reporting Centre (PRC) has revealed on the 14<sup>th</sup> of July (ICC-CCS 2011). According to the ICC-CCS (2011), more than 60 percent of attacks were by Somali pirates, a majority of which were in the Arabian Sea area. But although Somali pirates are more active – 163 attacks this year up from 100 in the first six months of 2010 – they actually hijacked fewer ships, just 21 in the first half of 2011 compared with 27 in the same period last year (ICC-CCS 2011). That change took place because: 1) increased ship hardening; and 2) to the actions of international naval forces to disrupt pirate groups off the east coast of Africa (ICC-CCS 2011). Despite this, costs attributed to piracy are still costing the industry considerably. As of 30 June 2011, Somali pirates were holding 20 vessels and 420 crew, and demanding ransoms of millions of USD for their release (ICC-CCS 2011).

The cost of maritime piracy on the international economy is calculated to be between USD 7 to USD 12 billion per year (Bowben and Basnet 2011). The same figure is quoted from the UN (Sambidge 2011). If the lowest cost case scenario (USD 7 billion) has been considered, that means that according to calculations conducted by experts such as Mike Wackett (Containerisation International), the cost of piracy adds USD 1.68 per every kilo traded through the high risk area (Wackett 2012d). That number

includes the 43 million loaded TEU that are shipped through the piracy affect areas every year. It also derives from the piracy added container charge, which is between USD 50 – USD 150 (Fossey 2012a). In addition, the cost of ransoms paid for the secure release of the crew and ships have to be added. That cost has risen by 69 percent compared with 2010 at USD 135 million (Fossey 2012a).

The true cost of piracy is still unknown for the container maritime transport sector, in comparison with the wet and dry bulk maritime transport sectors. A study by the foundation One Earth Future (Bowben and Basnet 2011), demonstrates the costs of piracy that are relevant to the maritime transport sector. These are detailed as follows:

- 1) The cost of re-routing a vessel. The cost to re-route a 10,000 TEU containership is USD 100,000 per day. If a containership wants to make a voyage round the Cape of Good Hope in order to avoid the risk of transiting through the Gulf of Aden then it takes an additional 10 days. So, if a containership of 10,000 TEU wants to re-route and make a voyage round the Cape of Good Hope, it will incur an extra cost of USD 1,000,000.
- 2) Increased speed. As mentioned in Section 3.2.1, increased speed could raise costs due to higher bunker consumption.
- 3) Labour.
- 4) Prosecutions and imprisonment.
- 5) Military and counter-piracy operations.
- 6) The cost of shipping insurance comes in four main types:
  - a) war risk,
  - b) kidnap and ransom,
  - c) cargo, and
  - d) hull insurance.

It is to be appreciated that insurance costs can fluctuate according to the ship owner and the areas where the ship operates.

- 7) The cost of ransoms. One of the more spectacular increases in the costs of piracy in recent years has been the increasing price of ransoms paid to release hijacked ships. These fluctuate according to the negotiations between the ship-owner and the pirates.
- 8) Security equipment and guards.

### International terrorism

International terrorism is another risk, which was enhanced following the 9/11 terrorist attacks in the USA. Due to the threat of terrorist attacks, some countries (e.g. the USA) want to use X-rays to scan all high-risk container cargoes for weapons and nuclear material. Indeed, the scanning of some containers already takes place in some countries that export containers to the USA (Preston 2010). Of course, that action will add more costs and will reduce connectivity if the policy makers decide that the USA will import only cargo which has been scanned, as many countries do not have the resources available. Paul and Maloni (2010) claim that disasters at seaports that are caused by weather and terrorism can lead to significant economic losses from cargo and vessel delays. Therefore, USA policy makers want to eliminate the second variable (terrorism) with the 100 percent scanning of containers; whereas, this is largely uncontrollable for the first variable (weather).

### Operating and voyage cost risks

Stopford (2009) introduces the concepts of operating and voyage cost risk, which has a high relevance to the costs of the maritime transport sector. This form of risk includes costs that can easily change and are mainly the following: fuel costs, crew costs, port cost, repair costs and insurance. For example, assessment of the sensitivity of shipping company against changes in the oil price can be measured.

### Chance

Some of the chance factors affecting the maritime transport sector were noticed in the academic literature; for example, Notteboom (2006) mentions the factors mechanical problems caused on-route, unexpected waiting times due to weather circumstances and unexpected waiting times at a bunkering site or port, while some others were mentioned from the industrial literature, as strikes, flooding and earthquakes. The most recent and adverse chance factor that seriously impacted maritime transportation, was the earthquake and the subsequent tsunami at Fukushima, Japan. This event caused closures of at least two weeks at more than half of the Japanese ports, as Figure 3-48 illustrates. Another chance factor which is faced for more often is the weather. Sometime it takes days, or weeks, before terminals in Europe and the USA East Coast can fully recover from major schedule disruptions caused by heavy weather in the Atlantic Ocean. Moreover, on other trade routes, weather conditions can seriously disrupt schedules and

port operations (Notteboom 2006). For instance, the port of Felixstowe is sometimes closed by high winds during the winter months (BBC 2002; BBC 2010). Another example is the port of Qingdao in China. The port was forced to close for an average three days a week in July 2011, as dense fog prevented ships from berthing. Consequently, CMA CGM has announced a USD 125 operational surcharge per TEU, which has been in effect since the 15<sup>th</sup> of July 2011 (The Journal of Commerce 2011b). The surcharge was introduced because the company was losing operations time. The company was trying to recover the lost time by sailing at higher speeds (which entails an increase in fuel consumption) and by omitting some ports (which generates additional feeder expenses). The surcharge was removed when the operations had returned to normal (The Journal of Commerce 2011b).



Figure 3-48 Map of Japan, destroyed ports and exclusion zone due to nuclear accident (19 April 2011)

Source: Thomson Reuters 2011, pers. comm., 20 April

### Possible risks in shipping

A broader range of sources of possible risks in shipping, according to Kavussanos and Visvikis (2006) and by Stopford (2009), is as follows:

- Business risk, which is engendered by fluctuations in Earnings Before Interest and Taxes (EBIT). The factors that cause fluctuations in the EBIT and the associated sources of business risk in shipping are the following: freight rates, voyage costs, operating costs, and foreign exchange rates.

- Liquidity risk: a company cannot sell assets on short notice at market prices.
- Default risk: the possibility that a company cannot either pay back the debt when it is under loan or make principal payments on its debt.
- Financial risk: the degree of financial leverage and its debt obligations.
- Credit risk: this can have various forms of risk for the shipping business, one example could be the delayed payment for a 12 months' time-charter contract.
- Market risk: if a company is listed on the stock exchange, this is at risk of changes in the value of its stock resulting from any change in the stock market.
- Political risk: risks that can affect the business and are caused from various political decisions; i.e. civil unrest in Libya in 2011 (Port Technology International 2011).
- Technical and physical risk: the risk of a breakdown of a vessel or from and caused by a natural disaster, (e.g. the disaster from the connected earthquake, tsunami and subsequent nuclear catastrophe) in Japan in 2011 (R. Adams 2011). This also refers to ship accidents.
- Counterparty risk: a vessel can be commercially sub-chartered several times.
- Competitive risk: when adverse competition affects the financial performance of a company.
- Ship size and age risk: new ships are vulnerable to fluctuations of capital costs as they carry a high capital replacement cost, while old ships are less vulnerable as they carry less capital replacement cost.
- Workout risk: the level of readiness which a company has in order to respond to and deal with a default.
- Environmental risk: pollution liability is a major risk that may be affected by cargo, geography and insurance.
- Management risk: how a risk management team performs, responds to developing problems and maintains high professional standards.
- Diversification risk: every shipping market has its own risk.

After examining the dry and the tanker market, Kavussanos (1996) found that every vessel has its own level of risk, and that smaller vessels are less volatile than larger vessels. The risk to the shipping market was measured with the Value-at-Risk (VaR) technique, and which is the most commonly-used technique by regulators, institutional investors, investment and commercial banks and by financial institutions. The VaR has

three methodologies: 1) the analytic VaR (or variance-covariance); 2) historical simulation; and 3) the Monte Carlo simulation (Kavussanos and Visvikis 2006).

Increased connectivity for a country, such as the UK, means that if an emergency situation stops the exports from a country or region (e.g. the Japan earthquake - tsunami - nuclear accident), the importing country (e.g. the UK) can try to find the resources required from another country or region relatively instantly. Of course, the reverse is true when a UK company wants to send products to a country like Japan. Drewry Maritime Research (Shippers' Voice 2011) argues that "international sourcing has introduced in global business more and higher risks related to transport and logistics, and that these risks are often more complex and more significant than in the past but are still misunderstood". Paul and Maloni (2010) try to understand part of this complex issue and they point out that when a well coordinated network of ports exists, they can react better to a disaster than a single port (in their case, a disaster was identified as a weather, labour or terrorist event), and which is taking place in one or in a number of ports. This better reaction saves ports, shippers, carriers and other stakeholders from higher costs and longer delays.

#### Freight rate volatility

The issue of rate volatility has been addressed by the UK forwarders. One example of the importance of this volatility is provided in a statement made by a UK forwarder, which says "that volatility of Asia-Europe freight rates forces some importers to source goods elsewhere" (Weir 2012c).

#### Cargo misdeclaration

One form of risk that exists, according to some commentators (Beddow 2012b; Wackett 2012c) of the liner shipping industry, is the misdeclaration of cargo. This could lead potentially to fire or explosion in the containers. Over the last 10 years, six vessels were damaged by fires caused by undeclared cargo. Those were: Hanjin Pennsylvania (2002), Hyundai Fortune (2006), MOL Prosperity (2009), Charlotte Maersk (2010), MSC Flaminia (2012) (Wackett 2012c) and Amsterdam Bridge (2012) (Wackett 2012a). After some explosions involving reefer containers in 2011, an explosion on a dry container occurred in Ukraine in July 2012. Fortunately, the 6,400 TEU containership vessel Maersk Kinloss and its other cargo had been left undamaged from the explosion



(Beddow 2012b). Misdeclared cargo could also lead to other cargo contamination, but this is rare in the container shipping industry.

Risks in container shipping should be addressed thoroughly as vessels are getting larger; thereby increasing their risk. These vessels, along with their cargo, could reach an average value of USD 750 million (Girard and Motte 2011). So, some attention is clearly needed on that issue, as only an incidence of fire on-board or a large explosion, or a pirate attack could impact the largest number of containers. Consequently, the supply chain will have to absorb the greatest impact.

### *Risks in supply chain (SC) and transport*

One of the findings of the World Economic Forum (2012) was that business models operating globally are increasing and, while the interconnectivity of the supply chains and transport networks grows, this leads to the evolution of risk profiles and new systemic risk management priorities. An interesting finding was that 93 percent of those surveyed by the World Economic Forum stated that “supply chain and transport risk management has become a greater priority in their organisation over the last 5 years” (World Economic Forum 2012 p.7).

Experts in supply chain and transport processes, which deal with efficiency optimisation and cost reduction, need to be aware of the potential impact of these improvements on their risk profile (World Economic Forum 2012).

A new focus on managing and mitigating risk, which will extend beyond the four walls of a firm, is needed, as vulnerability increases in the supply chains. This requires a much greater level of awareness of where the risks lie (and to share information across corporate boundaries) (Christopher and Peck 2004).

Risk management across the supply chains and transport networks can improve its effectiveness if the level of risk exposure is better quantified and more visible (World Economic Forum 2012). Presently, there is a lack of metrics, as identified in a workshop organised from the World Economic Forum for business managers. This does not provide the opportunity for companies to be able to quantify the risk exposure of their own organisations or to compare providers (World Economic Forum 2012).

In summary, a detailed review of the risk factors has attempted to enlighten any potential factors that could affect the maritime transport costs and connectivity for the

container sector. That light will be shed through the use of a numeric value and an associated probability of each factor. Through that probability, the UK maritime transport sector will acquire a better overall market visibility. Table 3-6 summarises, based on the preceding literature review and discussion, the factors affecting the maritime container transport costs, connectivity and risks for the UK.

After studying and mapping the range of factors affecting costs, connectivity and risk to the maritime transport sector, the actual index will be formulated and generated. The development of indices is a common yet technically complex task that requires a breadth of knowledge about the subject under consideration. The available indices relevant to the maritime transport sector have been studied through an in-depth literature review accompanied by a content analysis. These indices are discussed in the following section.

<b>Cost factors affecting UK maritime transport</b>		
Bilateral trade (volume exported)	Freight rates	Refrigerated cargo
Container service (schedule) reliability	Frequency of services	Regulatory framework
Containerisation	Insurance	Surcharges
Containership loading	Level of organised crime	Tariffs
Corruption (institutional quality)	Load of the container	Time spent at sea
Cost of labour	Number of shipping lines	Trade imbalance
Economies of scale (vessel capacity)	Oil price	Transport cost sensitivity
Environmental issues	Pipeline stocks	Vessel characteristics (vessel design)
Exchange rates	Port efficiency	100 percent container scanning
Flag of registry	Port privatisation	
<b>Connectivity factors affecting UK maritime transport</b>		
Annualised Slot Capacity (ASC)	GDP per capita in exporting country	Service frequency
Average port charge per vessel	Inter-modal transport capabilities in ports (inter-modal connections)	Total annual operating hours
Collaborating partners	Port cargo traffic	Trade volumes (national trade volumes)
Common political block	Port infrastructure	Type of vessels deployed
Depth of the port (ship draft)	Schedule of port calls (number of port calls)	
<b>Costs and connectivity factors of UK maritime transport</b>		
Access channels	Industry structure	Ports location
Common language between trading countries	National economic characteristics; per capita income and country size	Transshipment routings
Distance	New intercontinental routings	Turnaround time
<b>Risk factors affecting UK maritime transport</b>		
Business risk	Environmental risk	Piracy
Cargo misdeclaration	Financial risk	Political risk
Chance	Freight rate volatility	Risk in SC and transport
Competitive risk	International terrorism	Ship size and age risk
Counterparty risk	Liquidity risk	Technical and physical risk
Credit risk	Management risk	Workout risk
Default risk	Market risk	
Diversification risk	Operating and voyage cost risks	

Table 3-6 Factors affecting maritime transport cost, connectivity and risk for the UK (listed alphabetically)

### **3.3 The Nature and Structure of Indices**

According to Hermans et al. (2010), the interest in indices creation and use has increased in recent years; Collis and Hussey (2009 p.279) define the purpose of an index as “A statistical measure that shows the percentage change in a variable from a fixed point in the past”. Rodrigue et al. (2009 p.29) points out that: “Indices are more complex methods to represent the structural properties of a graph since they involve the comparison of one measure over another”. An additional ‘interesting’ quote for indices is that given by Jacques (2006 p.184): “Index numbers enable us to identify trends and relationships in the data”. In this research, the goal is to generate a new index to measure and combine the factors expressing: a) cost; b) connectivity; and c) risk, but also to reflect the overall Prime Index, under which the prism of the UK maritime transport sector is being conducted. The indices are numbers that have units (Jacques 2006), which will be particularly useful as it provides the opportunity to make comparisons of cost, connectivity and risk and the Prime Index for the years during which their values are tracked. This means that the researcher will create a complex statistical measurement for cost, connectivity and risk, and for the overall outcome of the aforementioned factors for the UK maritime transport sector. This complex statistical measurement will help to improve the maritime sector, as defined by Harrington (1991 p.82): “If you cannot measure it, you cannot control it. If you cannot control it, you cannot manage it. If you cannot manage it, you cannot improve it”. The same logic is applied to the industrial sector. Maersk has published recently this observation and has established some Key Performance Indicators (KPIs) that are formatted as scorecards. These scorecards measure the energy performance of some of the company’s vessels. The measurements recorded since 2009 have helped Maersk to save USD 90 million. As Anup Rajan, the Performance Manager in Maersk Line Vessel Management explains: “If you cannot measure something, you cannot control it. If you cannot control it, you cannot improve it. It is essential to realise that the scorecards are only a valuable tool if they help facilitate decision making amongst stakeholders” (Hellenic Shipping News Worldwide 2012j). One example of those measurements has led to the saving of 160,000 tons of fuel, due only to higher propulsion efficiency (Hellenic Shipping News Worldwide 2012j). However, to achieve such improvements, and because the issue of the creation of an index is relatively complex, a first step is to map and understand how other indices

relate to the maritime sector function. In order to achieve such an understanding, a systematic study was conducted of existing indices using a content analysis approach of 10 leading journals and reports. The style of the content analysis will be presented in detail later in Section 3.4. The content analysis applied for the 10 journals and reports is the Quantitative Content Analysis (NCA). The selected journals and reports cover holistically all of the views available for the maritime sector, ranging from ship-owners to the academics. These sources included: Fairplay, Seatrade, Ship Management International, R.S. Platou Monthly Report, Lloyd's List (Daily Newspaper), Lloyd's Shipping Economist, UNCTAD Transport Newsletter, Maritime Policy and Management, Maritime Economics and Logistics and the Journal of Transport, Economics and Policy. The knowledge of the various indices was not limited only to these 10 journals and reports, but came also from a study of various indices available in the academic and the commercial literature. This identification and study of the literature, together with the additional undertaking of some interviews that were conducted with experts of the maritime sector, has helped the researcher to evolve the development of the proposed index. The research approach design is described in Methodology Section, where the whole methodology plan formed for the research is outlined and reviewed.

### ***3.3.1 Index development and risk theory***

#### ***Introduction – Indices as a risk management tool***

Some indices (which are mostly of a time series nature) are used within the maritime transport sector as forecasting models, which attempt to anticipate future trends. These indices use various explanatory variables to forecast risk (FreightMetrics 2003). Some of the freight indices are used in the shipping sector as measuring tools; for example, one of the most important forms of risk is identified as the freight market risk. This refers to the possibility of financial losses arising from the unfavourable changes in the market (FreightMetrics 2003).

Freight rates are extremely volatile, as can be observed from their recent fluctuations. This is particularly so for the dry bulk sector, where a step rise of the freight rates upwards was observed until the second quarter of 2008, caused by the inelastic short-term supply in the market with ships. That inelastic short-term supply was caused by the limited number of shipyards around the globe, and the time required to respond to

market needs was, on average, 3.5 years (Clarksons 2013). Therefore, the ship-building industry could not match the demand with the supply, which had a reverse effect when the economic crisis began and the demand for products had then fallen due to the oversupply of the market with available vessels. Currently, the shipping rates have started to collapse. An example was the Baltic Dry Index, which from the 20<sup>th</sup> of May 2008 (11,793 points which was the highest peak of the index since its creation) fell by 94 percent until the 5<sup>th</sup> of December 2008 (663 points - the lowest level since 1986) (The Baltic Exchange 2010).

Another example of risk that exists in the maritime transport sector industry and applies only to the container market is the shortage of containers. This can be best understood by the box inventory to vessel capacity ratio, which is presented in Figure 3-49. This ratio was predicted to reach 1.99 in 2011, according to estimations of Alphaliner, compared with a 2.99 ratio that existed in 2000 (Alphaliner 2011f). A recently published number from Drewry Maritime Research for the box inventory to vessel capacity ratio demonstrates the adoption of greater operating efficiencies by shipping companies, as the ratio for the first half of 2012 was 1.85 (Hellenic Shipping News Worldwide 2012d). That slighter ratio demonstrates the observation that the containers are managed more efficiently than the carrier vessels, especially after the ‘Global Trade Collapse’ when the production of new container units was halted. However, that halt led to a container shortage in the Far East due to the fact that the carriers were unprepared for the high increase in demand that occurred in 2010. That volatility, described in the previous examples, illustrates a high risk for those involved in the liner shipping industry.

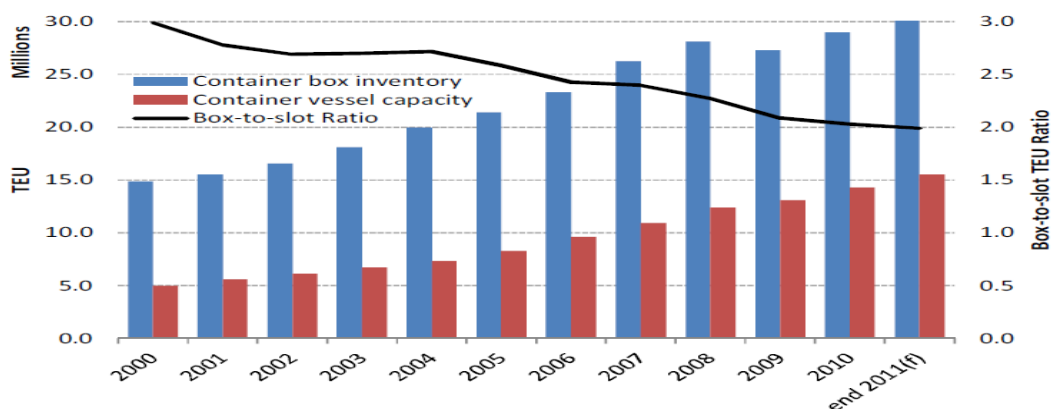


Figure 3-49 Container box inventory-to-containership fleet ratio; 2000-2011

Source: Alphaliner (2011f)

Indices in some cases, such as the Risk Management Index (RMI), provide performance measurements in risk management. The RMI gathers data for a group of indicators, which measure collectively a country's risk management performance. These indicators reflect the organisational, development, capacity and institutional actions that have been taken to reduce vulnerability and losses, to prepare for future possible crisis and to plan to recover efficiently from unforeseen disasters. The RMI is created from an aggregation of qualitative and quantitative indicators, and provides a risk management performance. The RMI value is compiled from Equation 3.2.

$$RMI = \frac{Risk\ identification + Risk\ Reduction + Disaster\ management + Governance\ and\ financial\ protection}{4} \quad (3.2)$$

Each indicator is estimated to equate to a value on a five point Likert scale, with one being low and five being optimal (Cardona 2007).

### ***3.3.2 Indices found during the literature review***

The indices identified in the literature review were found in two stages. One stage was the conducting of the content analysis in the 10 journals and reports. The second stage was a continuous review of the academic and commercial literature for the presence of indices. The actual results obtained from the first stage (content analysis of the 10 journals and reports) are placed in an appendix for two reasons. First, the size of the table containing is quite large; a total of 109 indices were found. Second, after the 18<sup>th</sup> ranked index, the subsequent indices published appearances percentage of the total number of appearances were less than one percent in each case.

A combination of techniques known as the Herfindahl – Hirschman Index (HHI) and the Concentration Ratio, are often used by business analysts to measure a company concentration in markets. The researcher found that indices with a percentage of less than one percent can be considered negligible as the concentration in sample of this research is 'moderate'. Gerhards and Schafer (2010) appropriated the technique of HHI for the analysis of concentration in the context of a content analysis. The more important indices found from the content analysis were considered to be the first 18, which are presented in Table 3-7. In total, 142 indices were found (109 content analysis and 33 literature review).

All the indices found from the content analysis and from the review of academic and commercial literature, are placed into groups and presented in Table 3-8; Table 3-9; Table 3-10; Table 3-11 and Table 3-12. This survey was undertaken in order to extract

some characteristics which these indices have and could be relevant to this research. The creation of the groups was conducted according to the relevance of each index to this research. The indices are separated into four categories: 1) maritime indices (which itself is separated into three sub-categories relevant to the type of the vessel: wet, dry, container); 2) economic indicator indices; 3) environmental indices; and 4) miscellaneous indices. The total indices found were 142, of which 33 were found in the literature review. Those 33 additional indices were separated in categories, as demonstrated in Table 3-12. The research uses that categorisation in order to group the indices. Through that grouping, the extraction of some characteristics is attempted, which it is postulated that the eventual proposed index must contain. Therefore, the interviews conducted at the next stage of the research help to realise the validity of the results and organise the deliberation process.



Index	Publication Source										Total/ Percentage	
	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport, Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist		
Baltic Dry Index (BDI)	65	3	4	0	0	0	0	4	18	1	95	24.42%
Energy Efficiency Design Index	20	5	5	2	0	0	0	0	4	0	36	9.25%
Baltic Capesize Index	25	1	0	0	0	0	0	0	4	0	30	7.71%
New ConTex	20	0	0	0	0	0	1	1	3	0	25	6.43%
Baltic Panamax Index	12	1	0	0	1	0	0	0	0	0	14	3.60%
Howe Robinson	9	0	0	0	0	0	0	0	1	1	11	2.83%
Shanghai Containerized Freight Index	6	3	0	0	0	0	0	0	1	1	11	2.83%
Baltic Dirty Tanker Index	4	0	1	1	0	0	0	1	2	0	9	2.31%
Purchasing Manager Index	5	1	1	0	0	0	0	0	0	1	8	2.06%
Boxi Index (Braemar Seascope)	6	0	0	0	0	0	0	0	0	0	6	1.54%
Consumer Price Index (CPI)	0	0	0	1	2	3	0	0	0	0	6	
Malmquist Productivity Index	0	0	0	1	2	3	0	0	0	0	6	1.54%
Energy Efficiency Operational Index (IMO)	1	1	2	0	0	0	0	0	1	0	5	1.29%
Liner Shipping Connectivity Index	0	0	0	0	0	0	0	5	0	0	5	1.29%
Logistics Performance Index (LPI)	2	0	0	0	0	0	0	3	0	0	5	1.29%
Baltic Clean Tanker Index	2	0	0	0	0	0	0	1	1	0	4	1.03%
Baltic Handymax Index	4	0	0	0	0	0	0	0	0	0	4	1.03%
Baltic Supramax Index	4	0	0	0	0	0	0	0	0	0	4	1.03%
91 other indices	19	3	9	33	7	11	2	3	16	3	106	27.24%
Grand Total/ Total %	204	18	22	38	12	17	3	18	51	7	389	100%

Table 3-7 Results of the Quantitative Content Analysis (QCA) on the frequency of indices mentioned in 10 maritime transport publications

<b>Maritime Indices</b>	
<b>Wet Indices:</b>	<b>Percentage</b>
Baltic International Tanker Routes (BITR):	0.26%
Baltic Clean Tanker Index (BCTI)	1.03%
Baltic Dirty Tanker Index (BDTI)	2.31%
Riverlake Tanker Index (ReTI)	0.51%
Baltic VLGC Index	0.51%
Baltic Crude Index	0.51%
Baltic Gas Index	0.26%
R.S. Platou Chemical Tanker Index	0.26%
Tanker Market Index	0.26%
World Scale Index	0.26%
WS Index	0.26%
<b>Dry Indices:</b>	<b>Percentage</b>
Baltic Dry Index (BDI):	24.42%
Baltic Capesize Index (BCI)	7.71%
Baltic Panamax Index (BPI)	3.60%
Baltic Supramax Index (BSI)	1.03%
Baltic Handymax Index (BHI)	1.03%
Fearnley's Coal Index	0.26%
R.S. Platou Dry Bulk Freight Index	0.26%
<b>Container Indices:</b>	<b>Percentage</b>
Freight rate indices:	
Shanghai Containerized Freight Index	2.83%
Liner Freight Rate Index	0.26%
Charter rate indices:	
New ConTex Container Ship Time Charter Index	6.43%
Howe Robinson Index	2.83%
BOXi Index (Braemar Seascope)	1.54%
Clarksons Container Time – Charter Index	0.26%
Harpex	0.26%
Liner Shipping Connectivity Index	1.29%
European Liner Affairs Association (ELAA) Aggregate Price Index	0.51%

Table 3-8 Maritime Indices (wet, dry, container) found in QCA

<b>Economic indicator indices:</b>	<b>Percentage</b>
Purchasing Manager Index (PMI)	2.06%
Consumer Price Index	1.54%
HSBC China Purchasing Manufacturing Index (PMI)	0.51%
Human Development Index	0.51%
Retail Price Index	0.51%
Doing Business Index	0.26%
IHS Global Insight Index	0.26%
International Monetary Fund (IMF) Export Index	0.26%
New Exports Index	0.26%

Table 3-9 Economic indicator indices found in QCA

<b><u>Environmental indices:</u></b>	<b>Percentage</b>
Energy Efficiency Design Index (EEDI)	9.25%
Energy Efficiency Operational Index (EEOI)	1.29%
Environmental Ship Index (ESI)	0.51%
Vessel Total CO2 Index	0.51%
CO2 Maintenance Index	0.26%
Environmental Performance Ship Index (RiNA)	0.26%
GL's 'Fuel Saver' Analysis Ships CO2 Index	0.26%
Green Rating Composite Index	0.26%
OOCL CO2 Index	0.26%
The Rightship Operational Index	0.26%

Table 3-10 Environmental indices found in QCA

<b><u>Miscellaneous indices</u></b>	<b>Percentage</b>
<b>Freight Indices:</b>	
Freight Rate Index	0.77%
European Freight Forwarding Index	0.51%
Lloyd's Register Fairplay (LFR) Freight Index	0.51%
Corporate Price Service Index	0.26%
General Freight Index	0.26%
Price Index of Freight Services	0.26%
<b>Financial Indices:</b>	
Standard & Poor's 500 Index	0.51%
Argus Far East Index (FEI) (swap)	0.26%
AXS Maritime Capesize Coal Index	0.26%
AXS Maritime Capesize Iron Ore Index	0.26%
Capital Link Maritime Index	0.26%
Chicago Board Of Trade (CBOT) synthetic Futures Basket Index	0.26%
Clarksons Lines Share Price Index	0.26%
Clarksons Tanker Share Price Index	0.26%
CLSA Index	0.26%
CRSP Value Weighted Index of AMEX, NASDAC and NYSE firms	0.26%
DJ Euro Stoxx 50 Index	0.26%
Dow Jones Commodity Spot Index	0.26%
FTSE ST Maritime Index	0.26%
Global Interest Rate Index	0.26%
Morgan Stanley Capital International (MSCI) Asia Pacific Telecommunications Index	0.26%
Morgan Stanley Capital International (MSCI) World Stock Market Index	0.26%
NASDAQ Composite Index	0.26%
Stock Exchange Composite Index	0.26%
VIX Index	0.26%
World Stock Market Index	0.26%
WorkBoat Composite Index	0.26%
<b>Theoretical Indices:</b>	
Malmquist Productivity Index	1.54%

Bentler-Bonett Nonnormed Fit Index	0.26%
Comparative Fit Index (CFI)	0.26%
Concentration Index	0.26%
Gini Index	0.26%
HHI (Hirschman - Herfindahl Index)	0.26%
Incident Possibility Index (IPI)	0.26%
Incremental Fit Index (IFI)	0.26%
Person Correlation Index	0.26%
Prevalence Index	0.26%
Spatial Concentration Index	0.26%
General Logistics Indices:	
Logistics Performance Index (LPI)	1.29%
Cenrtality Index	0.26%
Congestion Index	0.26%
Disparity Index (or inter - regional disparity index)	0.26%
Ellison-Glaeser Index	0.26%
Foreland Diversity Index	0.26%
Global Logistics Business Confidence Index	0.26%
Lerner Index	0.26%
Maurel-Sedillot Index	0.26%
Productivity Index (for container port terminals):	
Scale effects index	0.26%
Technical change index	0.26%
Total factor productivity (TFP) index	0.26%
Market Indicator Indices:	
Cockett Bunker Price Index	0.51%
Crude Oil Index	0.26%
Iron Ore Index	0.26%
Anthropocentric Indices:	
Political Risk Index	0.26%
Rural Access Index	0.26%
Sudden Cardiac Arrest Association Index	0.26%
Ship Relevant Indices:	
Damage Stability Index	0.26%
Ferry - specific Efficiency Index	0.26%
Lloyd's Register Fairplay (LRF) Demolition Price Index	0.26%
Ship Index	0.26%
Spill Propensity Index (SPI)	0.26%
Ungrouped Index:	
FTAS World Index	0.26%

Table 3-11 Miscellaneous indices found in QCA

<b><u>Charter</u></b>	<b><u>Theoretic</u></b>
Clarksea Index	Alpha Index
<b><u>Environmental</u></b>	Beta Index
Clean Shipping Index	Cargo Handling Restriction Index
<b><u>Financial</u></b>	Cooperative Working Agreements Index
BDIFutures	Crime Index
Daxglobal Shipping Index	Detour Index
MSCI World Marine Index	Eta Index
S&P Global Infrastructure Index	Gamma Index
<b><u>Freight indices</u></b>	Index Comparison Between the Gateway Regions
CCFI	Low Cost Port Competitiveness Index
Container Trade Statistics (CTS) price indices	Pi Index
The Costpartner's Seafreight Index	Port Infrastructure Index
The Seafreight Index	Price Fixed Agreement Index
World Container Index	Specialisation Index
<b><u>Market</u></b>	Theta Index
Instability Index (II) of the Container Liner Shipping Industry	Transport Cost Index
<b><u>Performance</u></b>	<b><u>Trade</u></b>
Global Port Congestion Index	Global Competitiveness Index
Mandatory Port Services Index	Global Enabling Trade (GET) Index
Quality of Port Infrastructure (or Port Efficiency Index)	

Table 3-12 Indices found in literature review (listed alphabetically)

### 3.3.3 *Maritime indices*

#### *Baltic Indices (dry and wet indices)*

The Baltic indices derive their name from The Baltic Exchange, which is based in London and covers the dry and the wet ship markets. The most widely used and known index in the maritime transport sector, but also in the general maritime world, is the BDI. This is an index covering dry bulk shipping rates and it is managed by the Baltic Exchange. The BDI is a number that is updated and issued five days per week (Figure 3-50). The index provides an assessment of the freight of moving the major raw materials by sea. Changes in the BDI can give insights into how the global trends of supply and demand are changing. Simply, the BDI reflects the costs of hiring (chartering) a vessel for transporting major bulk – raw materials (Bloomberg 2010; Clarksons 2010b).

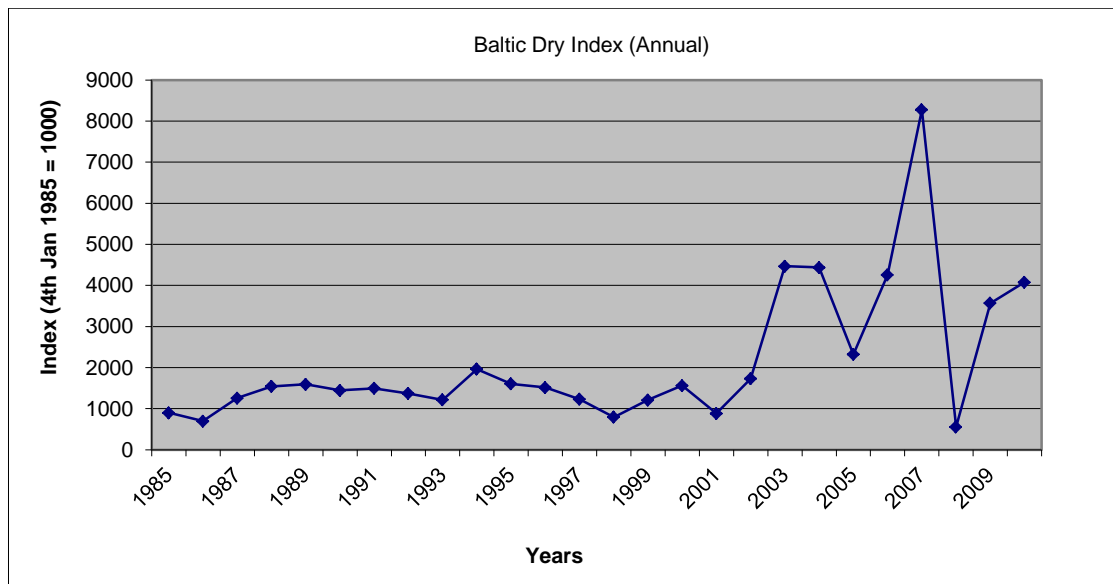


Figure 3-50 Baltic Dry Index, annual average; 1985-2010

Source: Clarksons (2010b)

The index, thus, tracks worldwide international shipping prices of various dry bulk cargoes. Taking in 20 shipping routes measured on a time-charter and voyage basis, the index covers Capesize, Panamax, Supramax and Handysize dry bulk carriers carrying a range of commodities, including coal, iron ore and grain. The index is comprised of an average of the Baltic Capesize, Panamax, Supramax and Handysize indices (BCI, BPI, BSI, BHSI) (see Figure 3-51) with each of them counting 25 percent; that is, they are assigned equal weighting (Bloomberg 2010; Clarksons 2010b).

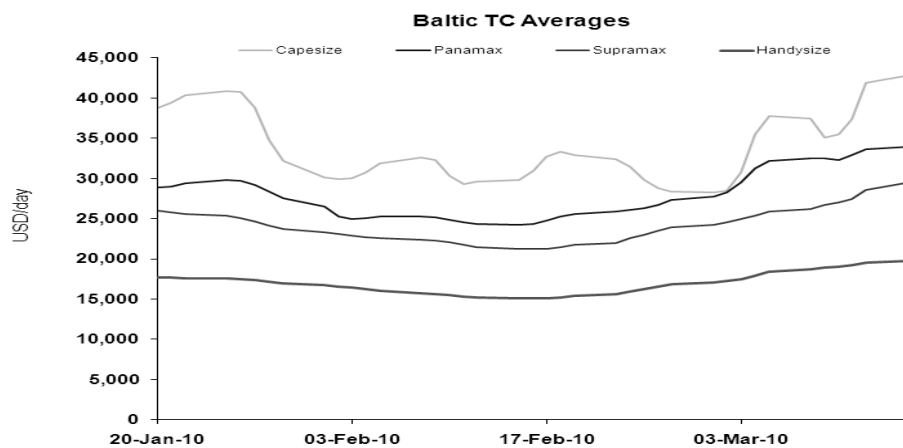


Figure 3-51 The four indices which are used for the creation of the BDI (March 2010)

Source: Howe Robinson (2011)

The number of component routes of the BDI changes according to the assessment judging panel of the company. Since October 2010, the BDI has been calculated based on 26 individual shipping routes, as detailed in Table 3-13.

As mentioned above, each of the individual Capesize, Panamax, Supramax and Handysize indices account for 25 percent of the BDI. The final calculation is determined from Equation 3.3.

$$BDI = \left( \frac{CapesizeTCavg + PanamaxTCavg + SupramaxTCavg + HandysizeTCavg}{4} \right) * 0.1134473601 \quad (3.3)$$

where TCavg is the Time charter average, and the multiplier (0.113473601) was first applied when the BDI replaced the earlier BFI (BFI: Baltic Freight Index), which was the first index that was published from the Baltic Exchange at 4<sup>th</sup> January 1985. This has changed over the years as the contributing indices and the methods of calculation have been modified (Container Transportation 2010).

To calculate the value of the BDI, it is first necessary to determine the actual values of time charter rates for the 20 routes. Then, one must multiply the time charter rates of each route by analogous weightings, in order to determine the average time charter for each vessel type (Capesize, Supramax, Panamax and Handysize). Finally, the BDI is generated using the mentioned formula (Equation 3.3).

For a period of years, the BDI used was referred to as being an economic indicator; however, as observed during the last year it does not seem to be reacting like that. As Sam Chambers from Seatrade (2010 p.11) mentions: “we should stop using the BDI as an economic barometer because it is not reacting like that, especially the last year. That is caused from various reasons, but the most important is the oversupply of vessels to the market. That had led to the decrease of the index”.

The other indices published by The Baltic Exchange appear to follow the same philosophy as the BDI. The differences are that they are measuring other types of ships and routes, with various weightings for each of them. The Capesize, Supramax, Panamax and Handysize indices are calculated according to the routes and their weightings, which are presented in Table 3-13. The Handymax Index, which also belongs to the dry sector, is calculated in a similar manner, as are the other dry Baltic indices mentioned above.

Route	Description	Weightings
<b>4 Capesizes T/C routes (with 6 other voyage charter routes) to form BCI</b>		
C2	160000lt Tubarao - Rotterdam	10%
C3	150000mt Tubarao - Beilun/Baoshan	15%
C4	150000mt Richards Bay - Rotterdam	5%
C5	150000mt W Australia - Beilun/Baoshan	15%
C7	150000mt Bolivar - Rotterdam	5%
C8	172000mt Gibraltar/Hamburg trans Atlantic RV	10%
C9	172000mt Continent/Mediterranean trip Far East	5%
C10	172000mt Pacific RV	20%
C11	172000mt China/Japan trip Mediterranean/Cont	5%
C12	150000mt Gladstone - Rotterdam	10%
<b>4 Panamax T/C routes to form BPI</b>		
P1A	74000mt Transatlantic RV	25%
P2A	74000mt SKAW-GIB/FAR EAST	25%
P3A	74000mt Japan-SK/Pacific/RV	25%
P4	74000mt FAR EAST/NOPAC/SK-PASS	25%
<b>6 Supramax T/C routes to form BSI</b>		
S1A	54000mt Antwerp - Skaw Trip Far East	12.5%
S1B	54000mt Canakkale Trip Far East	12.5%
S2	54000mt Japan - SK / NOPAC or Australia rv	25%
S3	54000mt Japan - SK Trip Gib - Skaw range	25%
S4	54000mt US Gulf - Skaw-Passero	12.5%
S4B	54000mt Skaw-Passero - US Gulf	12.5%
<b>6 Handysize T/C routes to form BHSI</b>		
HS1	28000mt Skaw / Passero - Recalada / Rio de Janeiro	12.5%
HS2	28000mt Skaw / Passero - Boston / Galveston range	12.5%
HS3	28000mt Recalada / Rio de Janeiro-Skaw / Passero	12.5%
HS4	28000mt US Gulf / NC South America - Skaw / Passero	12.5%
HS5	28000mt SE Asia via Australia - Singapore / Japan	25%
HS6	28000mt S Korea/Japan - S'pore/Japan range incl. China	25%

Table 3-13 BDI routes and their weightings

Source: Adapted from Container Transportation (2010) and Clarksons (2012g)



The Baltic Tanker Indices, or Baltic International Tanker Routes (BITR), is an index covering the wet shipping rates and is also managed by the Baltic Exchange. The BITR is combined from two indices, namely the: 1) Baltic Clean Tanker Index (BCTI), and the 2) Baltic Dirty Tanker Index (BDTI). Both were established in October 2001 (Penn 2005).

The BCTI is an index with both daily worldwide and non-worldscale assessments on international clean tanker routes and is a selection of basket and individual Time Charter Equivalent (TCEs) (The Baltic Exchange 2010). The index captures only the trade involving refined products of oil. According to Clarksons (2010a), the types of ships which comprise the index are: a) Aframax tanker; b) Panamax tanker; and c) Handysize tanker. The index has a rate of development on selected routes for the product tanker segments, namely: Handysize, MR and LR1 (Product tankers for the transport of refined oil products of the order of 60,000-75,000 dwt) (NORDEN 2010). Figure 3-52 below shows how this index has fluctuated over the last 12 years.

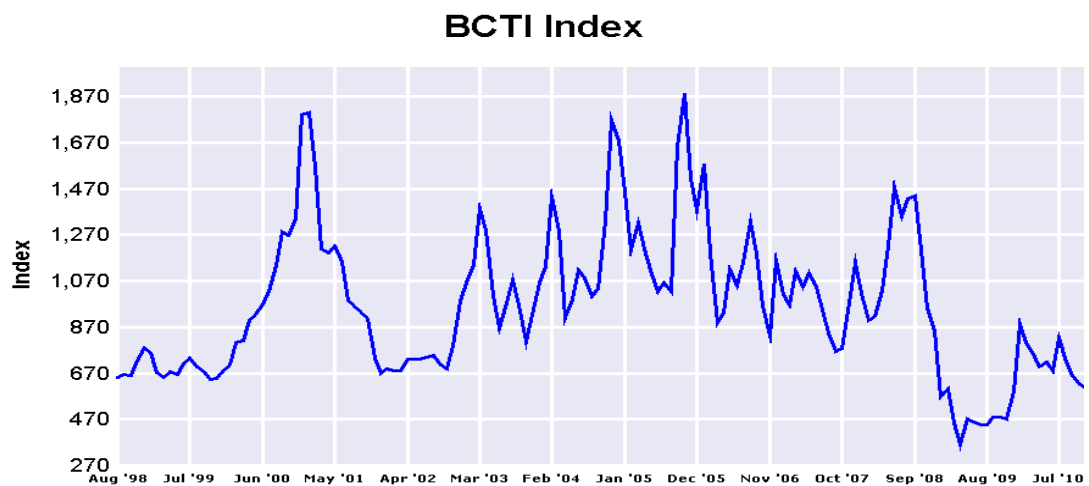


Figure 3-52 BCTI from Aug 1998 until July 2010

Source: Clarksons (2010a)

The BDTI is an index with a daily worldwide and a non-worldscale assessment on international dirty tanker routes and is composed of a selection of basket and individual TCEs (The Baltic Exchange 2010). The routes of the BDTI as of 8<sup>th</sup> October 2007 are presented in Table 3-14. Figure 3-53 shows how this index has fluctuated over the last 12 years.

<u>Route</u>	<u>From</u>	<u>To</u>	<u>Size</u>	<u>Class</u>
TD1	ME Gulf	US Gulf	280,000mt	VLCC
TD2	ME Gulf	Singapore	260,000mt	VLCC
TD3	ME Gulf	Japan	250,000mt	VLCC
TD4	West Africa	US Gulf	260,000mt	VLCC
TD5	West Africe	USAC	130,000mt	Suezmax
TD6	Black Sea	Mediterranean	135,000mt	Suezmax
TD7	North Sea	Eur Continent	80,000mt	Aframax
TD8	Kuwait	Singapore	80,000mt	Aframax
TD9	Caribbean	US Gulf	70,000mt	Aframax
TD10	Caribbean	USAC	50,000mt	Panamax
TD11	Mediterranean	Mediterranean	80,000mt	Aframax
TD12	Antwerp	US Gulf	55,000mt	Panamax
TD14	SE Asia	EC Austrailia	80,000mt	Aframax
TD15	West Africa	China	260,000mt	VLCC
TD16	Black Sea	Mediterranean	30,000mt	Handymax

Table 3-14 Baltic Dirty Tanker Index, routes and ship size - class, as of 8 October 2007  
Source: Adopted from Anon (2010) and Clarksons (2012g)

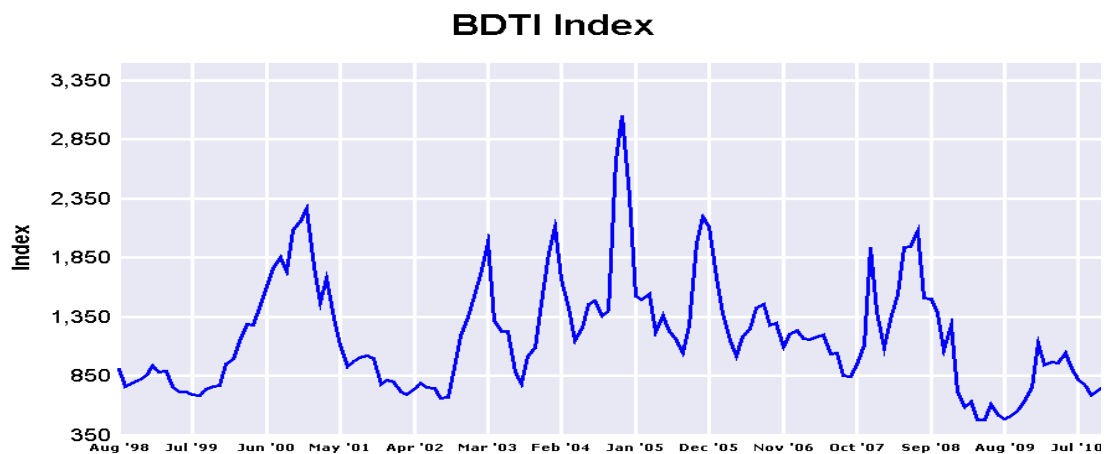


Figure 3-53 BDTI from Aug 1998 to July 2010  
Source: The Baltic Exchange (2010)

For the Baltic Crude Index and the Baltic VLGC Index, which were found through a content analysis of the journal Fairplay and the newspaper Lloyd's List correspondingly, there was no freely available information.

#### Howe Robinson Containership Index

The Howe Robinson Containership Index reflects, in summary, the development of charter rates for containerships up to and including the Panamax size class (Hanseatic Lloyd 2010). Figure 3-54 illustrates the index fluctuations from 1993 until 2010.



Figure 3-54 Howe Robinson Container Index; April 2010

Source: MCT Treuhand (2010)

The index is composed of 14 sub-indices. Each sub-index has a different weighting for the subsequent calculation of the final index. Every sub-index is calculated against three parameters: 1) the ship size; 2) the presence of gear in the ship; and 3) the speed of the ship. Table 3-15 demonstrates that the index is calculated by an assigned percentage weight according to vessel type and speed.

	<b>Vessel Type</b>	<b>Speed</b>	<b>Weighting</b>
1	510 TEU / 285 @ 14t Gearless	15 Knots	2.5%
2	520 TEU / 270 @ 14t Geared	15.5 Knots	2.5%
3	650 TEU / 410 @ 14t Geared	15 Knots	5%
4	1000 TEU / 650 @ 14t Geared	17.5 Knots	2.5%
5	1100 TEU / 700 @ 14t Gearless	19 Knots	7.5%
6	1100 TEU / 750 @ 14t Geared	19 Knots	7.5%
7	1200 TEU / 900 @ 14t Gearless	19 Knots	10%
8	1600 TEU / 1168 @ 14t Gearless	18 Knots	12.5%
9	1700 TEU / 1120 @ 14t Geared	19.5 Knots	12.5%
10	2080 TEU / 1640 @ 14t Gearless	21.5 Knots	7.5%
11	2500 TEU / 1850 @ 14t Geared	22 Knots	10%
12	2800 TEU / 2050 @ 14t Gearless	22 Knots	10%
13	3500 TEU / 2500 @ 14t Gearless	22.5 Knots	5%
14	4300 TEU / 2900 @ 14t Gearless	24 Knots	5%
Index			100%

Table 3-15 Parameters on which the Howe Robinson Container Index is calculated (on 20/10/2010)

Source: Rehder (2010)

A recent chart of the index is provided in Figure 3-55, where the disappointing market conditions for the last three quarters of 2011 for containership owners are illustrated, as low freight rates and an expansion in operator-owned tonnage took their toll on charter rates.

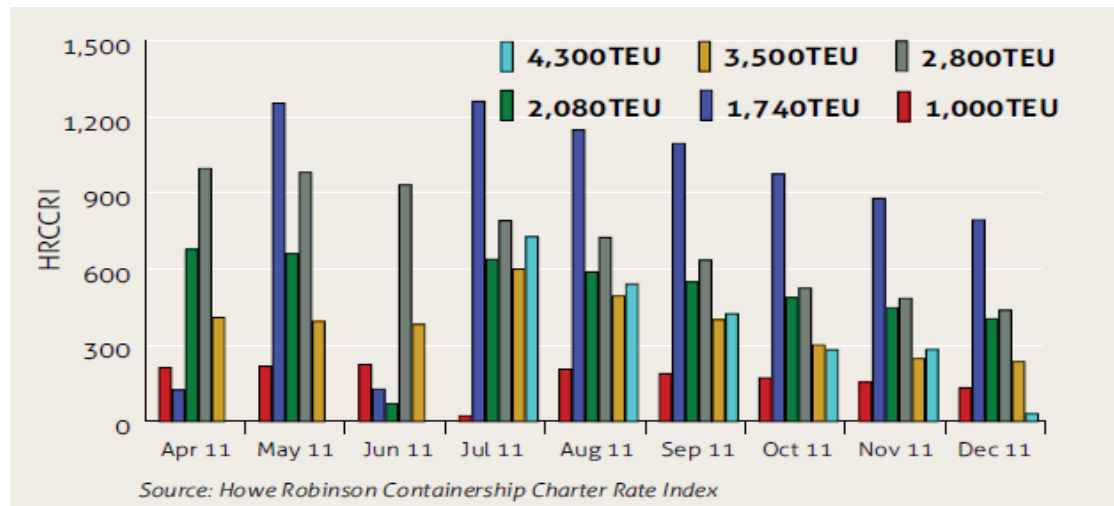


Figure 3-55 Howe Robinson Container Charter Rate Index (April 2011-Dec 2011)  
Source: Fossey (2012b)

#### New ConTex or Hamburg Index

The New ConTex Index (or, as it was used to be called, the Hamburg Index) provides a market analysis of containership time charter rates for above a minimum elapsed time duration of 12 months. The New ConTex Index was created by the Hamburg Shipbrokers' Association (VHSS) in 1998. The German ship-owners currently dominate the global liner shipping market and, together with the Hamburg brokers, they control about 75 percent of available containership charter tonnage (UNCTAD 2009a). Figure 3-56 illustrates the variations in time-charter rates from 2000 until 2007 according to the various ships and their characteristics, while Figure 3-57 captures the different vessel sizes and their time charter contracts from October 2007 until August 2012. Several other indices that track the containerships time charter rates exist, as Figure 3-58 illustrates; however, the New ConTex Index is the most broadly used within the industry.

Ship type	Yearly averages							
	2000	2001	2002	2003	2004	2005	2006	2007
<b>Gearless</b>								
200–299	15.71	15.74	16.88	19.57	25.02	31.71	26.67	27.22
300–500	14.52	14.72	15.14	17.48	21.73	28.26	21.67	22.27
<b>Geared/Gearless</b>								
2,000–2,299	10.65	7.97	4.90	9.75	13.82	16.35	10.51	11.68
2,300–3,400 <sup>a</sup>			5.96	9.29	13.16	13.04	10.18	10.74
<b>Geared/Gearless</b>								
200–299	17.77	17.81	17.01	18.93	27.00	35.35	28.04	29.78
300–500	14.60	14.90	13.35	15.55	22.24	28.82	22.04	21.34
600–799 <sup>b</sup>			9.26	12.25	19.61	23.70	16.62	16.05
700–999 <sup>c</sup>			9.11	12.07	18.37	21.96	16.73	16.90
1,000–1,299	11.87	8.78	6.93	11.62	19.14	22.58	14.28	13.69
1,600–1,999	10.35	7.97	5.67	10.04	16.08	15.81	11.77	12.79

Figure 3-56 Containership time-charter rates (USD per 14-ton slot/day)

Source: UNCTAD (2008a)

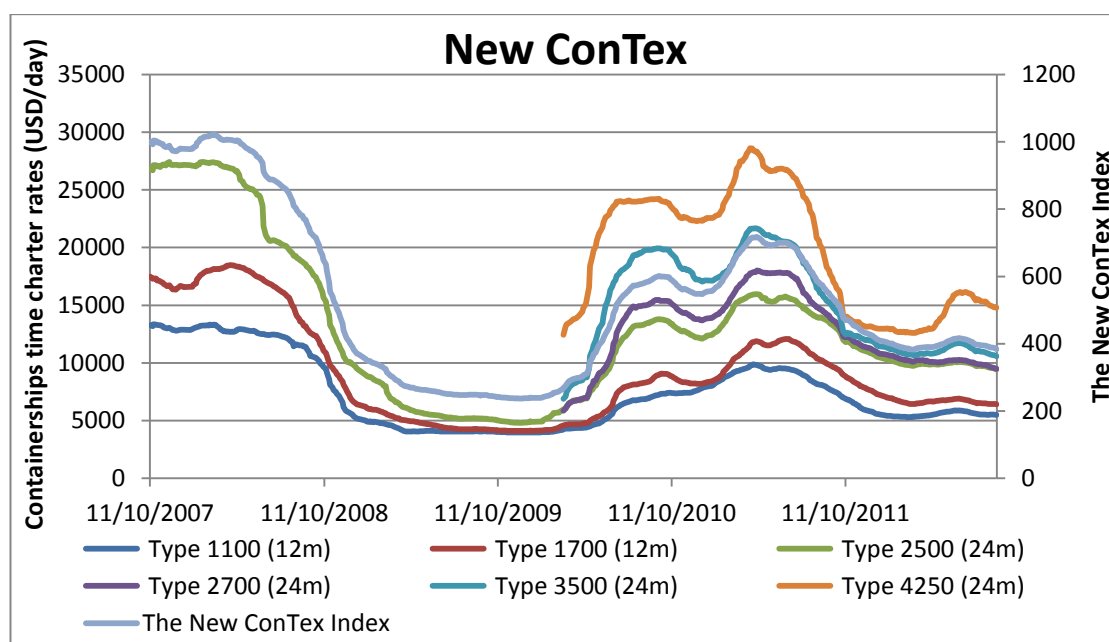


Figure 3-57 Vessel types and contract duration on left axis and the overall New ConTex index on the right axis (11 Oct 2007 until 23 Aug 2012)

Source: VHSS (2012)

The New ConTex is the only index worldwide for containership chartering, and it is computed from the input provided by a panel of international brokers who, collectively, have an extensive coverage of the container markets. The current panel, composed of 16 brokers, is made up from recognised broking houses not only from Hamburg, but also from Copenhagen, London and Paris (VHSS 2010; Fairplay 2010c).

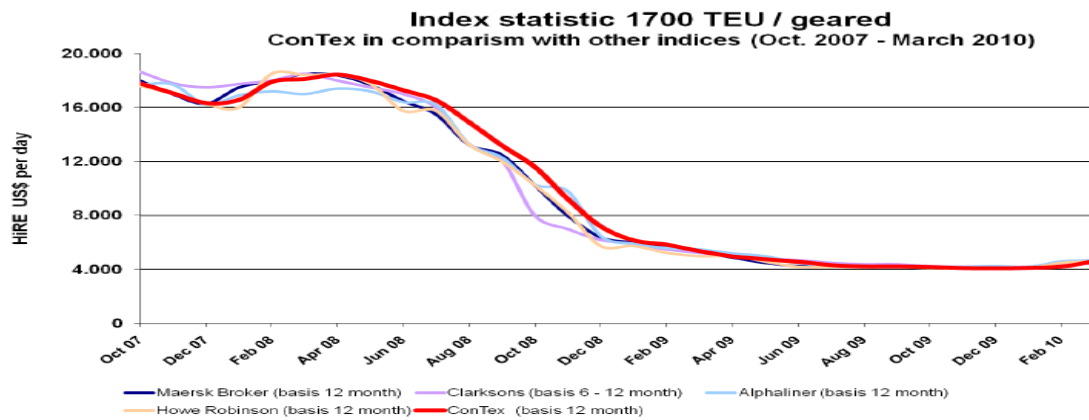


Figure 3-58 The ConTex Index in comparison with other indices (Oct 2007-March 2010). (The other indices: Maersk Broker, Howe Robinson, Clarksons – Clarksea, Alhaliner)

Source: VHSS (2011)

After the 25<sup>th</sup> of February 2010, the ConTex captured data from an additional three new types of vessels for the calculation of the index. These are for: 2,700; 3,500 and 4250 TEU vessels. The index was subsequently renamed as the New ConTex (VHSS 2011), which is fully inclusive of the ‘Old ConTex’ (VHSS 2011). The vessel classes captured by the New ConTex are the following: 1,100 TEU, 1,700 TEU, 2,500 TEU, 2,700 TEU, 3,500 TEU and 4,250 TEU, with charter durations of at least 12 months for the first two classes and 24 months for the rest (VHSS 2011).

As observed in Figure 3-57, the New ConTex index experienced a marked ‘free’ fall in 2009 which was caused by the ‘Great Trade Collapse’. The same figure illustrates that the container charter market has experienced many fluctuations since 2007.

### The Clarksea Index

The Clarksea Index is the only weekly published indicator of earnings for all of the main commercial vessel types. It is weighted according to the number of vessels in each fleet sector. Clarksons Research collects rates direct from the Clarksons brokers on a daily and weekly basis, and these are used to calculate the earnings that are used to make up the current Clarksea Index value. The sectors in the Clarksea Index are oil tankers (VLCC, Suezmax, Aframax and clean product carriers), dry bulk carriers (Capesize, Panamax, Handy max and Handysize), gas carriers (VLGC) and fully cellular containerships.

In short, the Clarksea Index is a weighted average of earnings for all of the main vessel types, where weighting is based on the number of vessels in each fleet sector. The Clarksea Index represents only the earnings side, but ignores completely the cost side, e.g. operating costs (Clarksons 2010c).

Figure 3-59 illustrates how the Clarksea Index has fluctuated since 1990. This has been caused by some major events, which Martin Stopford has nicely blended in Figure 3-60 in order to illustrate their influence on moving the index up or down.

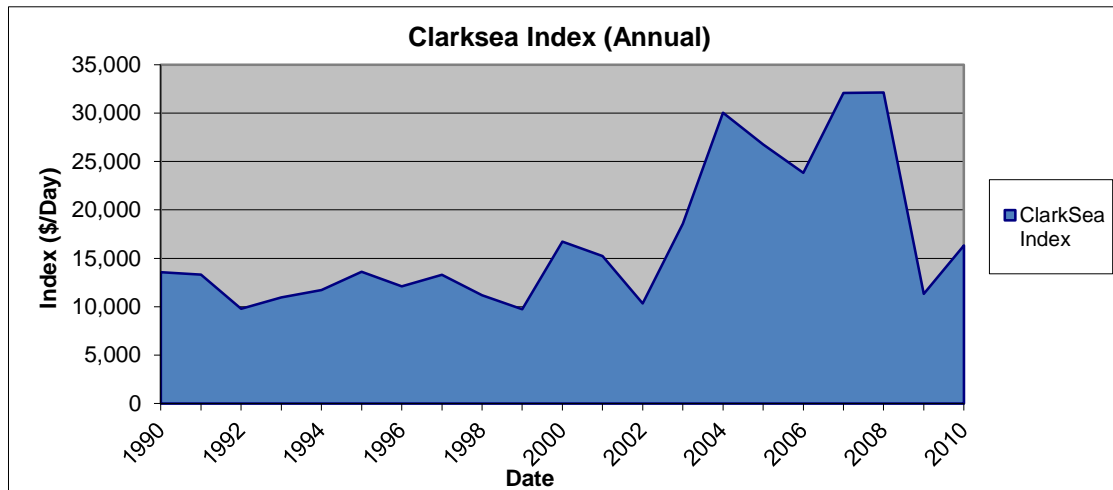


Figure 3-59 The Clarksea Index 1990-2010 (created with the use of data provided from the Clarksons Research Services Limited in 2010)

Source: Clarksons (2010c)

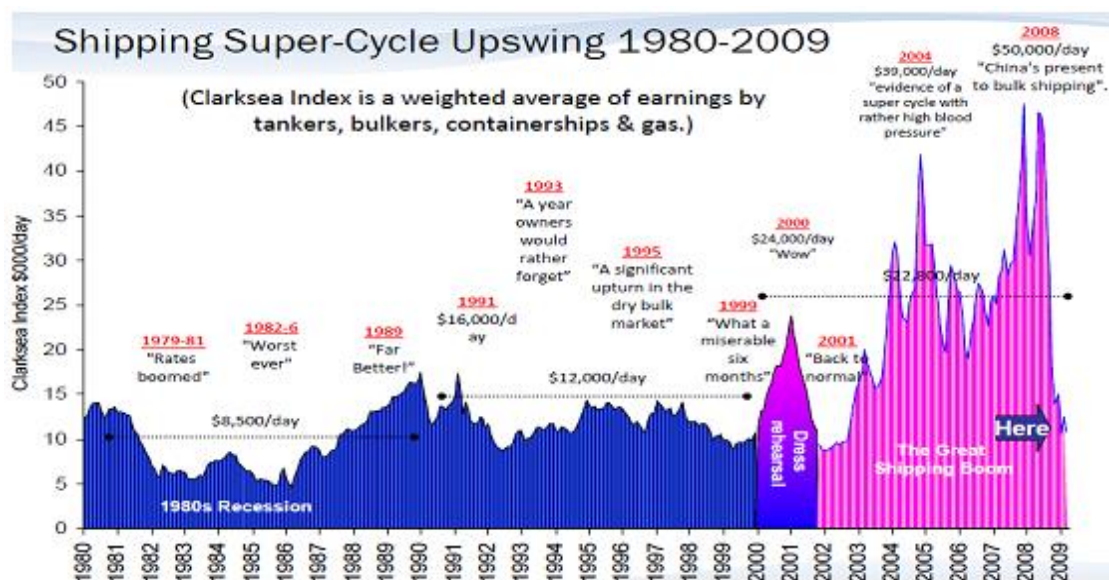


Figure 3-60 Clarksea Index and important events which had shaped the index prices

Source: M. Stopford (2011, pers. comm., 16 March)

### The Harpex Index

The Harpex Index is a containership index, prepared by the ship brokers Harper Petersen & Co. (GmbH & Cie. KG). The work of compiling the index was initially carried out in 2004 by staff of Harper Petersen & Co. and Nordcapital Holding, with additionally support provided by Professor Berthold Volk of the Department of Shipping at the University of Applied Science Oldenburg/Ostfriesland/Wilhelmshaven. For eight classes of all-containerships, the rate changes in the time charter market are recorded weekly in both nominal and indexed terms (Harper Petersen & Co 2010b).

On the basis of weighted individual indices, an additional overall index is calculated for the whole of the containership market. Using about 10,000 data records, it has also been possible to calculate the equivalent indices retrospectively to the 1986 (Harper Petersen & Co 2010b). Figure 3-61 shows the history of the index. The index itself does not reflect actual charter rates; rather, it reflects charter rates relative to the full cost of operating a vessel, which in turn includes a return on capital. Thus, a value of 1,000 indicates that rates are equal to the full cost of operating an ‘average’ ship. The index is extremely volatile and it has been close to today's levels in the past. The index is, therefore, not a leading indicator of economic activity, but rather a lagging indicator (Harper Petersen & Co 2010b).



Figure 3-61 The Harpex Index (2010)

Source: Harper Petersen & Co (2010a)



Shanghai Containerized Freight Index (SCFI)

The SCFI measures box-rates, including surcharges<sup>5</sup> on exports from Shanghai to the rest of the world. Terminal handling charges, USA automatic customs declaration fees, port facility surcharges, etc. are not included in this index (ICAP Shipping 2011). The SCFI also settles against a swap developed from Clarksons. The SCFI is a weighted average of rates from 15 trade routes originating from Shanghai. The index is published every Friday at 15:00 (Beijing time) after capturing the price of shipping a container along 15 different trade routes. The prices of shipping a container on every route are provided for 15 shipping lines<sup>6</sup> and 15 freight forwarders<sup>7</sup> (ICAP Shipping 2011). The concept behind the creation of the SCFI is similar to the methodology used by the Baltic Exchange for the creation of its indices covering the dry and tanker markets (ICAP Shipping 2011). The SCFI reflects the spot rates on the Shanghai export container transport market, which includes the 15 freight rates (indices) of the individual shipping routes and the resulting comprehensive index. These routes cover all of the major regions of trade out of Shanghai to global destinations, as illustrated in Figure 3-62.

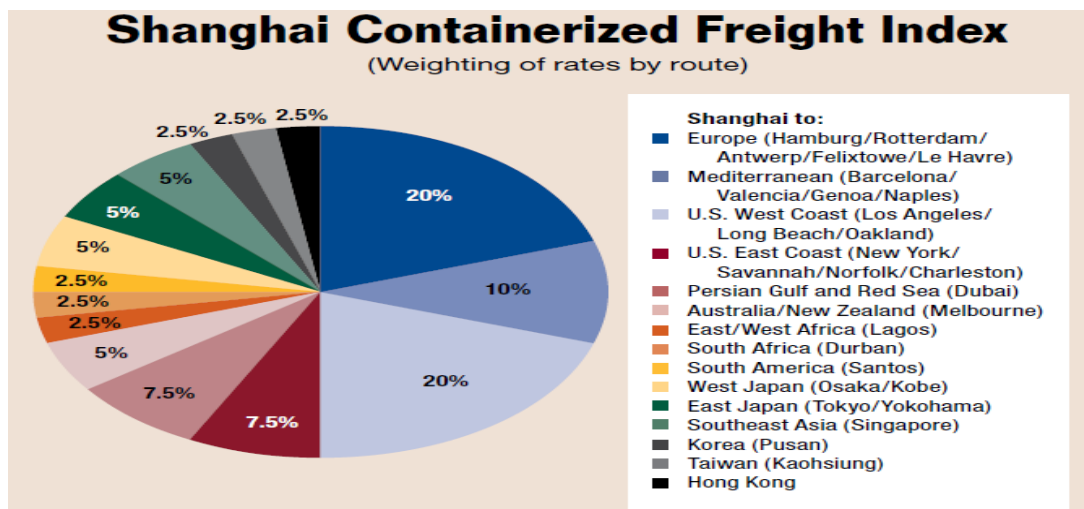


Figure 3-62 The routes of the SCFI and their weightings

Source: Chineseshipping (2010a); Fairplay (2010a)

<sup>5</sup> BAF or Fuel Adjustment Factor (FAF), Emergency Bunker Surcharge (EBS) or EBA (EBS is charged in the Australian route while EBA in the Central and South Africa routes), Currency Adjustment Factor (CAF) or Yen Appreciation Surcharge (YAS), Peak Season Surcharge (PSS), War Risk Surcharge (WRS), Ship Security Surcharge (SSC) or Suez Canal Surcharge (SCS) or Panama Canal Surcharge (PCS).

<sup>6</sup> CMA-CGM, COSCO, CSCL, HANJIN, HASCO, HLAG, JINJIANG, K-LINE, MAERSK, MOL, NYK, OOCL, PIL, SINOTRANS and SITC.

<sup>7</sup> Orient International, UBI Logistics, JHJ International, SIPG, Shanghai Orient Express International, Shanghai Huaxing International, Shanghai Jinchang, Shanghai Shenda, Shanghai Viewtrans, Shanghai Richhood, Shanghai Everleading International, Shanghai Asia Development, Sunshine- Quick Group, Cosco Logistics and Sinotrans.

The index basis is 1,000 points, with the data for the 16<sup>th</sup> October 2009 that was selected to be the base period as it was the official launch date for the index. Since its launch the index has fluctuated severely, as Figure 3-63 illustrates. It is not influenced by the specialty of the ship's type, the ship's age, the carrier or the transported volume (Chineseshipping 2010a; Fairplay 2010a). The panel of experts of which the SCFI is composed includes: CCFI panellists, liner companies, shippers and freight forwarders. All of the panel members are from world-renowned enterprises or firms with outstanding performances and high reputations in certain fields. Each panellist represents a specific line for which it provides information (Chineseshipping 2010a).



Figure 3-63 The SCFI from February 2010 until February 2012

Source: Hellenic Shipping News Worldwide (2012e)

A detailed overview of how the index is calculated is provided in Figure 3-64. In that figure, the last row demonstrates the percentage change of each trade line in comparison with the previous week.

Shanghai Container Freight Index				Prev. Week	Compare with	%
	Unit	Weighting	24/2/2012	17/2/2012	Last Week	change
SCFI			977	949	28	3%
Europe (Base port)	USD/TEU	20%	826	711	115	16%
Mediterranean (Base port)	USD/TEU	10%	867	735	132	18%
USWC (Base port)	USD/FEU	20%	1774	1798	-24	-1%
USEC (Base port)	USD/FEU	7.50%	2922	2943	-21	-1%
Persian Gulf (Dubai)	USD/TEU	7.50%	625	614	11	2%
Australia (Melbourne)	USD/TEU	5.00%	726	730	-4	-1%
East / West Africa (Lagos)	USD/TEU	2.50%	2016	2015	1	0%
South Africa (Durban)	USD/TEU	2.50%	989	999	-10	-1%
South Americas (Santos)	USD/TEU	2.50%	1355	1403	-48	-3%
West Japan (Osaka/Kobe)	USD/TEU	5.00%	317	318	-1	0%
East Japan (Tokyo/Yokohama)	USD/TEU	5.00%	317	318	-1	0%
Southeast Asia (Singapore)	USD/TEU	5.00%	229	223	6	3%
Korea (Busan)	USD/TEU	2.50%	159	159	0	0%
Taiwan (Kaohsiung)	USD/TEU	2.50%	252	265	-13	-5%
Hong Kong	USD/TEU	2.50%	156	151	5	3%

Figure 3-64 The SCFI on the 24<sup>th</sup> of February 2012

Source: Hellenic Shipping News Worldwide (2012e)

#### China (Export) Containerized Freight Index (CCFI)

The CCFI is a freight index that serves as a barometer of the shipping market and, thus, is widely applied. As claimed by the Chineseshipping (2010b), the CCFI is the second most important world freight index, after the BDI. This is because the index represents the market trends as assessed by using a scientific and authoritative approach (Chineseshipping 2010b). The index was first publicised on the 13<sup>th</sup> of April 1998, but its baseline was created on the 1<sup>st</sup> of January 1998 (Shanghai Shipping Exchange 2012). This date is its reference base period with a value of 1,000 points (Shanghai Shipping Exchange 2012). Prior to that date, the maritime container industry did not have a freight index (Xin 2000), due to the fact that the container freight was not influenced by the market, but was dictated by the liner conferences. The container freight was, therefore, essentially stable and the creation of an index was considered redundant (Xin 2000). The CCFI consists of 11 trade lines, which are presented in Table 3-16. The CCFI and the associated 11 individual shipping lines are published every Friday by the Shanghai Shipping Exchange (Chineseshipping 2010b). In mid May (2012), the index had reached a record of 1,336 points, the highest level since the index was introduced in January 1998 (Hellenic Shipping News Worldwide 2012g).

	SERVICE		SERVICE
1	Japan Service	7	Southeast Asia Service
2	Europe Service	8	Mediterranean Service
3	W/C America Service	9	Australia/New Zealand Service
4	E/C America Service	10	South Africa/South America Service
5	Hong-Kong Service	11	West East Africa Service
6	Korea Service		

Table 3-16 CCFI on 10 January 2011

Source: Chineseshipping (2010b)

The carriers' average revenues are not correlated with the CCFI, as it captures only 55 percent of the global freight capacity (Alphaliner 2012f). As Figure 3-65 illustrates, some trade lines are more linked to the CCFI than others. Of course, some trade lines are not linked at all with the CCFI, due to some being excluded because of their relatively tiny share. Furthermore, others are not included as they do not fall within the range of the index, which measures only lines related to China (Xin 2000).

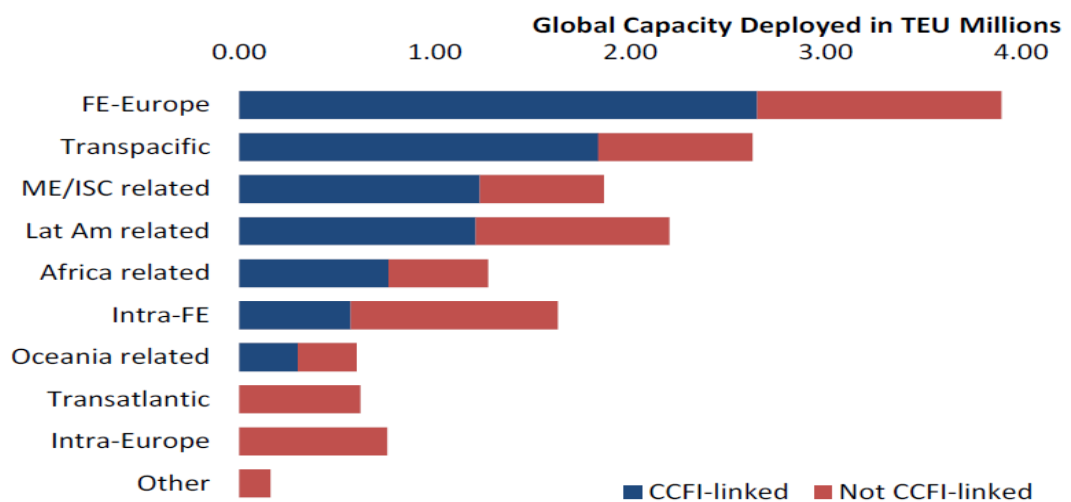


Figure 3-65 Estimated CCFI-linked share of global containership capacity, 2012

Source: Alphaliner (2012f)

### World Container Index (WCI)

This index is a 50:50 joint venture of Drewry Maritime Research with Cleartrade Exchange and it is generated from data created by the industry analyst team at Drewry Maritime Research. This team is merging data obtained from multiple market sources, including both carriers and intermediaries. The index reports individual market prices on major East-West container shipping routes. Initially, the prices were for 11 individual routes and a composite index was reported each week covering container

trade in both directions between Asia, North America and Europe (World Cargo News online 2011). The index, according to its creators, produces a new market price index that could be used by physical and derivative market participants to manage freight risk. The index fills an important gap in the market, offering wide geographical scope as well as the inclusion of backhaul routes. Moreover, it is obtained from an independent trusted research house (World Cargo News online 2011). The index was launched in September 2011 and it captures agreed freight rates that are reported in USD per Forty Foot Equivalent Unit (FEU); that is, equivalent to a 40ft-long 8ft 6in-high ISO maritime container as a Full Container Load (Hellenic Shipping News Worldwide 2011g). The value of agreed freight rates for the WCI is defined as the total ocean freight, including any bunker adjustment factor and all other applicable surcharges, plus THC [THC is a tariff, charged by the shipping line to the shipper and which (should) cover (part or all of) the terminal handling costs, which the shipping line pays to the terminal operator (Visser 2003)] when it is common market practice to include them. However, it excludes any surcharges related to inland transportation (Hellenic Shipping News Worldwide 2011g). The WCI collects data and publishes weekly market assessments for the following routes: Shanghai to Rotterdam; Rotterdam to Shanghai; Shanghai to Genoa; Genoa to Shanghai; Shanghai to Los Angeles; Los Angeles to Shanghai; Shanghai to New York; New York to Rotterdam; Rotterdam to New York; Los Angeles to Rotterdam and Rotterdam to Los Angeles (Hellenic Shipping News Worldwide 2011g). Figure 3-66 illustrates the benchmark rate for the trade line route of Shanghai to Rotterdam as it is captured by the WCI. According to some published thoughts, the WCI will soon try to cover 550 routes (Containerisation International Online 2011).

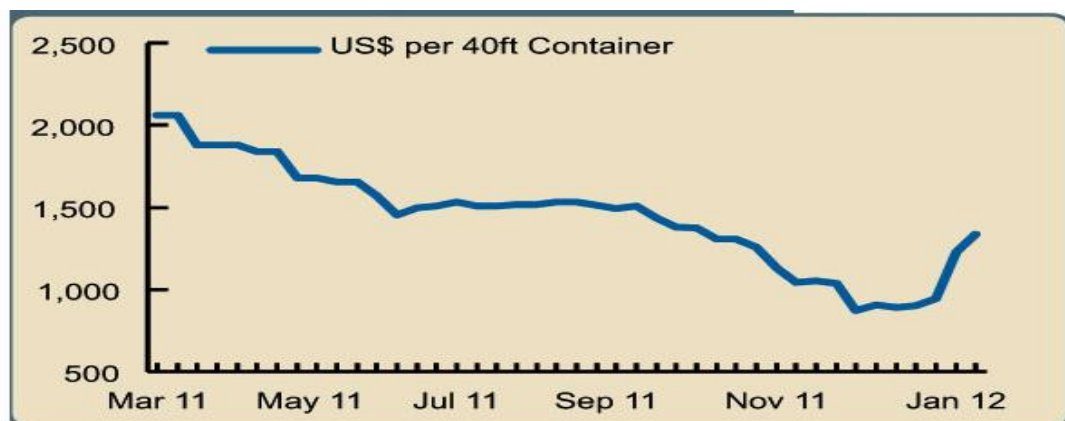


Figure 3-66 WCI benchmark rate between Shanghai and Rotterdam

Source: IFW (2012)

### Container Trades Statistics (CTS) price indices

The CTS has developed freight rate indices that measure the freight rates for importing and exporting containers both to and from Europe for the following six trade routes (Container Trades Statistics 2011b): Asia; India and Middle East; Australasia and Oceania; Intra Europe; South and Central America; and North America (Container Trades Statistics 2011b). The indices are called Aggregated Price Indices and are based on the weighted average of the sea freight rates, including all surcharges and ancillary charges - with the exception of charges for inland haulage - per trade route and direction (Container Trades Statistics 2011a). The indices that were created for the freight rates on every trade route are illustrated in Figure 3-67 and Figure 3-68. Based on these indices, Maersk Line has started to sign multi-year contracts with European customers and some major Japanese accounts (IFW 2011). The indices are based on both spot and contract rates and are weighted according to volume. Those measurements are able to provide a reliable and precise reflection of the changing container markets (IFW 2011).

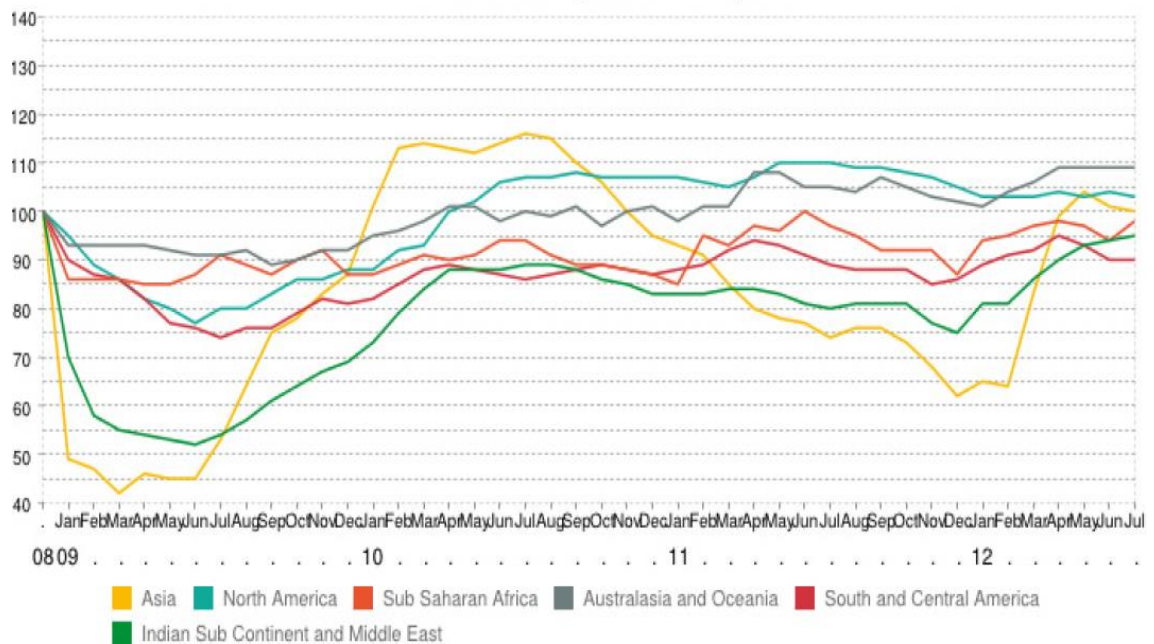


Figure 3-67 CTS price indices for imports to Europe (Dec 2008 - July 2012)

Source: Container Trades Statistics (2012)

In conformity with the IFW (2011), other liner companies are considering using the CTS indices to conclude longer-term agreements with customers that are fair to both sides.

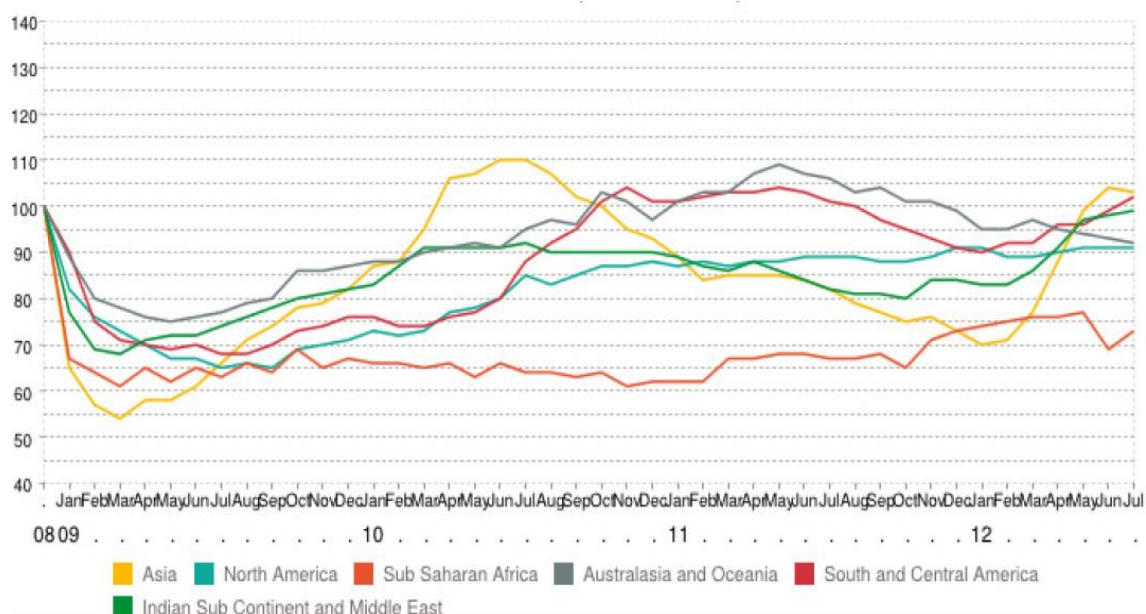


Figure 3-68 CTS price indices for exports from Europe (Dec 2008 - July 2012)

Source: Container Trades Statistics (2012)

Riverlake Tanker Index (RTI)

The RTI was introduced by the Geneva based brokerage company Riverlake, in May 2007. The index does not represent the actual sentiment manner of the market. Rather, it is as the representatives of the company believe reflects a measure of the daily basis of the market. The index represents 18 major European routes covering crude oil, dirty petroleum and clean products cargoes. The highs and the lows of the index follow the same patterns as the Baltic Exchange’s Dirty Tanker Index (McCarthy 2009a).

European Liner Affairs Association (ELAA) Aggregate Price Index

The ELAA Aggregate Price Index is created from seven European trades. The trades monitor the total trade volumes expressed in monetary terms (price of a container to be transferred from or to Europe) for dry and reefer containers (ELAA 2010).

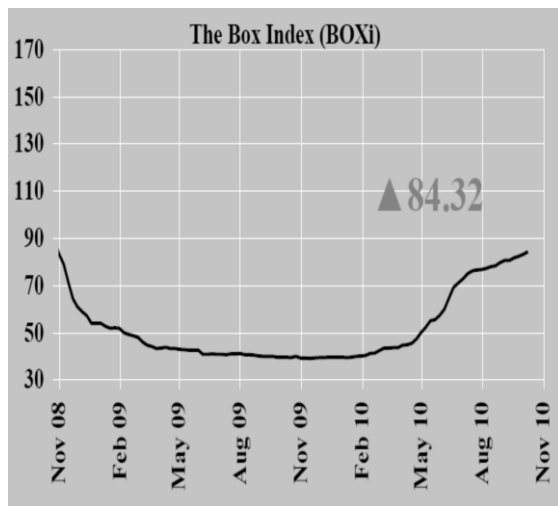
Fearnley’s coal index

This is an index been created by the Fearnley’s company, which counts the prices on various routes made by ships carrying coal around the globe (McCarthy 2009b).

The BOXi Index

The BOXi Index was created by the Braemar Shipping Services Company and is a container charter rate based index. The index is generated from a basket collection of

the rates for 2 vessel types [Gear (G) and Gearless (GL)], which the company deems to be most representative of vessels in the charter market. Each ship type is weighted according to its commercial importance and prevalence in the market (Braeman Shipping Services plc 2010). The BOXi Index shows the changes in one-year contract charter rates (estimated and updated on a weekly basis) based upon the charter rates for 13 vessel sizes, ranging from 285 TEU to 4,250 TEU, as shown in Table 3-17. The sum of the indices from every vessel provides the BOXi Index, which is presented in Figure 3-69.



VESSEL (TEU / HMG)	
510 / 285 TEU (GL)	15,5 K
700 / 440 TEU (GL)	17,5 K
1000 / 650 TEU (G)	17,5 K
1100 / 715 TEU (G)	19 K
1350 / 925 TEU (G)	20 K
1600 / 1150 TEU (GL)	18 K
1700 / 1125 TEU (G)	19,5 K
1740 / 1300 TEU (G)	20,5 K
2000 / 1600 TEU (G)	21 K
2500 / 1900 TEU (G)	22 K
2800 / 2000 TEU (GL)	22 K
3500 / 2500 TEU (GL)	23 K
4250 / 2800 TEU (GL)	24 K

Figure 3-69 The BOXi Index (BOXi) from Nov 08 until Nov 10

Table 3-17 BOXi Index and its indicators

Source: Woodington et al. (2010)

### Liner Shipping Connectivity Index (LSCI)

The LSCI aims to assess an individual country's level of integration into the overall global liner shipping network by measuring the specified country's liner shipping connectivity. The LSCI has been generated annually for 162 countries since July 2004.

Shipping connectivity is related closely to higher trade volumes and lower transport costs. Enhancing a country's connectivity contributes to its trade competitiveness, while simultaneously, higher trade volumes will usually lead to improved connectivity and lower transport costs (UNCTAD 2005; UNCTAD 2006; UNCTAD 2009c).

The five components that constitute the index are: 1) the number of ships deployed on liner services; 2) the container-carrying capacity of those ships; 3) the maximum vessel size; 4) the number of services; and 5) the number of companies (UNCTAD 2009b)



p.19). An example that is relevant to the UK is the scoring of the LSCI, which is presented in Table 3-18.

United Kingdom: 2009: 6<sup>th</sup> country, with an overall score: 84.82 (Maximum index 2004 = 100)

2004	81.69
2005	79.58
2006	81.53
2007	76.77
2008	77.99
2009	84.82
Rank2009	6
Change 2009 / 2008	6.83%
Change 2009 / 2004	3.14%

Table 3-18 LSCI for the UK 2004-2009

Source: UNCTAD (2009c)

### 3.3.4 *Economic indicator indices*

#### *The Purchasing Managers' Index (PMI)*

The original PMI was started in 1948 by the US-based Institute of Supply Management as an indicator of economic activity. It is one of the most closely watched indicators of business activity worldwide (The Economic Times 2010). The PMI is not a maritime-focused index, however, the maritime transport sector uses it on a large scale. Therefore, the index was found to be within the top 10 indices used in the maritime transport sector, according to the content analysis conducted in Section 3.4 of this study. The PMI is a logistics-oriented index that is able to provide information on the direction in which the economy will probably head in the following months. For that reason, it is regarded as an extremely valuable indicator for use in the financial markets, as on Wall Street, as it is considered the best indicator of probable future levels of factory production (Barnes 2010). The PMI reflects the percentage of purchasing managers, in a specified economic sector, that report better business conditions than were experienced during the previous month. This continuous process is taking place by undertaking a survey of information provided by 400 purchasing managers across the USA. The managers are required to select one from only three options (better, same, worse) in order to answer to the following questions: 1) production level (0.25); 2) new orders (from customers) (0.30); 3) supplier deliveries (are they coming faster or slower?) (0.15); 4) inventories (0.10)

and; 5) employment level (0.20). The weightings of each section are given in the brackets. If the resulting index has a score greater than 50, the industry is perceived to be expanding. If the score is less than 50, the industry is perceived to be decreasing (Barnes 2010; ISM 2009). Figure 3-70, presents the PMI and its performance against two recessions observed from 2000 and onwards.

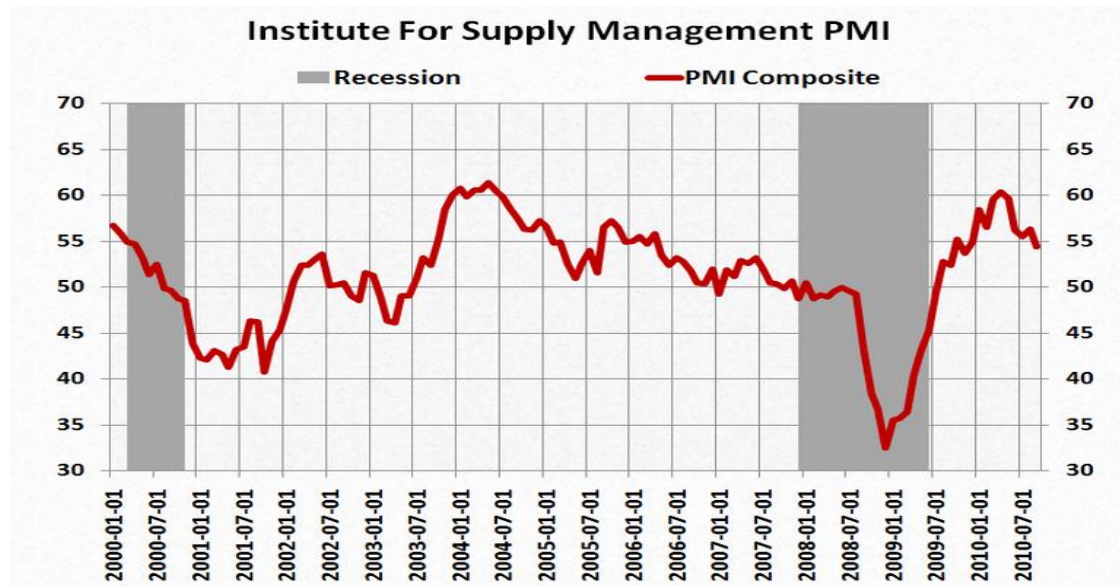


Figure 3-70 PMI between January 2001 and July 2010. Reactions of the index presented against the economic recessions of 2001 and 2008

Source: Faber (2010)

### HSBC China Manufacturing Purchasing Managers' Index

The HSBC China Manufacturing Purchasing Managers' Index has the same philosophy and usage as the PMI. The differences between the two are: 1) it is generated from data from the Chinese provinces; 2) it is the result of the sum of the positive responses plus a half of those that respond with 'the same'; and 3) the questions posed to the responding managers are slightly different and have different weighting percentages. The questions are as follows (weightings in brackets): New Orders (0.30); Output (0.25); Employment (0.20); Suppliers' Delivery Times (0.15); and Stock of Items Purchased (0.10) (HSBC and Markit 2010).

### Global Competitiveness Index (GCI)

The GCI is a composite index based on both macro and micro data, as well as on interviews with key business and societal stakeholders, defining the 12 pillars of competitiveness, namely: 1) Institutions; 2) Infrastructure; 3) Macroeconomic Stability;

4) Health and Primary Education; 5) Higher Education and Training; 6) Goods Market Efficiency; 7) Labour Market Efficiency; 8) Financial Market Sophistication; 9) Technological Readiness; 10) Market Size; 11) Business Sophistication; and 12) Innovation (Schwab 2010).

Several of the indicators are directly relevant to trade facilitation and logistics (Schwab 2010). The UK profile in 2009-2010 for the GCI is as follows,

United Kingdom: 2009-2010: 13<sup>th</sup> country, with an overall index score: 5.19  
2008-2009: 12<sup>th</sup> country (Schwab 2010).

#### Global Enabling Trade (GET) Index

The World Economic Forum's GET Index is an aggregate indicator constructed from a range of original data that is not focused only on logistics, but also on the broader trading environment of a country. The GET Index is based on more than 50 individual data sets, of which five are found to have a degree of correlation with the LPI (Lawrence et al. 2009; Lawrence et al. 2010). An example of a country's performance is quoted below using the UK performance as an example.

United Kingdom: 2010: 17<sup>th</sup> country, with an overall index score: 5.1  
2009: 20<sup>th</sup> country, with an overall index score: 4.93 (Lawrence et al. 2009; Lawrence et al. 2010).

#### Doing Business (Index)

The Doing Business Index is a quantitative measurement of regulations for starting a business, dealing with construction permits, getting electricity, registering a property, getting credit, protecting investors, paying taxes, trading across borders, enforcing contracts and resolving insolvency for the domestic SMEs (The World Bank 2012c). This index considers the regulations on employing workers, while capturing 11 areas of regulations affecting local businesses. However, it does not consider all aspects of the business environment or of all areas of regulation. Those 11 areas are grouped into the following four procedures that need to be undertaken for a business to be created:

- A. Start-up:
  - 1) Starting a business
- B. Expansion:
  - 2) Registering property

- 3) Getting credit
- 4) Protecting investors
- 5) Enforcing contracts

C. Operations:

- 6) Dealing with construction permits
- 7) Getting electricity
- 8) Paying taxes
- 9) Trading across borders (this factor has some relevance with the index that this research is aiming to develop)
- 10) Employing workers (rankings are not available for that factor, as it only takes in consideration the regulations applying to it)

D. Insolvency:

- 11) Resolving insolvency (The World Bank 2012c).

The Doing Business Index covers nearly all of the existing economies; however, data for each economy are coming only from the largest business cities. This is because the Doing Business Indicators are based on standardised case scenarios that make specific assumptions. These assumptions allow global coverage and facilitate comparability (The World Bank 2012c).

The Doing Business Index is, therefore, focused and works effectively as a form of cholesterol test, which does not measure the state of someone's health, but rather something that is important for influencing and ensuring someone's health. So, the Doing Business Index provides the ability to follow and change behaviours in a way that will improve not only the 'cholesterol level', but also the overall health (The World Bank 2012c).

### **3.3.5 *Environmental indices***

#### **Energy Efficiency Design Index (EEDI)**

The EEDI is an index that was launched in 2009 by the International Maritime Organization (IMO), under a trend study undertaken for the Netherlands. The aim of the index is to make the shipping industry more energy efficient (Anink and Krikke 2009). The index formulation has created considerable debate regarding the weighting values applied to the specific characteristics employed in order to calculate the final index (Nautika Xronika 2010). The purpose of the EEDI is to provide a fair basis for energy

efficiency comparison between vessels, to stimulate the development of more efficient engines and of ships in general, and to establish minimum efficiency targets for new ships depending on the ship type and size (IMO 2009). The EEDI also expresses the emission of CO<sub>2</sub> from a ship under specified operating conditions (e.g., engine load, draught, wind, waves, etc.) in relation to a nominal transport work rate (IMO 2009).

The unit for the EEDI is grams of CO<sub>2</sub> per capacity-mile, where ‘capacity’ is an expression of the cargo-carrying capacity relevant to the type of cargo that the ship is designed to carry. For most ships, capacity is expressed in deadweight tonnes (IMO 2009). The EEDI expresses the CO<sub>2</sub> emissions of a ship design per value for society, which is taken as tonnes deadweight times ship speed for transport ships, and gross tonnage times ship speed for passenger ships.

As can be observed from Figure 3-71, container vessels cause more air pollution per dwt than general dry cargo vessels. The liner industry is trying to address this issue with companies placing orders for new eco-friendly vessels, such as the triple E vessels ordered by Maersk in 2011 (Ministry of Foreign Affairs of Denmark 2011).

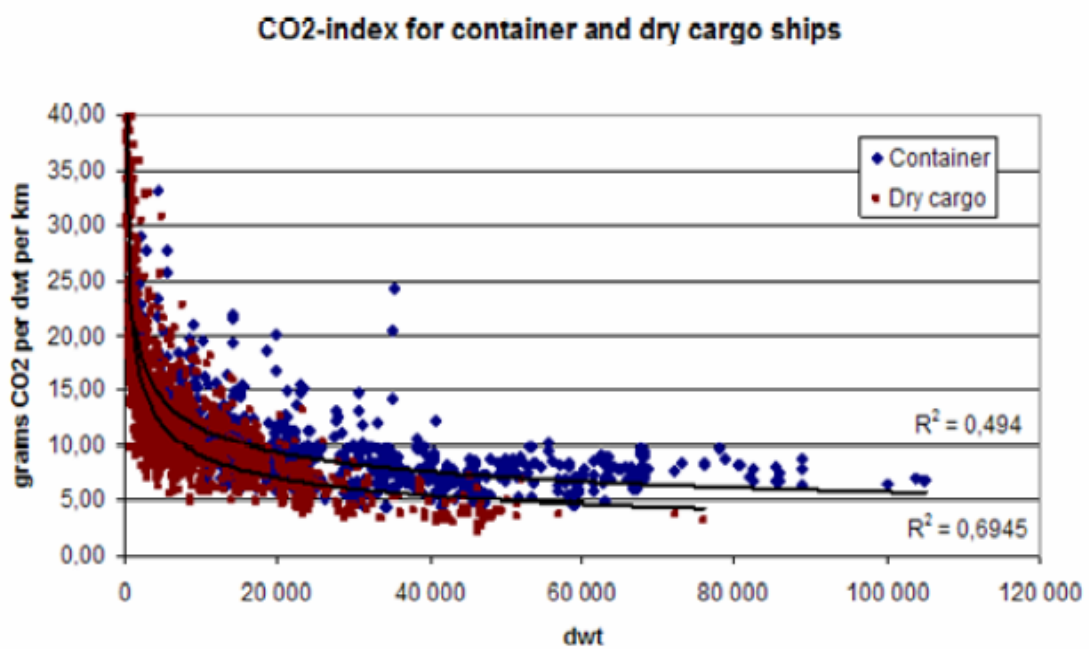


Figure 3-71 The effect of ship deadweight on CO<sub>2</sub> emissions design index

Source: IMO (2009)

### Energy Efficiency Operational Index (EEOI)

The EEOI has been developed to enable operators to assess the energy efficiency of existing ships. This index is expressed in CO<sub>2</sub> per cargo tonnes times distance for the efficiency of a specific ship; thereby enabling comparisons to be made between similar ships (Marorka 2010). The EEOI expresses actual CO<sub>2</sub>-efficiency in terms of emissions of CO<sub>2</sub> per unit of transport work, and it is made using Equation 3.4

$$EEOI = \frac{\sum_i FC_i * C_{carbon}}{\sum_i m_{cargo,i} * D_i} \quad (3.4)$$

where:  $FC_i$ : denotes fuel consumption on voyage i,  $C_{carbon}$ : is the carbon content of the fuel used,  $m_{cargo,i}$ : is the mass of cargo transported on voyage i, and  $D_i$ : is the distance of the voyage i.

The unit for EEOI is grams of CO<sub>2</sub> per capacity-mile, where ‘capacity’ is an expression of the actual amount of cargo that the ship is carrying. For most ships, capacity is expressed as tonnes of cargo transported. Unlike the EEDI, the EEOI changes with operational conditions. Thus, the EEOI is calculated for each leg of a voyage and reported as a rolling average or periodically (IMO 2010b).

### Environmental Ship Index (ESI) (Launched at end of 2010, in use since 2011)

The ESI indicates the environmental performance of seagoing ships (in terms of gaseous emissions) relative to IMO rules. This provides a tool that assists ports and other concerned parties to promote cleaner shipping. Its use voluntary, and the maximum responsibility lies with the ship owner. The ESI is composed of credits (on a scale of 0 – 100) for above-baseline environmental performance measures regarding NO<sub>x</sub>, SO<sub>x</sub> and CO<sub>2</sub> gasses (NE Delft 2010). The weighting factor of the ESI NO<sub>x</sub>, in the overall index, is twice that of ESI SO<sub>x</sub>. This reflects the fact that the average environmental damage from NO<sub>x</sub> in ship-air emissions is approximately twice that of the damage from SO<sub>x</sub> (Environmental Ship Index 2010). The ESI is aimed to encourage emissions reduction in the shipping industry through incentive-based port policies (e.g. through tariff incentive schemes). Several major ports in the Netherlands have announced that they would reward vessels that are highly rated on the ESI (Fairplay 24 2010b). That reward takes the form of a discount on port dues, which will be six to 10 percent of the normal overall port dues (Fairplay 24 2010c). The programme was launched on the 1<sup>st</sup> of January 2011 (Fairplay 24 2010c). How the ESI works is fully

explained on a web site that includes a data base and which is appropriately named; [www.environmentalshipindex.org](http://www.environmentalshipindex.org) (Environmental Ship Index 2010).

#### Clean Shipping Index (CSI)

The CSI is an instrument that provides the opportunity for cargo owners to assess the environmental performances of individual shipping companies. It measures the performance of ships, including their CO<sub>2</sub> and SO<sub>x</sub> emissions, particulate matter, and NO<sub>x</sub> gasses and of chemical products and wastewater treatment (Fairplay 24 2011a). The CSI covers cargo owners from all over the world and has been created from the Clean Shipping Network, which consists of 30 large international cargo owners. In operation, 45 worldwide shipping companies voluntarily submit their environmental performance data, and the vessels and carriers are both ranked according to a scoring system built into the index. The vessels themselves are assessed by the three classification societies, which have been accredited by the CSI (Fairplay 24 2011a; Hellenic Shipping News Worldwide 2011e).

#### **3.3.6 Miscellaneous indices**

##### Instability Index (II) of the Container Liner Shipping Industry (market index)

The II for the container liner shipping industry is composed of the sums of the absolute value of the change between two defined points in time of the individual market share of each participating firm. The index is defined through Equation 3.5.

$$II = \sum_{i=1}^N (|s_{i,t} - s_{i,t-1}|) \quad (3.5)$$

where: N is the number of companies,  $s_{i,t}$  equals the market share of liner operator i at time t.

The value of the index ranges from zero and one. If the index is close to zero, this indicates that market share is relatively stable, while if it is close to one, the market share is relatively unstable. Thus, the higher the II, the greater the level of competition (Sys 2009). Figure 3-72 illustrates the evolution of the II since 2000 and the Herfindahl-Hirschman Index (HHI) since 1999. It can be observed that when the market share in the container market changes, as it did in 2006, the II also changes.

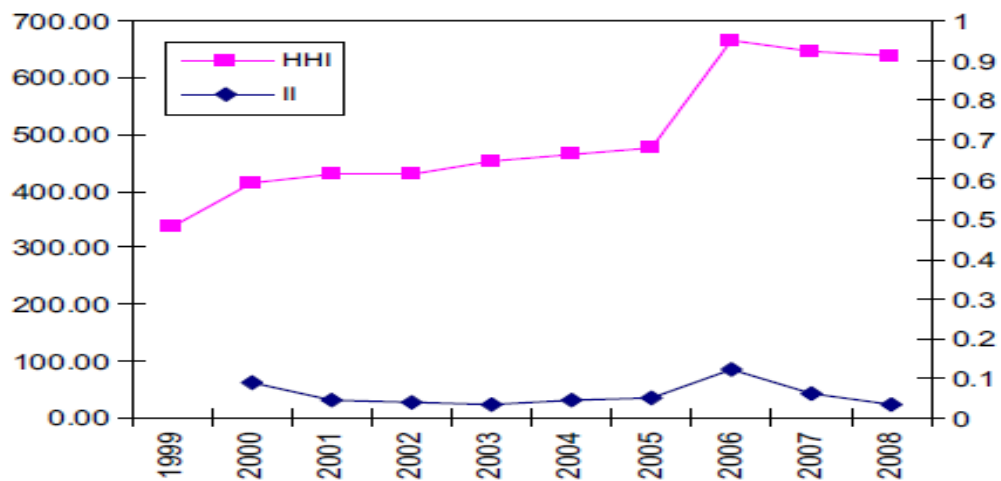


Figure 3-72 Evaluation of the II and the HHI since 2000

Source: Sys (2009)

In summary, the II provides a measurable indicator of a competitor's behaviour in the oligopolistic markets of container liner shipping. As it was found from the study conducted by Sys (2009), the container liner shipping industry is characterised generally by relatively stable competition in accordance with Figure 3-72.

The Logistics Performance (or Perception) Index (LPI) (logistic index)

“The international LPI is a summary indicator of logistics sector performance, combining data on six core performance components into a single aggregate measure” (Arvis et al. 2012 p.52). The LPI is the first international benchmarking tool to focus specifically on measuring the trade and transport facilitation friendliness of individual countries. It measures some of the critical factors of trade logistics performance, including the quality of infrastructure and logistics services, the security of property from theft and looting, the transparency of government procedures, macroeconomic conditions, and the underlying strength of institutions (Arvis et al. 2010). The individual score of each country considered in the LPI is compared with its relationship to income per capita, as given in Figure 3-73. Top performer countries are placed in the upper right hand corner of the graph. The UK LPI score is as follows:

United Kingdom 2010: 8<sup>th</sup> country, overall score: 3.95 (index max: 4.11)  
(Arvis et al. 2010).

United Kingdom 2012: 10<sup>th</sup> country, overall score: 3.90 (index max: 4.13)  
(Arvis et al. 2012).



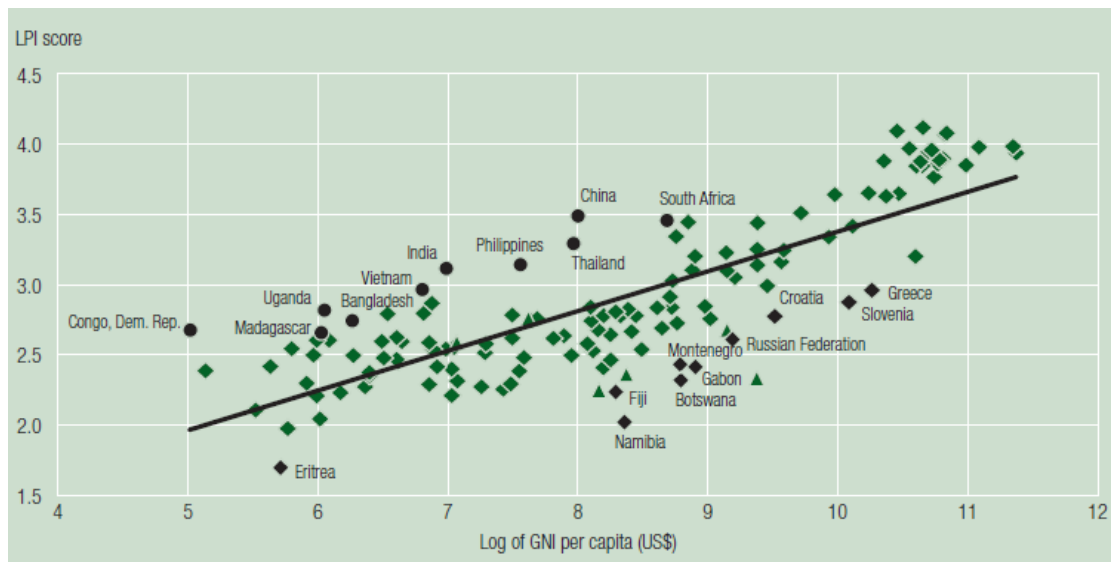


Figure 3-73 LPI over-performers and under-performers in 2010, relative to income per capita

Source: Arvis et al. (2010)

The weights associated with the indicators used for the LPI are generated from a Principal Component Analysis (PCA). The weights are chosen so that they can maximise the percentage of variation in the LPI's original six indicators (Arvis et al. 2012). The weights used in the LPI are given in Table 3-19.

Indicator	Weight
Customs	0.41
Infrastructure	0.41
International shipments	0.40
Logistics quality and competence	0.42
Tracking and tracing	0.41
Timeliness	0.40

Table 3-19 Weights for each original indicator as used in constructing the international LPI

Source: Arvis et al. (2012)

*Quality of port infrastructure or (Port efficiency index) (logistics index)*

According to the Global Competitiveness Report 2010 (Schwab 2010), the UK is ranked as the 23<sup>rd</sup> largest country in the world with a score 5.5. This is an index that ranks the quality of a country's port infrastructure based on surveys performed in representative firms for each country. The specific question used for the index generation is: 'How would you assess port facilities in your country?' A rating of one is

for being extremely underdeveloped, while seven is well developed and considered efficient by international standards (Schwab 2010).

Mandatory Port Services Index (logistics index)

The Mandatory Port Services Index is a measure that captures the extent to which the employment of port services is mandatory for incoming ships. This variable is constructed by assigning a value up to 0.125 (maximum) to each of the following eight services if they are mandatory: pilotage; towing; tug assistance; navigation aids; berthing; waste disposal; anchorage; and other mandatory services. The extent to which the use of each of such services is mandatory can be seen as reflecting the operational restrictiveness of the port service regime (Fink et al. 2002). According to the report which Fink et al. (2002) prepared for The World Bank, the UK has a score of 0.31, on a scale where the minimum is zero and the maximum possible is 1.0 (i.e. 8\*0.125).

Global Port Congestion Index (GPCI) (logistics index)

The GPCI is a weekly newsletter detailing current berthing delays at the major coal and ore ports worldwide. Given the impact that berthing delays can have on the supply of tonnage to the market and its subsequent effect on freight rates, the GPCI is an invaluable source for tracking and anticipating delays (Global Ports 2010). A sample of the GPCI is given in Figure 3-74, in which the congestion in the Atlantic and the Pacific Oceans ports can be easily compared.

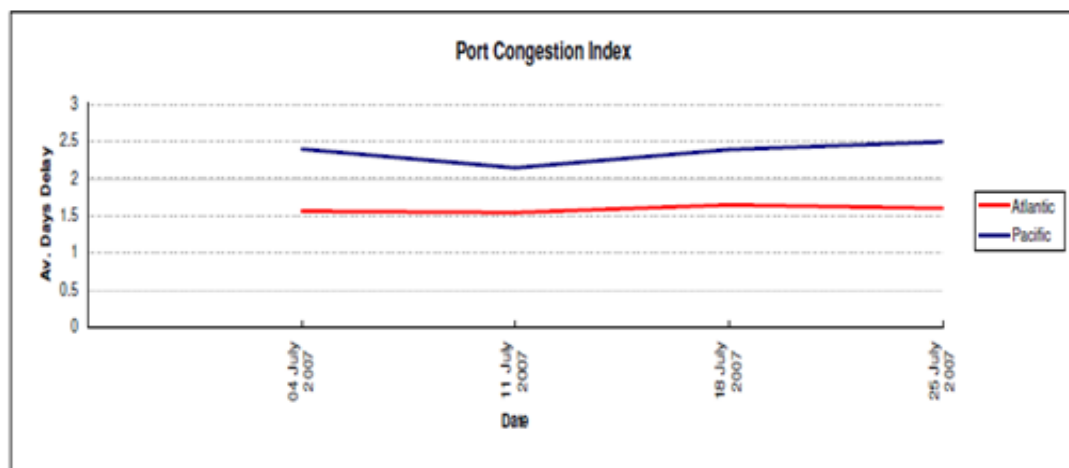


Figure 3-74 Sample of the GPCI. On the vertical axis the average days of congestion are recorded, while on the horizontal axis the actual day that the index recorded is demonstrated. The sample provides data for the Atlantic and the Pacific Ocean

Source: Global Ports (2010)

Low Cost Port Competitiveness Index(LCPCI): implementation in the Spanish ports (theoretical index)

The LCPCI is a proposed index been developed by three academics for the Spanish port system. The LCPCI was designed using the Promethee method, which is a decision theory methodology for multiple objectives. The index combines different decision factors that shape the competitiveness of a port in order to provide a ranking index for use by the Spanish port authorities (Castillo-Manzano et al. 2009).

Specialisation Index (theoretical index)

In maritime transport, in order to ascertain if a terminal is suitably specialised in the transshipment and/or handling of a particular kind of merchandise or if, inversely, it transfers a wide variety of merchandise. This could be evaluated and qualified by using a suitable Specialisation Index, which is calculated using Equation 3.6.

$$SI = \frac{\sum_i t_i^2}{(\sum_i t_i)^2} \quad (3.6)$$

The Specialisation Index is the total of the mathematical squares of the tonnage (or monetary value) of each type of merchandise  $i$  ( $t_i$ ) handled at a terminal, divided by the square of the total volume of tonnage (or monetary value) of all types of merchandise that handled at the terminal (Rodrigue et al. 2006; Rodrigue et al. 2009). Thus, the maximum value of SI for a terminal that only handles one forms of merchandise; for example, containers is 1.0.

Crime Index (theoretical index)

The incentive for the Crime Index is taken from a question in the World Economic Forum's (2010) Global Competitiveness Report and consists of a one-to-seven component-based index ranking of the severity of the influence of organised crime in a particular country (with seven meaning 'not a problem'). The idea behind this variable is that organised crime can constitute a direct threat to port operations and merchandise in transit (X. Clark et al. 2002). The level of organised crime can be measured based on surveys performed with the aid of representative firms in each country. The 26<sup>th</sup> question in the competitiveness report is: "Organized crime does not impose significant costs on business and is not a burden (1= strongly disagree, 7= strongly agree)". In 2010, the Crime Index ranked the UK 39<sup>th</sup> in the world, with a score 6.0.

### Port Infrastructure Index (theoretical index)

The Port Infrastructure Index is the ratio between the number of ports per country (squared) and the multiplied product of a country's surface and population. [The data used by X. Clark et al. (2004) to create this index had been obtained with the number of ports from Portualia S.A., and for corresponding surface and population had been obtained from The World Bank WDI, 2002, cited in X. Clark et al. (2004)]. The score of the UK according to X. Clark et al. (2004) is -22.822.

### Cargo Handling Restriction Index (theoretical index)

The Cargo Handling Restrictions Index has a value of zero to one, which captures both the restrictions and special requirements imposed on foreign suppliers of cargo handling services. The index takes a value of zero if no restrictions exist, 0.25 for minor restrictions, 0.5 if a joint venture condition is imposed, 0.75 if a very high national participation in the foreign company is required, and one if foreign companies are simply forbidden to provide cargo handling services. The UK has a score of zero, no restrictions in conformity with the report, which Fink et al. (2002) prepared for The World Bank.

### Transport Cost Index (theoretical index)

The Transport Cost Index (TCI) is the average of selected determinants that are indicative of maritime transport costs, using regulations and organised crime. The country-specific costs are identified by the following variables: level of containerisation, seaport infrastructure level, the regulatory environment and the level organised crime. For each of the four variables, the simple average per country becomes the costs index. Equation 3.7 is used to calculate the transport costs index.

$$TCI_k = \frac{1}{N_i} \sum \varepsilon_i (\rho_{ijk} - \hat{\alpha}_j - \hat{\beta}_k - \hat{\psi} w v_{ijk} - \hat{\delta} d_{jk} - \hat{\theta} I m b_j - \hat{\eta} q_{ij}) \quad \forall k = 1, \dots, 4 \quad (3.7)$$

where  $N_i$  is the number of observation from country  $i$ , and  $\hat{\alpha}$  the other coefficients used from X. Clark et al. (2004) to estimate the index, using the following independent variables (distance, weight value, containerisation, directional imbalance, total liner volume, policy variables, foreign port efficiency, mandatory port services, organised crime, developed country) (X. Clark et al. 2004).

### Index Comparison between the gateway regions (theoretical index)

The Index Comparison is made among gateway regions in the EU with respect to the emission of CO<sub>2</sub> and NO<sub>2</sub> gases, and energy consumption levels on specific origins – destination relations. The index was designed and created by Notteboom (2009).

### Price fixing Agreement Index (theoretical index)

The Price-fixing Agreement Index is effectively a dummy variable signalling the presence of carrier agreements on maritime routes, such as conferences and other price-fixing agreements. After the forbiddance of such conferences by the EU, that index must have dropped significantly; however, there is no data available at this time. The UK had a score of 1 (in 2002), in a scale where the minimum is zero and the maximum is one according to the report prepared by Fink et al. (2002).

### Simple theoretical indices used for logistic measurements

#### a) *Pi Index:*

Pi Index is a measure of distance per units of diameter and is considered an indicator of a network's shape. A high Pi Index is linked with a more extensively developed network and conversely a low Pi Index is linked with a low level of network development. The relationship between the total length of the graph L(G) and the distance along its diameter D(d) is called the Pi Index because of its similarity to the mathematical constant  $\pi$  (3.14), which expresses the ratio between the circumference and the diameter of a circle (Rodrigue et al. 2006).

#### b) *Detour Index:*

The Detour Index is a measure of the efficiency of a transport network in terms of how well it overcomes distances or the fraction of space. The closer the Detour Index gets to 1, the more the network is considered spatially efficient. This index can be calculated using Equation 3.8.

$$DI = \frac{D(S)}{D(T)} \quad (3.8)$$

For example, a straight distance D(S) between two nodes may be 40 km; however, the actual transport distance D(T); real distance) may be 50km. Thus, the Detour Index is 0.8 (40/50). The complexity of the route topography is often a good indicator of the level of detour (Rodrigue et al. 2006).

c) *Eta Index:*

The average length per link is called the Eta Index. Adding new nodes will cause the Eta Index to decrease as the average length per link declines (Rodrigue et al. 2006). The Eta Index is calculated from Equation 3.9.

$$\eta = \frac{L(G)}{e} \quad (3.9)$$

where L(G) the average length and e are the number of links.

d) *Theta Index:*

The Theta Index measures the function of a node that is the average amount of flowing traffic per intersection. The higher the value of theta, the greater the load on the network (Rodrigue et al. 2006). The Theta Index is calculated using Equation 3.10.

$$\theta = \frac{Q(G)}{v} \quad (3.10)$$

where Q(G) the average amount of traffic and v is the number of nodes in the network.

e) *Beta Index:*

The Beta Index measures the level of connectivity in a graph, and is expressed by the simple relationship between the numbers of links (e) over the number of nodes (v). (Rodrigue et al. 2006).

f) *Alpha Index:*

The Alpha Index is a measure of connectivity that evaluates the current number of cycles in a graph, compared with the maximum possible number of cycles. The higher the Alpha Index, the greater the network's connectivity. This index measures independently the level of connectivity of the number of nodes (Rodrigue et al. 2006). The Alpha Index is calculated using the Equation 3.11.

$$a = \frac{u}{2v-5} \quad (3.11)$$

g) *Gamma Index ( $\gamma$ ):*

The Gamma Index is a measure of connectivity that considers the relationship between the number of observed active links and the number of possible links. The value of Gamma is between zero and one, where a value of one indicates a completely connected and utilised network. In reality, this is actually extremely unlikely. The Gamma Index is

an efficient way to measure the development progression of a network in time (Rodrigue et al. 2006). The Gamma Index is calculated using the Equation 3.12.

$$\gamma = \frac{e}{\frac{v(v-1)}{2}} \quad (3.12)$$

Cooperative Working Agreement Index (theoretical index)

The Cooperative Working Agreement Index is a dummy variable signalling the presence of carrier agreements on specific maritime routes. The existence of cooperative working agreements has a weak impact that is not always statistically significant (Fink et al. 2002). This result confirms the importance of price-fixing agreements, more so than cooperative working agreements. The UK has a score of zero, on a scale where the minimum is zero and the maximum is one, in keeping with the findings of X. Clark et al. (2004).

European Freight Forwarding Index (freight index)

The European Freight Forwarding Index is composed of other Freight Forwarding Indices. Each sub-index represents a country and almost every EU country is represented. The UK participates to a level equal to 15 percent. The overall index captures all modes of freight, with sea-freight representing 32 percent. Figure 3-75 illustrates the overall index, while Figure 3-76 illustrates the UK freight forwarding index. Further, Figure 3-77 demonstrates the sea-freight forwarding index. The indices presented in Figure 3-75, Figure 3-76 and Figure 3-77 consist of a leading indicator, as it is possible to change their direction before the actual current situation. The indices are calculated simply, by only presenting two questions to the participants (Danske Bank 2010). The sea freight sub-index is a leading indicator for ocean freight and is based on responses from more than 170 freight intermediaries (Fairplay 24 2010a).

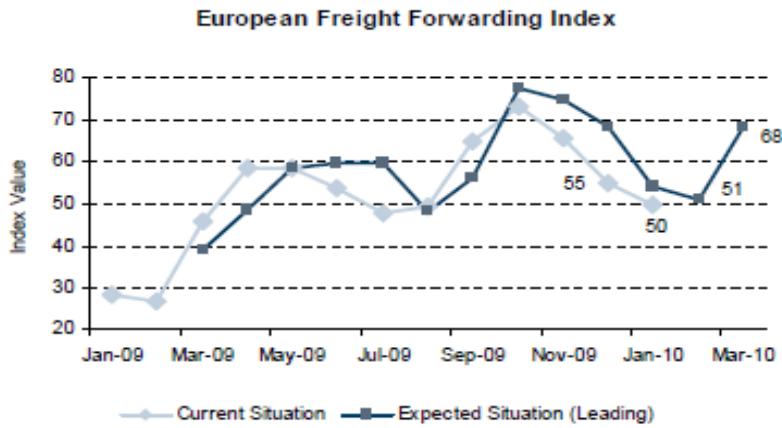


Figure 3-75 European Freight Forwarding Index (Jan 09 - Mar 10)

Source: Danske Bank (2010)

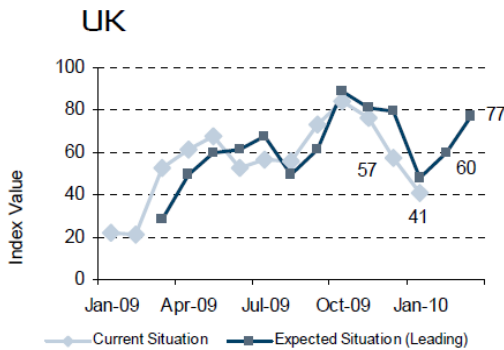


Figure 3-76 UK Freight Forwarding Index

Source: Danske Bank (2010)

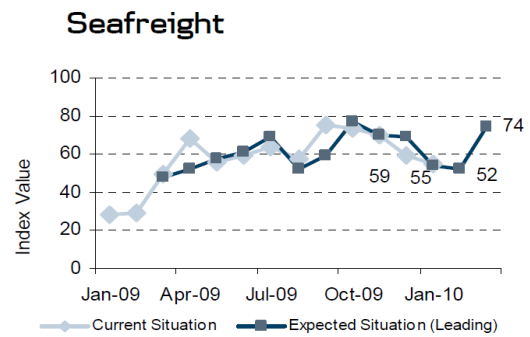


Figure 3-77 Sea-freight Forwarding Index

The CostPartner's Seafreight Index (freight index)

The CostPartner's Seafreight Index is a tool with which to compare the percentage development of participants' sea-freight rates with the percentage development of the related market. This allows the user to see his/her own index and a shared market index at all times (see Figure 3-78). As the name suggests, the users' actual rates are never revealed in absolute figures. The Seafreight Index is based on rates and surcharges (The CostPartner's Seafreight Index 2010).





Figure 3-78 The CostPartner's Seafreight Index

Source: Karin (2010)

*The Sea Freight Index (freight index)*

The Sea Freight Index is calculated on a Euro basis reflecting the regional price development in the sea trade services engaged by German importing and exporting companies (Statistisches Bundesamt Deutschland 2010).

*MSCI World Marine Index (financial index)*

The MSCI World Marine Index represents the investment in shipping by aggregating the performance of 10 major listed shipping stocks, and it has a relatively long data history. The index is designed to provide a measure of the global developed market equity performance (Grelck et al. 2009).

*Capital Link Maritime Index (CLMI) (financial index)*

The CLMI includes all of the USA listed shipping companies and currently comprises all 44 companies listed on the USA exchanges. In terms of historic data, companies listed after the 1<sup>st</sup> of January 2005 have been included in the Maritime Index; therefore, the sector provides indices for the period in which they were listed (Capital Link Shipping 2010). Figure 3-79 illustrates the performance of the Capital Link Maritime Index for the period March 2005-September 2012.

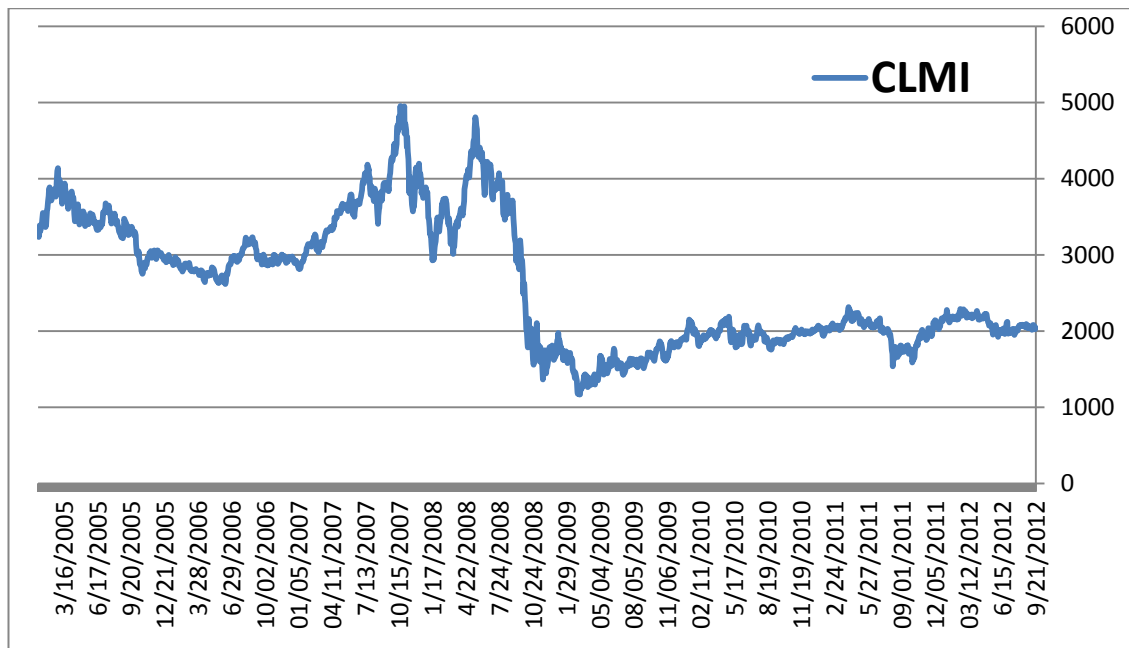


Figure 3-79 The Capital Link Maritime Index (March 2005 - Sept 2012)

Source: Capital Link Shipping (2012)

S&P (Standard & Poor's) Global Infrastructure Index (financial index)

The S&P Global Infrastructure Index provides liquidity and tradable exposure measures of 75 companies from around the world representing the listed infrastructure universe. To create a diversified exposure assessment across the global listed infrastructure market, the index has balanced weights across three distinct infrastructure clusters, namely: 1) utilities; 2) transportation; and 3) energy (Standard & Poor's 2009).

BDIFutures (financial index)

The BDIFutures is an index futures contract based on the BDI, with which someone can trade. Using the BDIFutures contract, investors and stock portfolio managers can protect the value of their shipping equities from upside and downside price risks in the broader dry bulk market. The Imarex BDIFutures contract can be traded in lots that are as tiny as USD 1 per point; thereby, providing low financial barriers to entry. [Lot Size: 1 lot = 1 USD x BDI tick (if index is 10,000 then 1 lot is USD 1 x 10,000 = USD 10,000)] (Imarex 2010).

FTSE ST Maritime Index (financial index)

The FTSE ST Maritime Index aims to capture the performance of companies that have a substantial proportion of their revenue delivered by maritime related activities. Stocks

included in the index must receive at least 55 percent of their revenue from manufacturing, ownership, operation and the repair of commercial/cargo vessels (FTSE 2010a; FTSE 2010b).

#### DAXglobal Shipping Index (financial index)

The DAXglobal Shipping Index consists of companies that are engaged primarily in freight transport via waterways and freighter shipbuilding. The selection criteria for incorporation in the DAXglobal Shipping Index are market capitalisation and the average daily exchange turnover for the previous three months. The market capitalisation of the participating index members must be at least USD 500 million, the average daily exchange turnover USD 2 million and the composite equities which are given a maximum weighting of 15 percent (Dax-Indices 2010). Figure 3-80 illustrates how the index fluctuated from September 2002 until September 2012.

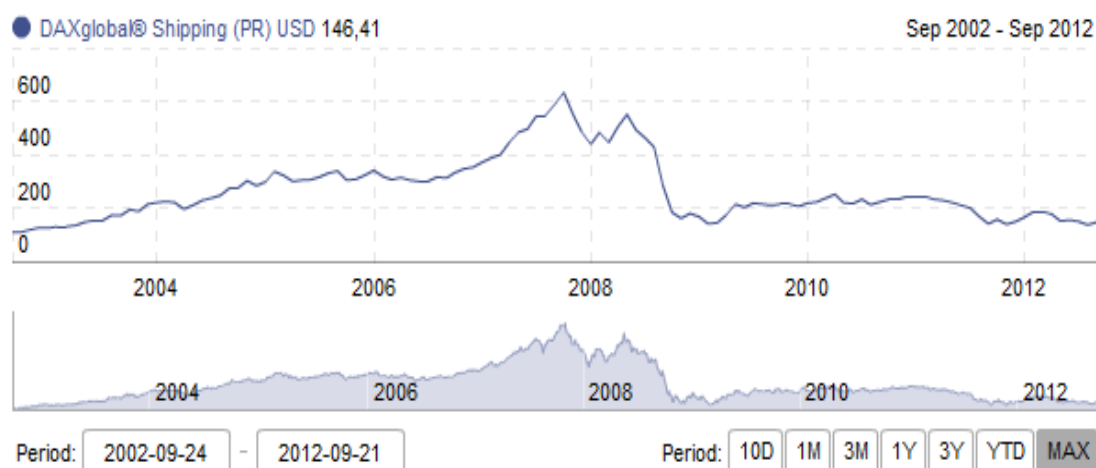


Figure 3-80 DAXglobal® Shipping index, prices in USD (Sep 2002 - Sep 2012)

Source: Deutsche Borse Group (2012)

#### Sudden Cardiac Arrest Association Index (anthropocentric index)

The Sudden Cardiac Arrest Association Index is an index that ranks the world's nationalities according to the percentage of citizens of a specific country that are likely to experience a sudden cardiac arrest. With such an index, a ship-owner can 'realise' which countries to consider excluding for employment as a seafarer. This is because, if the percentage of citizens likely to experience heart attacks is high, a seafarer from that country may also have a raised possibility of having a heart attack while aboard a vessel in service (Ship Management International 2010).

### Other indices

Information access for various indices found from the content analysis and the literature review was limited and, for some indices [i.e. L.R.F. (Lloyd's Register Fairplay) Freight Index, R.S. Platou Dry Bulk Freight Index and R.S. Platou Chemical Tanker Index], access was not freely available. The researcher has filled this gap with a continuous search of the literature and with the help of the interviews conducted. Of course, the information obtained was not sufficiently detailed to be able to quote specific information for such gaps, unlike the previously discussed indices where there was considerable information available in the academic and commercial literature. So, only a general idea has been obtained of how those indices work and are appropriately classified.

#### **3.3.7 Indices; sources of unexpected information**

Economists have found that some of the indices described above tend to capture or reflect various trends. For example, trends in freight shipments are especially useful. Freight volumes often change before they are indicated in sales and production (Notis 2010). That means that if the proposed index could consider all the above factors and work with a mechanism that reflects the changes as the freight indices, it might help economists to predict economy processes and associated trends, whether they move upwards or downwards. If that becomes the case, maritime cost, connectivity and risk index could soon become a key index, because it will indicate potential trends to changes in direction before the actual economy does.

Economists are potentially a group of people who will benefit from the proposed index, as a group that is continuously looking for more data to anticipate, if not determine, the economic trends, especially under the current confusing economic climate. This determination is crucial for any business, including maritime transport.

Many academics, organisations and industry people who are related to the maritime transport sector are also seeking other sources of data. Consequently, they often try to extract potential data through the correlation of various indices. That correlation has sometimes decoded various meanings in data and information that were not previously visible. Because the correlation of indices is something new and there are not yet many reliable data, the researcher has reviewed some examples from every 'section of interest' mentioned above.

B. Liu et al. (2010) have published an article detailing the correlation between the BDI and the Shanghai Stock Exchange Composite Index. As stated in the abstract of that paper, the correlation between the two indices for the last three years was found to be positive.

From an organisational point of view, the UNCTAD has conducted a comparison between two indices, the LPI and the LSCI. Although the two indices seem to cover different markets, with the LPI covering the entire supply chain and the LSCI capturing the level of connection of coastal countries into the global liner shipping networks, they were found to be positively correlated, with a partial correlation coefficient of 0.71. During that comparison, the indices' components have been compared, with some revealing a good correlation (UNCTAD 2010c).

Industry experts use correlations to extract useful information for more practical issues. Ms Dodra, of Kalimbassieris Maritime, examined a comparison of ship repair prices with other indicators of the market, such as the new-building prices and the BDI. She found a relatively close correlation between them. When freight rates or vessel prices were high, repair prices were also found to be high; conversely, low freight rates were reflected in lower repair costs (Brewer 2010).

The correlations noted above provide an opportunity for the researcher to consider how to better evaluate the various indices of the maritime sector and of their constituent components. An additional way of finding relationships between various indices that is less scientifically based but commonly used by industry experts, is the indices comparison, as explained in the following section.

### ***3.3.8 Indices comparison***

The comparison of two indices could shed light on potentially unknown information. One example is given in Figure 3-81, which Dowell (2007), from Howe Robinson, created at the end of 2007. The graph represents two indices (the BDI and the Howe Robinson Index) on the same scales. And illustrates that the demand for containers had declined by 33 percent, while the demand for dry bulk products had increased by 420 percent at the end of 2007. As the graph shows, the two indices were moving in parallel for a period of time until the middle of 2006, when the container index started to fall and the dry index started to rise.

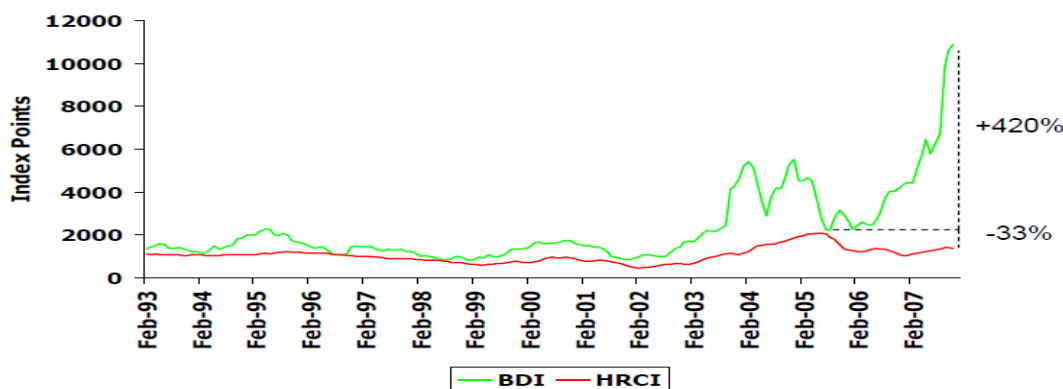


Figure 3-81 Comparison between the BDI and the Howe Robinson Container index  
Source: Dowell (2007)

An explanation of the reaction of the two indices since 2007, as illustrated in Figure 3-81, is attempted herein. The supply of raw products used mostly by developing countries, such as China, for the production of new products, had increased by 420 percent. The most probable cause was that the suppliers were affected by the preceding ‘good’ four years where the demand for goods in developed economies increased according to the Howe Robinson Container Index. This had a logical consequence for the suppliers to increase their volumes of production without recognising or appreciating the fact that the demand for goods of developed economies fell once at the end of 2005 and, for second time, at the end of 2007. So, the oversupply of goods to the market, combined with the bad performance of the USA economy in 2008 with a corresponding lowering of demand, led the global economy into recession. This clearly affected all of the economic indicators, as well as the BDI with its significant decline since 2008. However, this decline was not only as a result of the oversupply of the market with bulk commodities, but also due to the oversupply of vessels. Consequently, a second large fall of the index was noticed during the summer of 2010, even though the signs were that the economy had returned to positive growth rates (by 3.9 percent in 2010 and by 3.3 percent in 2011) in comparison with the -3.05 percent in 2009 (UNCTADstat 2011a; The World Bank 2011). Figure 3-82 illustrates how the BDI and the world economy were affected by the ‘Great Trade Collapse’ and how GDP rates were changing for both emerging and developing countries, and that the BDI was moving generally in parallel. The same parallel impression can be taken from Figure 3-83, whereby the BDI is compared with the World Trade volumes.

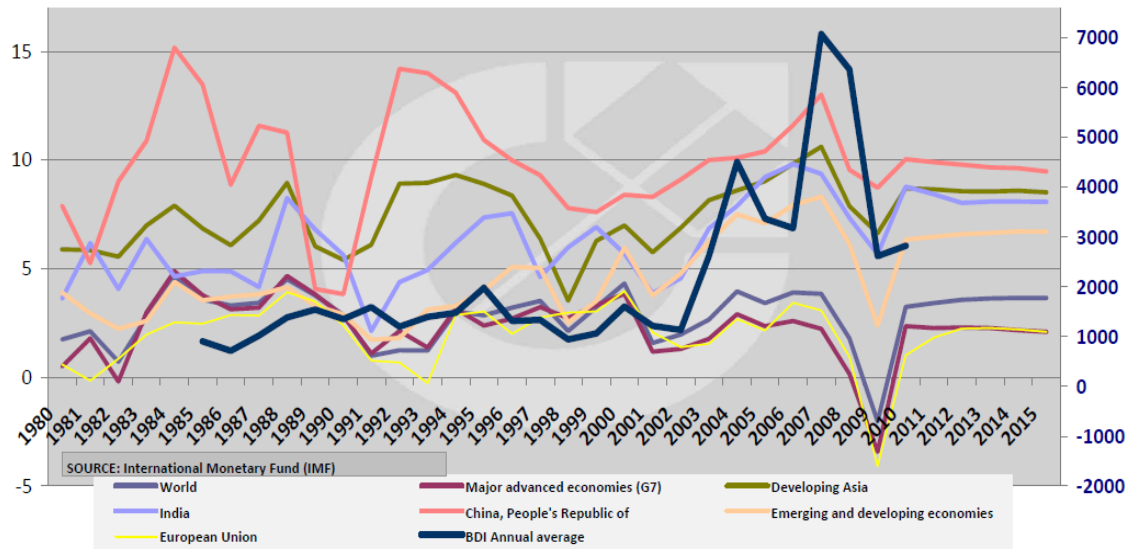


Figure 3-82 Baltic Dry Index against GDP growth of selected countries and regions (1980-2015)

Source: N. Contzias Shipping Consultants (2011)

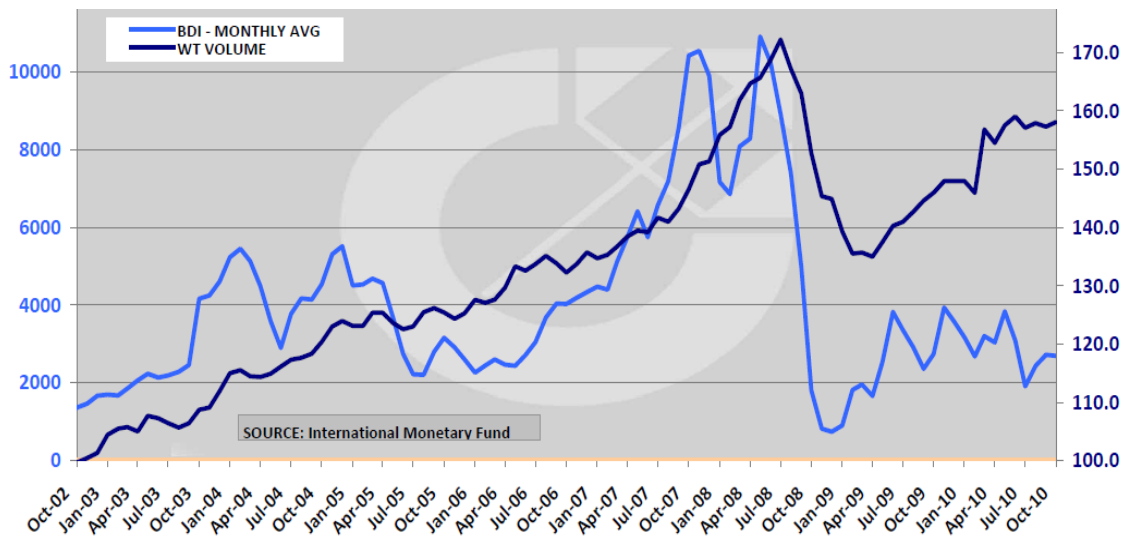


Figure 3-83 BDI against World Trade volume (2003-2010)

Source: N. Contzias Shipping Consultants (2011)

As discussed so far, various indices exist in the maritime transport sector with each having a different role and function. In order to understand the validity of the indices existing in the maritime transport sector, a content analysis was undertaken.

### 3.4 Content Analysis<sup>8</sup>

A content analysis was undertaken to enhance knowledge about where and how often the identified indices are used in the maritime transport sector. This information has helped this research realise the validity of the indices studied. Through that realisation, only the valid indices were retained for the next step, which involves their understanding and interpretation.

By adopting the method of content analysis, all of the indices mentioned in 10 journals and reports can be captured. A total of 10 maritime publications were chosen because of the need to cover a broad range of views and to check the usage of the various indices across the maritime transport sector. The perspectives of ship-owners, ship managers and the shipping industry were obtained by analysing the following publications: Fairplay, Seatrade, Ship Management International, R.S. Platou monthly report, Lloyd's List (Daily Newspaper) and Lloyd's Shipping Economist. A public policy and trade perspective was captured through an examination of the UN quarterly publication UNCTAD Transport Newsletter. Finally, academia/research areas were covered by including the journals Maritime Policy and Management, Maritime Economics and Logistics and the Journal of Transport, Economics and Policy. The results of the content analysis are reported in Table 0-6 (Appendix C).

Content analysis is a highly useful research method for transport studies, as it is possible to generate quantified data from non-quantified sources (Rodrigue et al. 2009). This method has not only been applied to transport studies but also to logistics for example, those of Ellinger et al. (2003) and Spens and Kovacs (2006). Additionally, it is an approach whereby the researcher is able to conduct an analysis of the documents and texts (which may be printed or visualised) that attempt to quantify a specified content material in terms of predetermined named categories; moreover, it takes place in a systematic and repeatable manner. A definition of content analysis is provided by Krippendorff (2004 p.18): "Content analysis is a research technique for making replicable and valid inferences from text (or other meaningful matter) to the contents of their use". Furthermore, it is a flexible method that can be applied to a variety of media. In other words, it is not a research method aimed at analysing documents and texts; rather, it generates data from them. Even so, it is commonly treated as a research

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<sup>8</sup> The findings from this section have been published by the researcher in the following peer-reviewed publication: Karamperidis, S., Jackson, E. and Mangan, J. (2013). The Use of Indices in the Maritime Transport Sector. *Maritime Policy & Management*, [e-pub ahead of print].



method because of its characteristic approach to analysis (Bryman 2008). One disadvantage, however, is that its quality depends on the quality of the sources being examined (Bryman 2008). Therefore, a broad range of high quality journals and reports which are applicable to the maritime transport sector was examined.

Within the logistics literature, content analysis has been used to inform: 1) literature reviews (Defee and Stank 2005); and 2) analyse interviews and other empirical data (Fawcett et al. 2006). Results from the content analysis involve fundamental model development, which are considered instructions for subsequent practice, and recognition of barriers to collaborative practices (Dinwoodie et al. 2010).

Millward (1995) presents three main types of content analysis:

- Quantitative content analysis (NCA). NCA is used for the identification of statistical frequencies of particular categories of characteristics which are present in a message. These frequencies may then be ranked or otherwise manipulated statistically.
- Qualitative content analysis (LCA). LCA is used to inquire the meaning hidden within a body of content, and to supply a detailed outline of the social reality, with the use of categories based on the research questions to code segments of text.
- Structural content analysis (SCA). SCA represents the relationship that exists between elements of a text. That representation is taking place through specific rules that report the relationships among response categories.

The differences between the various types of content analysis are connected to the level whereby the researcher interprets the meaning of a message, and not only to count the actual content of the data. In this research effort, NCA was deemed most appropriate method in terms of stated objectives. By using this type of content analysis, statistical frequencies of particular 'key' words were found within the examined publications. Simple frequency analysis of the key words was conducted using Microsoft Excel 2007; key words were then ranked according to frequency of occurrence. The sample comprised the 10 aforementioned publications for the period October 2008 to September 2010. Five key words were deemed appropriate for use in the subsequent content analysis. The first three key words were chosen to detect the word index and its derivatives. The final two were selected because they are linked specifically to the

maritime transport. The key words for the research were: index, indices, measurement, cost and connectivity.

With the use of NCA, the content of the publications was visually scanned for the key words. Some data access problems were experienced due to the lack of availability of some titles during the chosen period, and which covered the post-economic crisis period (or 'Great Trade Collapse'), as the IMF named the economic crisis of 2008 (Hellenic Shipping News Worldwide 2011a). The time period for which each journal was available and examined is presented in detail in Table 3-20.

<b>Publication Title/ Frequency</b>	<b>Number and information for every journal examined, and problems - limitations that appeared during the content analysis</b>
Fairplay / (weekly)	October 2008 until September 2010, 101 issues.
Seatrade / (bi - monthly)	November 2009 until October 2010, 6 issues.
Ship Management International / (bi - monthly)	September / October 2008 until July / August 2010, 12 issues.
Journal of Maritime Policy and Management / (bi - monthly)	December 2008 until September 2010, 12 issues.
Journal of Maritime Economics and Logistics / (quarterly)	December 2008 until September 2010, 8 issues.
Journal of Transport, Economics and Policy / (four - month)	September 2008 until May 2010, 6 issues.
R.S. Platou Monthly Report / (monthly)	October 2008 until September 2010, 24 issues.
UNCTAD Transport Newsletter / (quarterly)	4th quarter 2008 until 3rd quarter 2010, 7 reports.
Lloyd's List / (daily)	Daily newspaper (released Monday to Friday). One issue per month picked at random, total 24 issues examined. October 2008 until September 2010.
Lloyd's Shipping Economist / (monthly)	January 2010 until September 2010, 9 reports.

Note: Some of the selected publications have regular features which report on specific indices (e.g. shifts in the BDI are reported each day in the market section of Lloyd's List). Where this was the case, such indices were only counted once, not every time they appeared.

Table 3-20 Journal title and data availability for the content analysis

The results of the top 18 indices found during the NCA are demonstrated in Table 3-7, in comparison with the complete table of the 109 in total indices found from content analysis conducted, which is given in Appendix C.

### Sampling

Sampling is a method that links to the content analysis and applies to the research aims. This is useful because sampling helps to draw conclusions from a selected record (little part) taken from a population, known as the sampling frame (Collis and Hussey 2009). A sample is an unbiased subset that represents a larger population. A population is a body of people or a collection of items under consideration for statistical purposes (Collis and Hussey 2009). As a result, one can draw conclusions that represent the whole population by examining only a small proportion. For that reason, a sampling method was applied, in conjunction with the content analysis, as mentioned above; this selected method is called the cluster sampling method. The cluster sampling method makes a random selection from a sampling frame listing groups of units rather than individual units (Collis and Hussey 2009). This method allows the selection of individuals belonging to selected groups. More information on the existing sampling techniques is provided in Section 4.6.

### **3.5 Landed Costs**

Many companies today work in a global environment, with supply and demand points spanning the world. In such an environment, they can source, manufacture and sell from anywhere to anywhere. But why are companies wasting resources to coordinate a global supply chain when they could source all their products locally? The answer is simple: because they can find cheaper raw materials and cheaper labour, and they can place their products in new, more profitable markets. Therefore, global supply chains are hugely important for the modern economy and way of living.

The problem facing many companies is that, in most cases, they have taken that decision based only upon the lower labour costs or the sourcing of the cheapest raw materials. They fail to consider the fact that additional costs could be incurred when the final product is manufactured overseas. These are known as the total landed costs, and are outlined in detail in this section.

The concept of ‘total landed costs’, as defined by Mangan et al. (2008 p.198) is to: “...compare alternative sources while taking account of all of the various costs that will be incurred”. At this stage, it is prudent to draw a distinction between the difference of the total landed costs and total supply chain costs. The definition of the total supply chain costs is given by the Supply Chain Council (2011): “all the costs associated with

acquiring and delivering material, planning and order management, but none of the expenditures associated with Research and Development or sales and marketing”. It is clear from these definitions that the total supply chain costs are part of the total landed costs. The total landed costs, according to Mangan et al. (2008), include the logistics and material procurement costs. The total landed costs are composed from the following costs.

- Raw material sourcing cost. The sourcing cost is the cost which is associated with the raw material procurement.
- Manufacturing cost. Manufacturing costs can be considered the costs of equipment operation, labour, and the general overhead of the facility.
- Warehousing cost. The local buffer inventory storage may increase if the product requires longer lead time.
- Transportation cost. When the distance increases between the product and the manufacturing unit or the product and the customer, the freight cost also increases. This is the case if maritime transportation is chosen as the mode of freight movement, which is far cheaper than air transportation. Maritime transportation has the disadvantage, however, in comparison with air transportation in that, when the distance increases, the time needed for the completion of the transportation does likewise.
- Inventory cost:
  - Finished goods inventory
  - Raw materials inventory

The inventory cost can be separated in two categories as demonstrated above. In both cases, the supply chains will have a higher inventory when the product needs longer transit time. That higher inventory will lead to an increase in the working capital being employed and the risk for product obsolescence, damage and shrinkage.

- Taxes and duties. The general rule is that if a product is sourced from overseas, import-related taxes and duties will apply. Of course, there are some exceptions for some products sourced from specific countries.
- Package cost. If a product needs to be transferred for longer distances and time, the need arises for better quality packaging and carrying environment conditions.

- Localisation cost. The cost of converting a product to local standards may be prohibitive due to high conversion costs (Mangan et al. 2008).

The costs outlined above illustrate the focus of this research on transportation cost components. The transportation costs are those that can change dramatically in the short-term and are, therefore, considered to have high importance for companies. The reason for the fluctuation of transport costs is due largely to changing fuel and security surcharges, differing demand patterns for cargo and changing air and ocean timetables (Mangan et al. 2008). Thus, companies have to review constantly their landed costs, as they can change severely and rapidly simultaneously.

### **3.6 Map of a Container Journey**

There is limited amount of information available regarding the detailed costs of shipping a container from one country to another. In most cases, such information is kept secret, as they are the ‘tools’ with which shipping companies attract new contracts or renew contracts with existing customers. Therefore, they are regarded as company ‘commercial secrets’. A pilot study, conducted by the researcher on the charges applied by carriers to moving containers in and out of the Republic of Ireland and the UK, helped to appreciate how difficult it is to gain access to these ‘commercial secrets’.

This research has focused only on moving containers between ports. So, costs, connectivity and risk factors should be applied only after leaving the port yard of the exporting country to a UK port yard, or the other container flow direction, from a UK port yard to an importing country’s port yard.

The shipping costs of a container, according the OOCL, can be separated into three main parts, namely:

- 1) the actual freight rate for the container
- 2) the surcharges for the service provided (for the carriage of the container from the port of origin to the port of destination)
- 3) the local surcharges (charges which apply according to the ports of origin and destination).

In the literature, it was found that when the shipment of a container is direct it is considerably cheaper than when the movement of a container involves transshipments. As mentioned in Section 3.2.3, Wilmsmeier and Hoffmann (2008) discovered that one

transshipment has the equivalent impact on freight rates as a distance increase of 2,612 km between two countries.

At this particular stage of the research, an attempt was made to map the transport costs of a container, conducted with the aid of data available on the internet from the companies: shipping-worldwide.com, OOCL and Maersk. As this research focuses on the UK, and with regard the absence of useful data for the costs of transshipment, two hypothetical journeys were created. The first was from Shanghai to Southampton for a standard 20-foot dry container, loaded with 17,000 kg of footwear, on the 7<sup>th</sup> of May 2011. The second was from Singapore to Felixstowe for a standard 40-foot dry container, loaded with 27,000 kg of paper (paper, paperboard, and packing material) on the 1<sup>st</sup> of October 2012. The ports were chosen as direct services exist between them. Of course, the Ports of Felixstowe and Southampton are the two largest container ports in the UK, with 3,249,000 and 1,590,000 TEU container traffic respectively in 2011 (Department for Transport 2012c).

### ***3.6.1 Cost of moving a container from the Far East to the UK***

Various factors could affect the prices charged for the carriage of a container. These could range from the type of the container (dry, refer, dangerous, or dangerous refer), its size (20-foot, 40-foot, 45-foot, etc) or even from the unitary value of the product as mentioned in Section 3.2.1. The last factor, as mentioned during the interviews conducted, no longer exists from the perspective of carriers, while from the perspective of shippers, it does. Consequently, one 'light' and one 'heavy' commodity have been chosen to map their respective charges. In the following examples, an attempt was made to map a dry standard 20-foot container and a dry standard 40-foot container containing footwear and paper products respectively. These two types of containers are mapped as they are the two main ones that are used in the UK market as Figure 2-10 illustrates. The trade routes mapped were: Shanghai (China) to Southampton (UK) for the 20-foot container, and Singapore (Singapore) to Felixstowe (UK) for the 40-foot container, on the 7<sup>th</sup> of May 2011 and on the 1<sup>st</sup> of October 2012 respectively.

The freight rates, surcharges and local surcharges for the 20-foot container are demonstrated in Table 3-21, Table 3-22 and Table 3-23, and for the dry 40-foot in Table 3-24. Table 3-21 and Table 3-24 demonstrate the final freight rate that the user of the

service has to pay, which is calculated from the basic freight rate and various surcharges. Those could be regional or country-specific.

<b>Description</b>	<b>Value</b>	<b>Rate</b>	<b>QTY.</b>	<b>Amount</b>
Freight (Footwear)	20' Container	USD 1,475.00	1	USD 1,475.00
Bunker Adjustment Factor [BAF Charges]	20' Container	USD 120.00	1	USD 120.00
Wharfage	17 MT	USD 2.90		USD 49.30
Bill Of Lading				USD 50.00
GRI Charges	USD 100.00		1	USD 100.00
Terminal Handling Charges		USD 400.00	1	USD 400.00
Shipper's Declaration (Over USD 1.00)	USD 24.37			USD 150.00
<b>Total</b>				<b>USD 2,344.30 or £1,433</b>

Table 3-21 Freight rate for dry 20-foot container shipped from Shanghai to Southampton (on the 7th of May 2011)

Source: Air Parcel Express ([www.shipping-worldwide.com](http://www.shipping-worldwide.com)) 2011, pers. comm., 29 April 2011

Table 3-22 and Table 3-23 demonstrate the possible surcharges for this hypothetical 20-foot container for the journey from Shanghai to Southampton. While Table 3-24 demonstrates all the charges and surcharges for the 40-foot container from Singapore to Felixstowe.



<b>Local Surcharges for Europe per TEU</b>	<b>Amount</b>
Booking Cancellation Fee (BCF)	€ 25
Booking Amendment Fee (BKA)	€ 25
Foreign-to-Foreign Booking Administration Fee (FFB)	€ 60
Export Documentation Charge (DOC)	€ 52
Export Customs Clearance (CCC) (subject to provision of a commercial invoice)	€ 50
China24 Advance Manifesting (AMC) (shipments to or via China only)	€ 20
China24 Amendment Fee (AAC)	€ 30
Security Manifest Fee (AAC)(Advance Manifesting for North America)	€ 20
Amendment Fee (ADM) (Advance Manifesting)	€ 30
Admin Fee for Multi Currency Invoicing (ADM)	€ 30
Late SI Fee (LSI)	€ 30
Telex Release Fee (ADM)	€ 15
Import Customs Clearance (CCC)	€ 50
Import Bond Fee (BON)	€ 75
Port Security Fee (SEC, SED)	€ 14
Freight Handling Fee (FHF) (also known as Payable Elsewhere Fee)	€ 50
Import Documentation Charge (DCF)	€ 52
Terminal Handling Charge (THC, THD, CSC)	€ 130
<b>Total</b>	<b>€ 758 or £ 665</b>

Table 3-22 Local surcharges for a dry 20-foot container (for Europe) (on the 7<sup>th</sup> of May 2011)

Source: OOCL (2011a)

<b>Surcharges per TEU</b>	<b>Amount</b>
Priority Booking Surcharge (PBS)	USD 650
Bunker Adjustment Factor (BAF)	USD 734
Low Sulphur Fuel Surcharge (MAR)	USD 10
Currency Adjustment Factor (CAF)	USD 21
Suez Canal Transit Charge (SUZ)	USD 9
Peak Season Surcharge (PSS)	USD 200
Gulf of Aden Surcharge (GAS)	USD 43
<b>Total</b>	<b>USD 1,667 or £1,019</b>

Table 3-23 Surcharges for a dry 20-foot container (journey Far East – Europe) (on the 7<sup>th</sup> of May 2011)

Source: OOCL (2011b)

Charge type	Type	Details	Valid to	Local currency	USD
Basic Ocean Freight (BAS)	Tariff			1,340.00 USD	1,340.00
Bunker Adjustment Factor (BAF)	Tariff			.00 USD	.00
Currency Adjustment Factor (CAF)	Tariff			131.14 USD	131.14
Congestion Fee (CON)	Tariff			.00 USD	.00
Terminal Handling Service-Destination (DHC)	Tariff			131.00 GBP	212.43
Equipment Management Service (EMF)	Tariff			7.00 SGD	5.70
Emergency Risk Surcharge (ERS)	Tariff			110.00 USD	110.00
Terminal Handling Service- Origin (OHC)	Tariff			325.00 SGD	264.61
Arbitrary - Origin (OPA)	Tariff			50.00 USD	50.00
Peak Season Surcharge (PSS)	Tariff			.00 USD	.00
Standard Bunker Adjustment Factor (SBF)	Tariff		31-10-2012	1,120.00 USD	1,120.00
Carrier Security Service (SER)	Tariff			12.00 USD	12.00
Suez Canal Fee (STT)	Tariff			80.00 USD	80.00
Submission of Cargo Declaration - Import (CDD)	Tariff			25.00 USD	25.00
Documentation Fee- Destination (DDF)	Tariff			25.00 GBP	40.54
Documentation Fee - Origin (ODF)	Tariff			80.00 SGD	65.14
<b>Total</b>					<b>3,456.56</b>

Table 3-24 Freight rate for a dry 40-foot standard container 27000 kg from Singapore to Felixstowe on the 1<sup>st</sup> of October 2012

Source: Maersk Line (2012b)

As illustrated in the above tables, some charges can vary considerably even for the same time period. One factor causing many disagreements amongst shippers and carriers is the Bunker Adjustment Factor (BAF). As demonstrated in Table 3-21 and Table 3-23, the forwarding company is charging USD 120 for BAF, while OOCL charges USD 734. The price differentiation between the two BAF figures is USD 614. That difference is nearly half the price paid for the basic freight rate (USD 1,475). That charge, as can be seen in Table 3-24, has increased over time in tandem with the price of the bunkers, as discussed in Section 3.2.1. Of course, the BAF charge has now been renamed as the Standard Bunker Adjustment Factor (SBF).

As the tables illustrate, being a shipper is a challenging task, as they have to deal with many factors that can increase the cost of moving a container from one port to another. Furthermore, these factors could fluctuate vastly over time. That fluctuation will be captured from the proposed index and will try to be mitigated. The results of the index are detailed in Chapter 5.

### **3.7 Concluding Remarks**

With the review of the academic and commercial literature, this research has found and summarised the factors contributing to maritime costs, connectivity and risk. It has also found the indices existing in the maritime transport sector through a general literature review and content analysis in line with two of the research aims and objectives set out in Section 1.4.2. The findings were distilled and knowledge was broadened regarding the indices creation, in order to solve the research problem defined in Section 1.4. The indices used in the maritime transport sector were identified by the application of the content analysis method. Consequently, sampling was addressed in the context of this research to support the content analysis, which was used for the collection of data relevant to the indices. Finally, the concept of the total landed costs were explained, while an exercise of mapping the container costs was conducted. The next chapter will outline the methodology used for the index development.

## Chapter 4. Methodology

*“Wise men talk because they have something to say; fools talk because they have to say something”.*

Plato, Greek philosopher, 428-348 BC

## **4.1 Introduction**

The methodology section is the most important part of this thesis. It not only deals with the research philosophies, approaches, strategies, choices, time horizon and techniques and procedures employed, but also provides an explanation of why the index was developed using the methods chosen. Since the research follows an exploratory approach, this is advantageous as it has the virtue of being more fluid than the positivist approach (M. Saunders et al. 2009). Due to its complexity and uniqueness, this research aims to implement the most effective methodologies to achieve validity and reliability of research outcomes. Thus, having researched various methodologies, the mixed method approach fulfils the requirements explained above. This entails and enables a more holistic and sustainable approach for this research, considering that both quantitative and qualitative research can provide reliable results. This chapter outlines the various methodological steps followed by the research.

## **4.2 Methodological Steps of the Research**

### ***4.2.1 Research philosophy***

P. Johnson and M. Clark (2006) state that it is important for business and management researchers to be aware of the philosophical commitments undertaken through research strategy choices. This happens because a researcher's philosophical position has a significant impact not only on what they want to do, but also on their understanding of the investigation. The philosophy selected by every researcher will be influenced by practical considerations. However, researchers might be influenced largely by the particular view of the relationship between knowledge and the process by which it is developed (M. Saunders et al. 2009). P. Johnson and M. Clark (2006) raise the fact that it is as important that a research is philosophically informed, as long as it reflects the philosophical choices selected by researchers. Of course, there is no single, correct research philosophy; rather, there are philosophies that are 'better' than others in terms of answering the specific research questions (M. Saunders et al. 2009). In practice, it is very rare to have research questions that match precisely one philosophical domain, as suggested by the classic research onion model (M. Saunders et al. 2009). The research onion (Figure 4-1) illustrates: 1) research philosophies; 2) research approaches; 3) research strategies; 4) research choices; 5) research time horizons; and 6) research techniques and procedures, which researchers choose to follow and conduct a research

project (M. Saunders et al. 2009). This model will be used herein as the structure for designing and justifying this research.

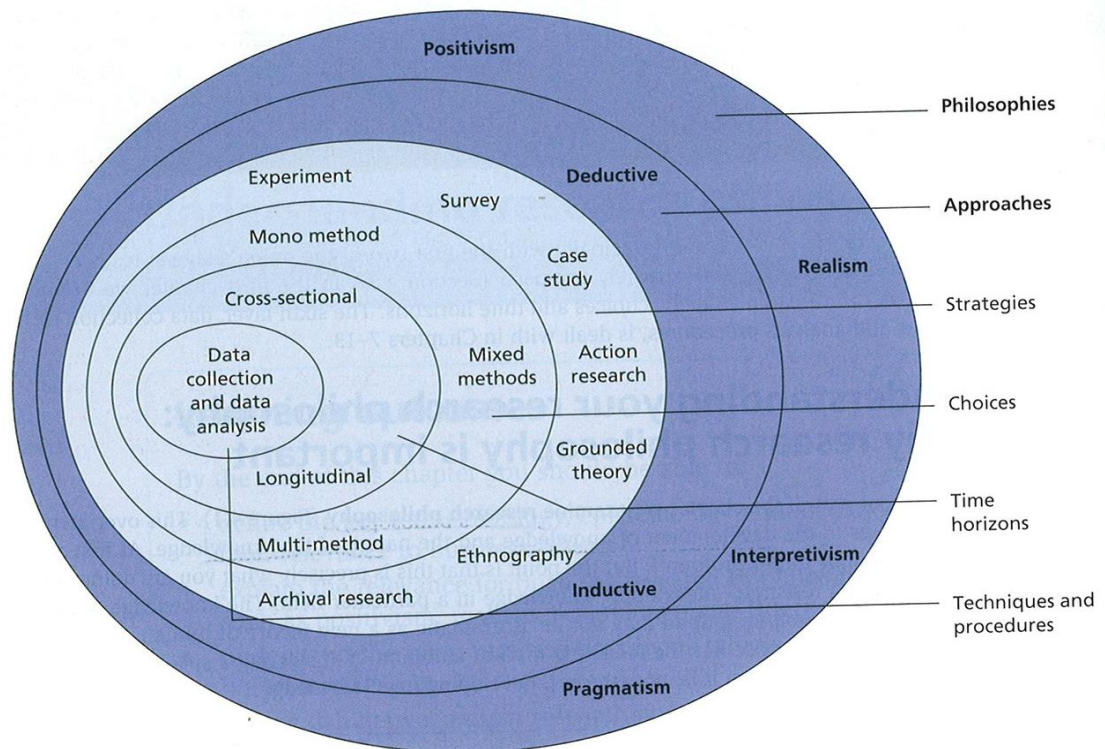


Figure 4-1 The research onion

Source: M. Saunders et al. (2009 p.108)

Before examining M. Saunders et al's (2009) framework, a consideration was undertaken of which research paradigm best suits the parameters of the overall project. The definition of the paradigm according to M. Saunders et al. (2009 p.118) is "a way of examining social phenomena from which particular understandings of these phenomena can be gained and explanations attempted". To start choosing a paradigm, as Guba and Lincoln (1994 p.105) state: "both qualitative and quantitative methods may be used appropriately with any research paradigm. Questions of method are secondary to questions of paradigm, which we define as the basic belief system or world view that guides the investigation, not only in choices of method but also in ontologically and epistemologically fundamental ways". In other words, questions of research methods have a secondary importance to those from which the paradigm applies to a research. Therefore, this research cites the interrelated paradigm assumptions of: 1) ontology; 2) epistemology; and 3) axiology (Collis and Hussey 2009). The rhetoric and the

methodological assumption will not be referred to in this research, as they are complementary (Collis and Hussey 2009).

Ontology is a branch of philosophy that studies metaphysics and is concerned with the nature of the reality (M. Saunders et al. 2009). In other words, it is the researcher's view of the nature of reality or being (M. Saunders et al. 2009). For business and management researchers, four aspects of ontology exist; these are compared in Table 4-1.

Epistemology is a branch of philosophy that studies the theory of knowledge. This involves the examination of the relationship between researchers and the topic being researched (Collis and Hussey 2009). In other words, it concerns the researcher's view regarding what constitutes acceptable knowledge. That study can be separated into four research philosophies for the business and management research, which are presented in Table 4-1.

Axiology is a branch of philosophy that studies judgements about value (M. Saunders et al. 2009). Axiology, in other words, is the researcher's view of the role of value in the research. Those views can be separated into four research philosophies, which are presented in Table 4-1.

According to Table 4-1, the four research philosophies (positivism, realism, interpretivism and pragmatism) fall under the three philosophical views of ontology; epistemology and axiology. Data collection techniques that can be used within those philosophies are also considered.

	<u>Positivism</u>	<u>Realism</u>	<u>Interpretivism</u>	<u>Pragmatism</u>
<u>Ontology</u> : the researcher's view of the nature of reality or being	External, objective and independent of social actors	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple	External, multiple, view chosen to best enable answering of research question
<u>Epistemology</u> : the researcher's view regarding what constitutes acceptable knowledge	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest elements	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or contexts	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions	Either or both observable phenomena and subjective meanings can provide acceptable knowledge dependent upon the research question. Focus on practical applied research, integrating different perspectives to help interpret the data
<u>Axiology</u> : the researcher's view of the role of values in research	Research is undertaken in a value-free way, the researcher is independent of the data and maintains an objective stance	Research is value laden; the researcher is biased by world views, cultural experiences and upbringing. These will impact on the research.	Research is value bound, the researcher is part of what is being researched, cannot be separated and so will be subjective	Values play a large role in interpreting results, the researcher adopting both objective and subjective points of view
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative	Mixed or multiple methods designs, quantitative and qualitative

Table 4-1 Comparison of four research philosophies in management research

Source: M. Saunders et al. (2009 p.119)



After consideration of the four research philosophies, pragmatism was deemed most appropriate for this thesis. “Pragmatism argues that the most important determinant of the epistemology, ontology and axiology you adopt is the research question...if the research question does not suggest unambiguously that either a positivist or interpretivist philosophy is adopted, this confirms the pragmatist’s view that is perfectly possible to work with variations in your epistemology, ontology and axiology” (M. Saunders et al. 2009 p.109). This thesis is expressed well from pragmatism since the research questions do not fit with either a positivist or an interpretivist philosophy. These theories have a precise approach in the research, while pragmatism uses a more holistic approach, involving qualitative and quantitative strategies. The realistic approach is also excluded, because it omits human thoughts or beliefs. Those thoughts and beliefs are fundamental to this research, as the basis for the creation of the index. Therefore, the pragmatic views are consistent with the researcher’s epistemology, ontology and axiology.

Furthermore, it is encouraging to note that Panayides (2006) advocates strongly more qualitative and quantitative approaches to research in the field of marine logistics.

#### ***4.2.2 Research approach***

Following the previous section on research philosophy, pragmatism was determined as the most appropriate approach for this thesis after discussing various methods. In general, three research approaches exist; the first is deduction, the second is induction and the third is a combination of both. Deduction is a research approach commonly linked to positivism, in which the researcher develops a theory and hypothesis (or hypotheses), and designs a research strategy to test it (M. Saunders et al. 2009). Induction is a research approach commonly linked to interpretivism, in which the researcher collects data to develop a theory from the data analysis (M. Saunders et al. 2009). The combined research approach is the marriage of deduction and induction research approaches (M. Saunders et al. 2009).

The main points of the deductive approach according to M. Saunders et al. (2009) are:

- Scientific principles
- Moving from theory to data
- The need to explain causal relationships between variables
- The collection of quantitative data

- The application of controls on quantitative data
- The operationalisation of concepts to ensure clarity of definition
- A highly structured approach
- Researcher independence of what is being researched
- The necessity to select samples of sufficient size in order to generalise conclusions.

The main points of the inductive approach in accordance with M. Saunders et al. (2009) are:

- Gaining an understanding of the meanings that humans attach to events
- A close understanding of the research context
- The collection of qualitative data
- A more flexible structure to permit changes of research emphasis as the research progresses
- A realisation that the researcher is part of the research process
- Less concern with the need to generalise.

This thesis follows the pragmatism philosophy, which is comprised of both qualitative data (in-depth face-to-face interviews, Delphi survey and focus group were used to collect information, for building the index) and quantitative data (data available from various sources which was condensed to generate a 'single' number, the proposed index). Thus, the combination research approach was selected for this research, as the researcher generates data with the use of qualitative data, but simultaneously 'squeezed' the qualitative data to produce the proposed index.

#### ***4.2.3 Research purpose and research strategy***

Before choosing the research strategy for this thesis, an overview of the research purpose was outlined. Three research purpose classifications exist in order to answer the basic research question of the project. Those classifications, which are explained briefly below, are the exploratory, the descriptive and the explanatory (M. Saunders et al. 2009).

Exploratory research is a valuable way to discover "what is happening; to seek new insights; to ask questions and to assess phenomena in a new light" (Robson 2002 p.59). Three ways are suggested to conduct exploratory research; 1) research the literature; 2) interview experts in the subject; and 3) conduct focus group interviews. Exploratory

research is advantageous to the researcher as is more fluid than the positivist approach (M. Saunders et al. 2009).

Descriptive research has been described by Robson (2002 p.59) as a portrayal of “an accurate profile of persons, events or situations”. For a descriptive study, it is necessary to have a clear picture of a phenomenon; for that reason, data is collected for the phenomenon before their data collection (M. Saunders et al. 2009).

Studies that aim to explain causal relationships between variables can be considered explanatory. The emphasis of the explanatory researches is to study a problem or a situation and try to find the relationships between the variables (M. Saunders et al. 2009).

The purpose of this study is changing over time, due to its complexity. As Robson (2002) points out, a research project may have more than one purpose; therefore, the enquiry may change over time. This allows the researcher to combine research approaches as illustrated in Table 4-4.

The next step to consider is the selection of a research strategy. Every research strategy can be used for any research purpose (exploratory, descriptive and explanatory) (Yin 2003). Some research strategies belong to the deductive approach while others belong to the inductive approach. Of course, as mentioned before for the research philosophies, the same applies for the research strategies; as there are no existing ‘superior’ or ‘inferior’ approaches. The most important point for the research strategies is that they are not mutually exclusive (M. Saunders et al. 2009). The strategies that exist for business and management research vary widely from experimental studies [which are associated with pure positivism, and are used in order to investigate the relationship between variables, where the independent variable is deliverable manipulated to observe the effect on the dependent variable (Collis and Hussey 2009)] to ethnographic studies [which are associated with pure interpretivism and the researcher uses socially acquired and shared knowledge in order to understand the observed patterns of human activity (Collis and Hussey 2009)]. Hence, the breadth of research strategies available is vast.

In the case of this research, no hypotheses or theory were generated.

The case study strategy is used in exploratory and explanatory research. It does not attempt to generate theory because it simply investigates a particular contemporary phenomenon (M. Saunders et al. 2009). As this thesis combines exploratory and

explanatory research, it is wise to choose a research strategy which can be applied to both. Case study, according to Robson (2002 p.178), can be defined as: “a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence”. Further, case study helps the researcher to gain in-depth understanding of the context of a research and the processes being established (M. Saunders et al. 2009). This can be achieved through answers to various types of questions, such as: why, what and how (M. Saunders et al. 2009). In case studies, it is very useful to ask ‘basic’ questions to demonstrate the ignorance of the researcher. It is welcome for someone who is conducting a case study not to be familiar with the industry or the organisation being examined, because he or she will ask more questions someone who is familiar them (M. Saunders et al. 2009). In that case, probably the unfamiliar person will draw more information, which is relevant to the case study.

The use of exploratory and explanatory research from the researcher during the case study strategy implies the employment of various data collection techniques (M. Saunders et al. 2009). So, if a researcher uses a case study strategy, they are likely to need and use triangulation of the various sources of the data (M. Saunders et al. 2009). According to Collis and Hussey (2009 p.85), “triangulation is the use of multiple sources of data, different research methods and/or more than one researcher to investigate the same phenomenon in a study”.

This research adopted the pragmatistic philosophy with an exploratory approach. Findings from the data were triangulated to draw conclusions from a multi-dimension research plan. Triangulation of the data is an important component of the research plan as data from multiple methodologies are used to achieve the ultimate research aim of developing an index of maritime transport costs, connectivity and risk for the UK.

Collis and Hussey (2009) identify four types of triangulation:

- Triangulation of theories; where a theory is taken from one discipline and used to explain a phenomenon in another discipline.
- Data triangulation; where data are collected at different times or from different sources.
- Investigator triangulation; where different investigators independently collect data.

- Methodological triangulation; where both qualitative and quantitative techniques are employed.

The type of triangulation employed in this research is methodological triangulation, because it combines quantitative and qualitative methods. The methodological triangulation provides multi-dimensional insights into many management research problems, especially in logistics, as Mangan et al. (2004) demonstrate.

#### **4.2.4 Research choices (or research design)**

Research choices, in conformity with M. Saunders et al. (2009), are the ways in which someone can make a decision to combine quantitative and qualitative techniques and their associated procedures. Tashakkori and Teddlie (2003) use a more generic term, ‘research design’, when referring to multiple methods. The research choices, according to M. Saunders et al. (2009), are:

- Mono methods
- Multiple methods:
  - ✓ Multi-method:
    - Multi-method quantitative studies
    - Multi-method qualitative studies
  - ✓ Mixed-methods:
    - Mixed-method research
    - Mixed-model research.

This research used mixed methods designs as it adopted the methodological triangulation research strategy which uses both qualitative and quantitative research techniques, as mentioned above.

R. B. Johnson and Onwuegbuzie (2004 p.14) define the outcome from the use of mixed method methodology as: “The goal of mixed methods research is not to replace either of these approaches but rather to draw from the strengths and minimize the weaknesses of both in single research studies and across studies”.

#### **4.2.5 Time horizons**

The time horizons are independent of the research strategies or of the choice of methods of every research (M. Saunders et al. 2009). The time horizons options defined by M. Saunders et al. (2009) are:

- Cross-sectional studies; those referring to a particular phenomenon (or phenomena) at a specific time.
- Longitudinal studies; those concerning changes and developments over time. The basic question answered by longitudinal studies, according to Bouma and Atkison (1995 p.114), is: “Has there been any change over a given period of time?”

As the purpose of this research is to develop an index and to find how costs, connectivity and risks have changed over the years, this research adopted the longitudinal studies in an effort to answer the question stated above.

#### **4.2.6 Data collection**

The final layer of the research onion addresses how the researcher collected data and how they were analysed. Data collection methods, according to M. Saunders et al. (2009), include:

- Sampling:
  - ✓ Probability sampling: each case is usually equally selected from the population or the change for each case to be selected is known. That technique is frequently used in survey and experimental research strategies.
  - ✓ Non-probability sampling: in this technique the probability of each selected case from the total population is unknown. Thus, a statistical conclusion for the population examined is impossible to be extracted.
- Use of secondary data:
  - ✓ Documentary:
    - Written materials: any type of data which have a written form.
    - Non-written materials: any type of audio visual data as well as organisations’ databases.
  - ✓ Multiple source:
    - Area-based: data that are compiled according to a geographical area studied.
    - Time-series based: data that are compiled for a selected variable in a depth of time.
  - ✓ Survey:

- Censuses: usually, participation in that survey is obligatory. Thus, the population examined is very well covered as usually the survey is carried out by governments.
  - Continuous and regular surveys: are surveys that are repeated over time, as their data collection takes place throughout the year.
  - *Ad hoc* surveys: surveys that take place in a specific subject and are one-off.
- Collection of primary data through:
    - ✓ Observation:
      - Participant observation: is qualitative and its purpose is to find out the meanings deriving from people's actions.
      - Structured observation: is quantitative and its focus is on the frequency of people's actions.
    - ✓ Interviews:
      - Structured interviews: questionnaires based on a predetermined and standardised set of questions. Structured interviews can be more frequently used for descriptive research purposes and less frequently in explanatory research.
      - Semi-structured interviews: the researcher has a list of themes and questions; these may vary from interview to interview. Semi-structured interviews can be used more frequently for explanatory research purposes and less frequently in exploratory research.
      - Unstructured interviews or 'in-depth' interviews: there is no need for a list of questions for this interview style; therefore, it is classified as an informal interview. Unstructured interviews can be used for exploratory research purposes.
    - ✓ Questionnaires:
      - Self-administered: internet and intranet questionnaires, postal questionnaires, delivery and collection questionnaires.
      - Interviewer-administered: telephone questionnaires, structured interviews.

The research does not deal with the analysis of data. The methods used for collection and confirmation of the data are discussed in detail in Section 4.10. The research used

both secondary data and primary data. The secondary data that reflect the values of factors over the years are yielded from various sources. In order to monitor the fluctuations of the factors over the years, time-series were chosen for this research. The primary data were generated with the help of in-depth interviews.

As it is understandable, every factor mentioned in the literature review section that affects maritime transport costs, connectivity and risks has a different validity, reflected by a weight. Thus, in order to award a 'weight' to every factor for the proposed index, in-depth face-to-face interviews were applied with the use of mind map. The weights were extracted through the Budget Allocation (BA) method as described in Section 4.8.

The methods used for the creation of the index at the research process are described thoroughly in the following sections. The next section demonstrates which methods were used to extract weights. Moreover, it examines which method could fit best this research.

### **4.3 Review of Methods Used in Maritime Transport Research for Weights Generation**

As explained in Section 2.8, maritime transport costs were measured with various methods. Various debates have emerged recently as the maritime transport costs have attracted more attention in the literature. At this stage of the research, an attempt is made to summarise the available methods that are relevant to the maritime transport sector and can be used to analyse and interpret the research data, as mentioned in Section 4.2.6. The researcher has conducted a review of the methods and techniques used from various academics to extract weights in the maritime transport sector. This took place so that the researcher could become familiar with the methods and techniques used for weights extraction and select the one that fits best this research effort. After that review, Table 0-7 (Appendix D) was generated to provide an overview of the methods and techniques used by various academics.

The methodology applied for measuring the impact of various factors on decision-making environments is the Multi-Criteria Decision-Making (MCDM) method. This is also used in the maritime transport sector to measure performance. As found from the review, the development of the MCDM method in transport management studies is broad but relatively recent (Castillo-Manzano et al. 2009). The MCDM methods used in the literature in relation to the maritime transport sector, include:



- Analytical Hierarchy Process (AHP) (Lirn et al. 2004),
- Promethee-GAIA (Guy and Urli 2006),
- Grey Relational Analysis (GRA) (Teng et al. 2004),
- Fuzzy Multi criteria Grade Classification model (FMGC) (W. Huang et al. 2003),
- Multi-Attribute Utility Theory (MAUT) (Lagoudis et al. 2006).

The most commonly-used MCDM method in recent maritime transport sector studies is the AHP (Lirn et al. 2004; Song and Yeo 2004; C. H. Ugboma et al. 2006). Another MCDM method used in maritime transport studies is the Promethee-GAIA method (Castillo-Manzano et al. 2009). However, the best method for capturing the insights from the maritime transport sector, according to Lagoudis et al. (2006), is the MAUT. The researchers have compared four techniques, used for evaluating the maritime transport sector, namely: 1) the MAUT method; 2) the AHP; 3) the Structural Equation Modelling (SEM); and 4) the regression analysis. Lagoudis et al. (2006) found that the MAUT theory yields the most considerable insights from the four techniques. To determine the ‘weight’ of the factors affecting their research, Lagoudis et al. (2006) selected focus groups (details of what a focus group is, are provided in Section 4.10.3) as the most efficient method of ranking factors.

Another way of assigning weights would be via the gravity model. However, the traditional gravity model is excluded from the research. After analysing the methods used in the maritime transport literature, the researcher concluded that they were not suitable for the creation of the proposed index, as they provide the opportunity to generate weights, but mainly for taking decisions. According to Castillo-Manzano et al. (2009), the MCDM method was chosen because is appropriate in contexts where someone has to make a decision and where that choice is based on viewpoints that are not always quantifiable (Castillo-Manzano et al. 2009).

Due to the fact that the purpose of the research is to generate an index, appropriate methods for the generation of weights were sourced from other studies (see Section 4.8). Through those methods, the researcher chose the most objective to create a pellucid index capturing maritime container transport costs, connectivity and risk for the UK. Before describing the weighting methods, some important steps to be considered prior

to weighting generation are outlined. These were taken to verify the premium quality of the index.

#### **4.4 Brainstorming**

In accordance with Nardo et al. (2005)<sup>9</sup>, the selection of indicators (factors) is the most important parameter that a researcher needs to consider when creating an index. The brainstorming method, combined with a mind map, generated a final list of carefully-selected factors used for the research. This list fulfils the second objective of this research, as specified in Section 1.4.2.

Brainstorming is a method introduced by Osborn (1957) for the improvement of a group idea generation. For this research, the brainstorming method was applied to combine and improve the meaning of factors affecting costs, connectivity and risk which were found in the literature. Nijstad et al. (1999) suggest that, in order to maximise the productivity of brainstorming sessions, these should include fewer than four experts, who should work without any time pressure. The use of the brainstorm method for this research enables the researcher to rationalise the number of factors, and to reduce the erroneous possibility of capturing the same meaning twice.

The brainstorm session was conducted in two stages: the first was the brainstorming of all the factors affecting cost, connectivity and risk for the maritime container transport sector by the researcher (individual brainstorming) with the knowledge acquired from the literature review. The second stage was the brainstorming of the results of stage one with two additional academics who were relevant to the research topic (group brainstorming). This combination of individual and group brainstorming is optimal for maximising the generation of ideas (Paulus et al. 2002). The group brainstorming was conducted with a mixed-gender group, to overcome the negatives that only males or only females have (Nijstad et al. 2004). The results of stages one and two produced a mind map (see Figure 4-2) that was used to extract the weights from the experts during the in-depth face-to-face interviews, as Table 4-4 in Section 4.9 illustrates. Mind maps are nonlinear graphical representations of information, in conformity with Millen et al. (1997). The creation of mind maps during brainstorming sessions was observed from some other studies; for example, in studies of C. S. Fuller et al. (2000), and Cristea and

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<sup>9</sup> Nardo et al (2005) tested normalisation, indicator (factor) selection, aggregation, weighting, expert selection and imputation for the Technology Achievement Index (TAI) and they came to a conclusion that the indicator (factor) selection, the weighting method and the choice of expert were the most important parameters that a study has to consider.

Okamoto (2001). What mind maps are and how they were used in this research is explained in Section 4.5.

#### **4.5 Mind Maps**

The use of mind maps to gather evidence is a relatively new phenomenon. They provide a useful and innovative way to communicate meaning and knowledge (Wheeldon and Faubert 2009). Furthermore, mind maps are flexible tools whereby a central governing concept is explored using groupings or areas (Wheeldon 2010). In other words, mind maps are a visual means of organising complex, non-linear thoughts and processes (Wheeldon and Faubert 2009); therefore, this simple tool is highly effective for this research. The initial mind map that was created after the literature review and the brainstorm session contained 20 first layer factors, as illustrated in Figure 4-2. These factors were clustered under the relevant subject cost, connectivity and risk. The final mind map used by the researcher to derive the importance of each factor through weights attributed from the various experts, participating in this research is illustrated in Figure 5-5. The initial mind map was partially different from the final mind map, due to suggestions and alterations regarding the factors composing the index proposed by experts. The fact that the initial mind map generated by the researcher had many commonalities with the final mind map indicates that the literature review was successful.

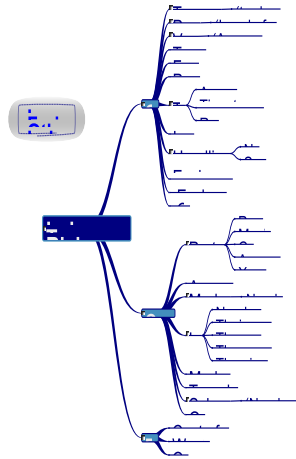


Figure 4-2 Mind map of the Index of Maritime Container Transport Costs, Connectivity and Risks for the UK

## 4.6 Sampling

Sampling of experts refers only to those used for the in-depth face-to-face interviews and the Delphi survey. The two focus groups were attended by participants invited from the CILT (Chartered Institute of Logistics and Transport) e-mailing list. Thus, the focus groups were composed entirely of transport experts.

Teddlie and Yu (2007) analysed numerous articles applying mixed methods methodology and found that many lacked detail of sampling. Sampling issues in academia are innately practical issues, as academics must take decisions based on theoretical concerns, but the theory has to meet the hard reality of time and resources (Tashakkori and Teddlie 2003). As a result, Curtis et al. (2000 p.1003) have created a 'checklist' for sampling, based on criteria set by Miles and Huberman (1994 p.33). This set of criteria for sampling includes:

- 1) The sampling strategy should be relevant to the conceptual framework and the research questions addressed by the research.
- 2) The sample should be likely to generate rich information on the type of phenomena which need to be studied.
- 3) The sample should enhance the 'generalisability' of the findings.
- 4) The sample should produce believable descriptions/explanations.
- 5) Is the sample strategy ethical?
- 6) Is the sampling plan feasible?

Sampling procedures that lie within the spectrum of social and behavioural sciences are often separated into two groups; probability and purposive, as stated by Tashakkori and Teddlie (2003), or probability and non-probability, in accordance with M. Saunders et al. (2009). These authors demonstrate and group together under the prism the available sampling techniques. For that reason, some minor differences are observed in the literature. An additional recent sampling technique is the mixed method sampling, where qualitative and quantitative sampling are combined (Teddlie and Yu 2007). The probability sampling technique can be found in the literature as: qualitative sampling, representative sampling, scientific sampling and random sampling; while the non-probability sampling can be found in the literature as: quantitative sampling, judgemental sampling, purposeful sampling and purposive sampling (Teddlie and Yu 2007; M. Saunders et al. 2009).

Sampling was used in Phase 1 and Phase 3b, where in-depth face-to-face interviews and a Delphi survey were conducted according to the research process discussed in Section 4.9. At both phases, only quantitative data were collected; therefore, the mixed method sampling was not applicable to this research. The views of M. Saunders et al. (2009) for sampling techniques classification were followed in this research. In accordance with M. Saunders et al. (2009), the most commonly used sampling techniques are the following:

- 1) Probability (or representative)
  - a. Simple random
  - b. Systematic
  - c. Stratified random
  - d. Cluster
    - i. Multistage.
- 2) Non-probability (or judgemental)
  - a. Quota
  - b. Purposive
    - i. Extreme case
    - ii. Heterogeneous
    - iii. Homogeneous
    - iv. Critical case
    - v. Typical case.
  - c. Snowball
  - d. Self-selection
  - e. Convenience.

The non-probability sampling group of techniques was selected, as the researcher tries to learn the most from the cases examined. That is a characteristic found only in non-probability sampling techniques, according to Teddlie and Yu (2007). As Teddlie and Yu (2007) demonstrate, the non-probability sampling techniques can provide focus on depth of information generated by the cases examined. That benefit has helped the researcher to understand everything for the topic examined, and provide the absolute inputs of the experts for this index, as the technique utilises the experts' judgements (Teddlie and Yu 2007).

From the aforementioned non-probability techniques, snowball sampling was selected for this research as it fulfils the checklist created by Curtis et al. (2000). The snowball

sampling technique was used in this research, but it has some drawbacks. The first, according to M. Saunders et al. (2009) is the difficulty that some researchers face for the initial contact. This is overcome with the assistance of the supervisory team, which provided initial contacts to the researcher. The researcher attended conferences related to the maritime container business (as demonstrated in Appendix E), and by sending various e-mails to industry people who were giving their contact details in public domain, was able to make a start and collect the desired sample for his research. The second, as M. Saunders et al. (2009) demonstrate, is that interviewees had to provide the researcher with contact details of other potential interviewees who would like to participate in the study. That drawback was overcome not only by the plethora of contact details obtained from the supervisory team, but also from the participation of the researcher in various conferences related to the research topic, where valuable contacts were established. As the maritime container industry is small and everyone knows each other, the researcher managed to find the sample for the research effort. However, this can be both positive and negative, as the maritime container industry is a very close community and not easily accessible. Consequently, a snowballing sampling technique was used, because it enables the researcher to make contact with the interviewee through someone they already know. Thus, making the interviewee feel comfortable sharing his ideas with the researcher.

Snowball sampling was used in this research for another reason, as it is a technique which is frequently used when the researcher faces difficulties identifying the members of the desired population (M. Saunders et al. 2009). As the container business is composed of a small number of people who are working 'secretly', the researcher followed the snowballing technique to assist in finding interviewees from all sectors of maritime container transportation. These were composed from the following groups:

- 1) Port operators
- 2) Freight forwarders
- 3) Shipping lines / agents
- 4) Government representatives / associations
- 5) Consultants
- 6) End-customers.

Figure 4-3 illustrates the percentages of participants in groups, as mentioned above. The interviewees had an in-depth face-to-face interview with the researcher and some wanted to fill the mind map used from this research.

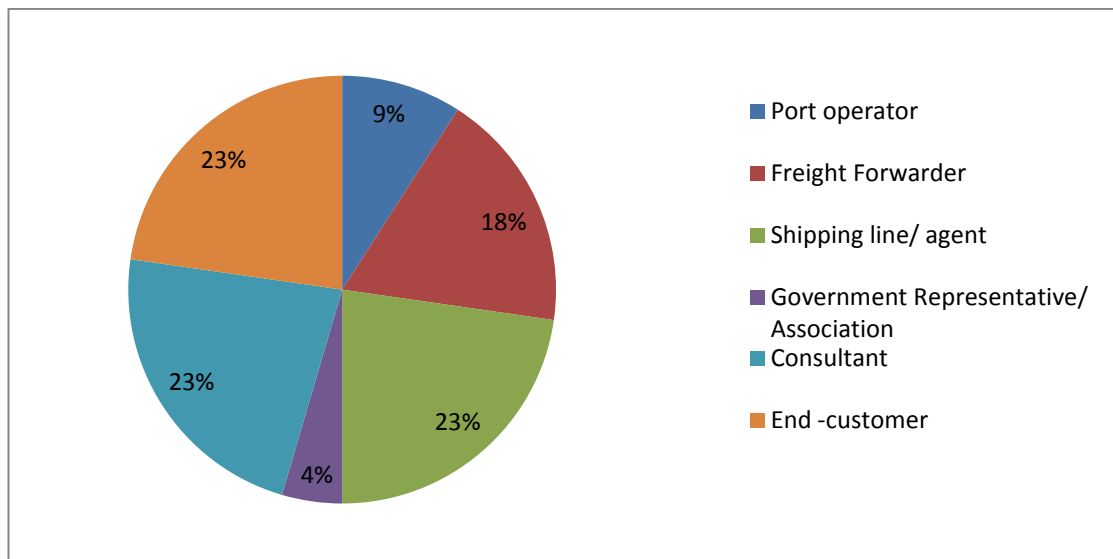


Figure 4-3 Percentages of different interviewee groups who had completed the mind map

The sample size for the non-probability sampling, in accordance with Teddlie and Yu (2007), is typically small (usually 30 cases or less). Twenty-two interviewees completed the mind map during a face-to-face interview, while six interviewees had a face-to-face interview without filling the mind map.

According to Glaser and Strauss (1967), the point at which the researcher stops gathering responses is the point when saturation will be achieved. They discuss the idea of theoretical saturation, whereby the marginal interview yielded little new information. According to Krueger and Casey (2000 p.26): “Saturation is a term used to describe the point when you have heard the range of ideas and are not getting new information”. This is the technique which was used to determine sample size of this research. As the researcher reached a point at which no additional information was produced from the interviews conducted and as he was close to the limit of 30 interviews or less, as stated by Teddlie and Yu (2007), the researcher stopped collecting data when 28 interviews had been conducted out of which 22 interviewees had completed the mind map. As Figure 4-3 illustrates, the sample size was almost equally distributed between the participating groups. Through such equal representation, the researcher wanted to verify the groups involved at the shipment of a container with the maritime mode participated



equally in this research and that their views did not supercede those of another group. Of course, the group, which includes the government representatives and associations, has the smallest representation in this research, as those deal with the maritime container movement in the UK are few. The same principle applies to the port operator group.

#### **4.7 Normalisation of Data**

Before providing further details of the normalisation method, the researcher wants to state the difference between the normalisation technique (or Min-Max normalisation) and the normalisation method. The normalisation technique exists under the normalisation method (OECD 2008). The normalisation technique is used in statistics for the transformation of data so they can fit into a normal distribution curve; therefore, parametric tests can be performed on the data (StatSoft 2011). This technique is explained further in this section, as Min-Max normalisation. The normalisation method is used prior to the aggregation of data when various data sets are considered from a study (OECD 2008). As indices (or composite indicators) are composed from various data sets that are expressed in different measurement units, normalisation is important before the aggregation of the data (OECD 2008). Therefore, normalisation of the data is important, as it helps the researchers not to sum apples with oranges.

According to the OECD (2008), the normalisation of factors for compiling an index is a method applied prior to data aggregation and weighting methods, since it is common for indices to be consisted of different metrics. Thus, factors should be normalised to render them comparable. Attention needs to be paid to extreme values as these may affect later steps in the process of creating a composite indicator. If any skewed data exist, they should be identified and accounted. Skewed data are not available for this research.

One example in which normalisation is essential and commonly used due to the nature of the data, is for environmental indices. In those indices, incommensurability is often a problem, as many variables are not comparable (Ebert and Welsch 2004). Therefore, the data are converted from their original units to 'standard' units and subsequently aggregated (Ebert and Welsch 2004). The logic behind data normalisation is that the crude data may differ in two dimensions: their range and units of measurement. These differences could cause abnormalities in the indices produced. Moreover, the weighting and aggregation methods applied would be useless since weights and aggregation techniques depend on the units measured (Ebert and Welsch 2004).

The OECD (2008) list a number of common methods used for normalising data sets:

- 1) *Ranking* scores accounts for outliers in a data set. Outliers can be a problem as they can contribute to misleading data analysis results. Using the ranking method allows the performance of countries to be followed over the time according to the position of the country's rank. In contrast, the performance of a country, in absolute terms, cannot be assessed as information on levels is lost.
- 2) *Z-scores* (or standardisation), adapts data to a common scale with a mean of zero and standard deviation of one. Factors with extreme values have a stronger effect on the composite indicator.
- 3) The *Min-Max* normalisation method standardises factors, by attributing them to a standard, arbitrary range [0, 1]. This method works by subtracting the minimum value and dividing it by the range of the factor value. Nevertheless, extreme values/or outliers could distort the altered factor.
- 4) *Distance to a reference measure*. This method calculates the comparative position of a given factor in relation to a reference point. The reference point could be the measurement of a factor in a specific time, usually called base year or baseline (Oakshott 2009). The base usually takes a value of 100 and, when the measurement increases, the value becomes greater than 100 (Oakshott 2009). The opposite occurs when the measurement decreases.
- 5) *Categorical scales* give a score to every factor. Categories can be numeric, such as: one, two or three stars, or semantic, such as: 'fully achieved', 'partly achieved' or 'not achieved'.
- 6) *Factors above or below the mean*. For this method, factors are standardised in relation to zero. Therefore, values around the mean receive zero, while those above/below certain threshold receive 1 and -1 respectively. This normalisation method is simple and unaffected by outliers. Conversely, this method is often criticised due to the arbitrary nature of the threshold level and the omission of absolute level of information.
- 7) *Cyclical indicators*. This method is used for the normalisation of time series. When indicators appear as time series, they could be normalised with the deduction of the mean over time, and then divide the mean of the absolute values of the difference from the mean.

- 8) *Balance of opinions* is a method by which managers of companies from a range of sizes and sectors, state their opinion of the performance of their company in comparison with the previous survey. The transformed indicator varies, by construction, between –100 (if all companies have reported a decline) and +100 (if all companies have demonstrated a development).
- 9) *Percentage of annual difference over consecutive years*. This method measures the percentage development of a factor, in comparison with the previous year instead of the absolute level. This method can only apply factors to time series data.

According to Ebert and Welsch (2004), the researcher should determine the best normalisation procedure for the research problem under two requirements: 1) to choose a normalisation procedure that fits the measurement units by which the indicator is expressed; and 2) the robustness of the normalisation procedure against the possible outliers in the data.

In addition to the list provided above, the OECD (2008) stresses that the normalisation method should consider the data properties and objectives of the index being developed. Scale adjustments and transformation of highly skewed factors may apply.

The normalisation method, which fulfils the aforementioned requirements and was applied in this research project uses; distance to a reference measure. The same method has been used from Xin (2000) to measure the China Container Freight Index. With this method, all the factors have a baseline year of 100 or 1000 (Xin 2000). In this research, the baseline is 100. Measuring the level and fluctuation of a factor can be achieved by comparing the value of the factor measured with the baseline period (Xin 2000). That approach of normalisation is similar to the Laspeyres', which is used to calculate simple weighted indices (Oakshott 2009). How to generate and sum weights are important parameters for the generation of an index, as explained thoroughly in Section 4.8.

#### **4.8 Weighting and Aggregation**

The OECD has produced a range of publications that summarises and compares the existing weighting methods for the development of indices (or composite indicators as mentioned in the literature); for example, the Handbook on Constructing Composite Indicators (OECD 2008). Such publications have been used by a variety of well-established institutions (e.g. Joint Research Institute) for indices creation. This research

examined the various methods used to generate weights in the maritime transport sector, as demonstrated in Section 4.3. However, the methods available from the OECD (2008) are the most suitable for this research, due to their use in generating indices.

The use of different weighting methods leads to different weights, in accordance with the OECD (2008). OECD (2008), with the use of Technology Achievement Index (TAI), demonstrates four different sets of weights, which have been calculated with the implementation of four different weighting methods: Equal Weighting (EW), Factor Analysis (FA), BA [or Budget Allocation Process] and AHP. The variation of weights, according to the weighting method applied, affects the ranking of the countries (OECD 2008). The same conclusion has been drawn by Hermans et al. (2008), who conducted a comparison between the five most important weighting methods namely: FA, AHP, BA, Data Envelopment Analysis (DEA) and EW. The treatment of the data from various European countries using the aforementioned methods revealed that differences in countries rankings exist due to the different weights generated from the five weighting methods. Therefore, it can be concluded from the two mentioned above studies (OECD 2008; Hermans et al. 2008) that every weighting method generates its own weights.

The generation of different results is not the only reason that leads this research to consider carefully the weighting methods applied. Two additional reasons arise from the studies conducted by Nardo et al. (2005) and Hermans et al. (2010). As Nardo et al. (2005) notes, the weighting method is the second most important parameter for the creation of an index. Moreover, Hermans et al. (2010) comment that, the generation of an index has to be the outcome of a cautious thought which supports the fact that valuable insights can be gained only from well constructed index.

There is plethora of weighting methods that could be applied to generate weights, as outlined in Section 4.3. There is no single method that performs better than another; there is only a method that best fits the index being developed (OECD 2008).

Consequently, there is a lot of criticism of the methods used for weights generation or aggregation; however, in line with Haq (1995), such criticism is borne of academic puritanism. Haq (1995) suggests that puritans have to accept that an index will not be able to capture 100 percent the topic it tries to measure; compromises have to be made. As Haq (1995 p.59), the pioneer for the development of the Human Development Index, demonstrates: "For any useful policy index, some compromises must be made. But such compromises must not sacrifice the professional integrity of the broad picture that the

composite index intends to convey”. For all the aforementioned reasons, the most commonly used weighting methods were reviewed herein, to choose the one which best fits this study.

Table 4-2 outlines some of the methods recommended by the OECD (2008) for weighting data; the advantages and the disadvantages of each method are also provided. The compatibility of some weighting methods and some aggregation methods are presented in Table 4-3.

The weights comprising an index can be segmented into three categories, according to the JRC (2011):

*Equal weights (EW)*. This category assigns equal weight to every factor, which means that every factor in the model has the same importance.

*Weights based on statistical models (Weights which reflect the statistical quality of the data)*. This category gives higher weights to statistical data which have high reliability and broad coverage; while on the other hand, it allocates lower weights to statistical data with measurement and identification problems.

*Weights based on public/expert opinion (Weights which fluctuate according to the importance of each factor)*. This category allows either statistical or participatory methods to be assigned weights to each factor. The participatory method gathers, experts’ opinion who can ‘subsidise’ (or reduce) the impact which factors composing the model can have on the model itself. Given the above discussion, weights were extracted by experts’ opinion for this research. This technique was chosen as it constitutes the common way for weights application in almost all the indices of the maritime transport industry, as it has been found in the exploratory part of the research.

The literature provides a substantial number of weighting methods. There is no right or wrong method; all have positive and negative attributes, as it was outlined in Table 4-2. The existing weighting methods can be segmented according to the model used to generate their weights. The weighting methods considered in this research are those detailed in Table 4-2 and Table 4-3. As some of those demonstrated in Section 4.3 are not suitable for the generation of weights for indices, this research excludes some categories in accordance with their characteristics.

<u>Advantages</u>	<u>Disadvantages</u>
<b>Benefit of the doubt (BOD)</b>	
<ol style="list-style-type: none"> <li>1) The factor is sensitive to national policy priorities, in that the weights are endogenously determined by the observed performances (this is a useful second best approach whenever the best – full information about true policy priorities – cannot be attained).</li> <li>2) The benchmark is not based upon theoretical bounds, but on a linear combination of observed best performances.</li> <li>3) Useful in policy arena, since policy makers could not complain about unfair weighting: any other weighting scheme would have generated lower composite scores.</li> <li>4) Such an index could be “incentive generating” rather than “punishing” the countries lagging behind.</li> <li>5) Weights, by revealing information about the policy priorities, may help to define trade-offs, overcoming the difficulties of linear aggregations.</li> </ol>	<ol style="list-style-type: none"> <li>1) Without imposing constraints on weights (except non-negativity) it is likely to have many of the countries with a composite indicator (index) score equal to 1 (many countries on the frontier).</li> <li>2) It may happen that there exists a multiplicity of solutions making the optimal set of weights undetermined (this is likely to happen when CI=1).</li> <li>3) The index is likely to reward the status quo, since for each country the maximisation problem gives higher weights to higher scores.</li> <li>4) The best performer (that with a composite equal to one) will not see its progress reflected in the composite (which will remain stacked to 1). This can be solved by imposing an external benchmark.</li> </ol>
<b>Unobserved Components Models (UCM)</b>	
<ol style="list-style-type: none"> <li>1) Weights do not depend on ad hoc restrictions.</li> </ol>	<ol style="list-style-type: none"> <li>1) Reliability and robustness of results depend on the availability of sufficient data.</li> <li>2) With highly correlated individual factors there could be identification problems.</li> <li>3) Rewards the absence of outliers, given that weights are a decreasing function of the variance of individual factors.</li> <li>4) If each country has a different number of individual factors; weights are country-specific.</li> </ol>
<b>Budget Allocation (BA) or [Budget Allocation Processes]</b>	
<ol style="list-style-type: none"> <li>1) Weighting is based on expert opinion and not on technical manipulations.</li> <li>2) Expert opinion is likely to increase the legitimacy of the composite and to create a forum of discussion in which to form a consensus for policy action.</li> </ol>	<ol style="list-style-type: none"> <li>1) Weighting reliability. Weights could reflect specific local conditions (e.g. in environmental problems), so expert weighting may not be transferable from one area to another.</li> <li>2) Allocating a certain budget over a too large number of indicators may lead to serious cognitive stress for the experts, as it implies circular thinking. The method is likely to produce inconsistencies for a number of</li> </ol>

	<p>indicators higher than 10.</p> <p>3) Weighting may not measure the importance of each individual factor but rather the urgency or need for political intervention in the dimension of the individual factor concerned (e. g. more weight on Ozone emissions if the expert feels that not enough has been done to tackle them).</p>
<b>Public Opinion</b>	
<p>1) Deals with issues on the public agenda.</p> <p>2) Allows all stakeholders to express their preference and creates a consensus for policy action.</p>	<p>1) Applies the measurement of ‘concern’ (see previous discussion on the Budget Allocation).</p> <p>2) Could produce inconsistencies when dealing with a high number of factors (see previous discussion on the Budget Allocation).</p>
<b>Analytic Hierarchy Process (AHP)</b>	
<p>1) Can be used both for qualitative and quantitative data.</p> <p>2) Transparency of the composite is higher.</p> <p>3) Weighting is based on expert opinion and not on technical manipulations.</p> <p>4) Expert opinion is likely to increase the legitimacy of the composite and to create a forum of discussion in which to form a consensus for policy action.</p> <p>5) Provides a measure of the inconsistency in respondents’ replies.</p>	<p>1) Requires a high number of pair-wise comparisons and thus can be computationally costly.</p> <p>2) Results depend on the set of evaluators chosen and the setting of the experiment.</p>
<b>Conjoint Analysis (CA)</b>	
<p>1) Weights represent trade-offs across factors.</p> <p>2) Takes into account the socio-political context and the values of respondents.</p>	<p>1) Needs a pre-specified utility function and applies compensability.</p> <p>2) Depends on the sample of respondents chosen and on how questions are framed.</p> <p>3) Requires a large sample of respondents and each respondent may be required to express a large number of preferences.</p> <p>4) Estimation process is rather complex.</p>

Table 4-2 Advantages and disadvantages of different weighting methods

Source: OECD (2008 p.102)

The equal weights method is not used for this research; in accordance with Hermans et al. (2008), it is a very simple technique from a scientific perspective. The main weakness of this method is that policy makers cannot gain any insights into the importance of each indicator used for the composition of the index. The use of the equal weights methods implies another weakness in, accordance with Freudenberg (2003), which is the creation of double or triple weighting by two or three indicators (correspondingly) measuring the same factor. Another example of criticising the use of equal weightings for generating an index derives from engineering. Sai On Cheung et al. (2003) generated an index to measure the performance of partnering projects with the application of equal weighting method. This index has been criticised by Yeung et al. (2009) for subjectivity due to lack of scientific and objective resolution methods. Yeung et al. (2009) propose the use of weights for the development of an index.

The second category for weights generation was not considered by this research because the weights were not generated from statistical data. One of the main acceptances of the research is that the index must be created as others that already exist in the maritime transport sector. The literature review and content analysis (see Section 3.3) revealed that indices used in the maritime transport sector are calculating their weights through experts' opinions.

Consequently, this research applies the third category for weights generation, which is public/expert opinion. Within this category, the research tries to find the most suitable weighting technique. According to the OECD (2008), the most commonly used techniques existing for weights generation in public/expert opinion category are the following: the BA, the Public Opinion, the AHP and CA approach.

From the aforementioned techniques, the BA approach was applied in this research. This approach provides the experts with a 'budget' of  $N$  points. The experts are then asked to distribute the points over a number of factors. The factors perceived as being of high importance will be awarded more points. It should be noted that the BA is optimal for a maximum of 10-12 factors (OECD 2008); however, this research examined 20 first layer factors, with the application of in-depth face-to-face interviews. During the interviews, a mind map was used, composed of all the factors (illustrated in Figure 4-2). Therefore, the BA was applied by asking the participants (industry experts) to allocate the  $N$  points after separating the index into three main parts (cost, connectivity and risk). Participants were asked to allocate  $N$  points between 11 cost factors, seven connectivity



factors and two risk first layer factors. Factors that consisted of sub-factors, such as ‘handling and clearing charges’, which, in turn, consist of the sub-factors: normal and surcharges, received an extra assessment from the participants. Participants assessed the sub-factors with a new set of  $N$  points. The separation of the index into three parts (cost, connectivity and risk) and then subsequent sub-factors, overcame the disadvantage of the BA approach. The disadvantage was that the experts were confused by the large number of factors they had to allocate to the  $N$  points.

Aggregation is defined by the OECD as “...the combination of related categories, usually within a common branch of a hierarchy, to provide information at a broader level to that at which detailed observations are taken” (OECD 2012). Variation exists between aggregation methods. Table 4-3 shows that not all aggregation methods are appropriate to use with all weighting methods. As a consequence, the BA method works with all three aggregation methods without any limitations.

Weighting methods	Aggregation methods		
	Linear <sup>4</sup>	Geometric <sup>4</sup>	Multi-criteria
EW	Yes	Yes	Yes
PCA / FA	Yes	Yes	Yes
BOD	Yes <sup>1</sup>	No <sup>2</sup>	No <sup>2</sup>
UCM	Yes	No <sup>2</sup>	No <sup>2</sup>
BA	Yes	Yes	Yes
AHP	Yes	Yes	No <sup>3</sup>
CA	Yes	Yes	No <sup>3</sup>

Notes:

- 1) Standardised with the Min-Max method.
- 2) BOD requires additive aggregation, similar arguments apply to UCM.
- 3) At least with the multi-criteria methods requiring weights as importance coefficients.
- 4) With both linear and geometric aggregations weights are trade-offs and not “importance” coefficients.

Table 4-3 Compatibility between aggregation and weighting methods

Source: OECD (2008)

The linear aggregation method is suitable when all factors have a common measurement unit, only under the consideration that some mathematical properties are respected.

Geometric aggregation suits a situation when a degree of non-compensation is desired between factors or dimensions. Additionally, linear aggregations recompense factors according to the weights, while geometric aggregations recompense simultaneously those countries with higher scores. Linear and geometric aggregation have trade-offs

between factors. Therefore, a shortage in one dimension can be recompensed from the excess in another.

In linear aggregation, the compensability is constant, while for geometric aggregation compensability is lower for the factors with low values. That means that a country with low scores in one factor will need a much higher score in the other to improve its situation when geometric aggregation is used. Of course, an improvement with a low absolute score factor could have larger impact in comparison with the improvement of a high absolute score factor if it was aggregated geometrically. That would encourage the countries to improve their sectors/activities/alternatives with a low absolute score, as they could improve their position in the ranking (Munda and Nardo 2005).

Another aggregation method used when non-compensability could apply between two factors is the non-compensatory Multi-Criteria Approach (MCA). This method is used when a factor (e.g. economic performance) cannot compensate for the loss of another factor (e.g. social cohesion).

With regard to the time element, weights could remain stable over time according to the will of the researcher to analyse the evolution of the factors (and their impact on the model). If a researcher wants to apply MCA, weights do not change. However, if the researcher wants to define the best practice or of setting priorities, weights should be modified over time.

The linear aggregation method is followed in this research for two reasons. The first is that the industry covered by the proposed index has been changing drastically over recent years (e.g. the freight rates fluctuation and the market consolidation). Therefore, the weights of the index have to be reviewed every five to 10 years. The time period for the review has been agreed by the industry experts participating in the research; for example, every five to 10 years [for instance, the same time period is used for evaluating the weights of the Consumer Price Index (Stutely 2010 p.219)]. The time period will be influenced by future changes in the industry in subsequent years. For that reason, experts were not able to address the precise time when the review will have to take place. The capture of the weights over the years will provide an idea of the 'dynamics' which the factors have and how they change over the years according to the industry experts. The second reason is that the index aims to capture the 'pure'

improvements (or worsening) of the factors composing the index; as described above, only the liner aggregation method can provide that.

The absence of an 'objective' way to establish weight and aggregation methods should not lead to the outcome that indices should be rejected due to lack legitimacy. In order to support the legitimacy of the indices, the whole process should be transparent and the research objectives must be clearly stated. Of course, the model needs to be tested to determine if it is a good fit to the data (OECD 2008).

In conclusion, factors that compile the proposed index should be aggregated and weighted in conformity with the underlying theoretical framework. After analysing the normalisation, weighting and aggregation methods, which are available in the literature, a detailed overview of the research plan for the development of an index for maritime transport costs, connectivity and risk for the UK is provided in the following section.

#### **4.9 The Research Process**

The process followed for this research combines the methods and techniques which fit best with the research aims and objectives. Of course, the outcomes were evaluated constantly by the experts to verify their correctness. De Langen et al. (2012) use a similar approach in their research, which tries to make long-term projections of the port throughputs by combining the views of industry experts with the findings of their calculations. Yeung et al. (2009) have developed an index, the Partnering Performance Index (PPI), which could be used in partnering projects for monitoring and benchmarking purposes. For the development of that index, Yeung et al. (2009) have utilised the following methods: 1) literature review; 2) content analysis; 3) face-to-face interviews with field experts; 4) Delphi survey; 5) empirical questionnaire survey; and 6) Fuzzy Set Theory. The empirical questionnaire survey and the Fuzzy Set Theory was used as the quantitative indicators used in their index were fuzzy in nature. This is a characteristic that requires the assessor's subjective value judgement. This research followed the same pattern, but replaced the empirical questionnaire survey and the Fuzzy Set Theory with two focus groups and an in-depth face-to-face interview. The focus groups were applied before and after the Delphi survey, while an in-depth face-to-face interview was conducted after the second focus group. The two methods used by Yeung et al. (2009) were excluded, as the indicators captured from this research are not fuzzy in nature. The first focus group was conducted with the help of academics who evaluated the outcome of the in-depth face-to-face interviews. The second focus group

was conducted with a mixture of industry and academic experts, who assessed the outcomes of the modified Delphi survey. The face-to-face interview was conducted with an academic expert on the field of risk, who had evaluated the risk factors and sources of the index. As found in the literature, the modified Delphi survey and the focus group technique can be combined for the extraction of consensus from industry experts (Keeney et al. 2011). With the consensus of the experts, this research effort achieved the confirmation of the weights, the factors captured by the index, the overall index and the sources used for its creation. That confirmation achieved to verify two of the three most important parameters for the generation of an index. According to Nardo et al. (2005), these are the factors selection, the weighting method and the choice of experts. The last factor choice of experts was justified in Section 4.6. A summary of the methods used, participants involved in each method and the time frame which each method was used is demonstrated in Table 4-4.

Having provided a theoretical discussion and justification of research methods and philosophy, a detailed plan of the research process is now given. As demonstrated in Table 4-4, this research is separated into three phases.

<b>Phase</b>	<b>Title</b>	<b>Method</b>	<b>Participants</b>	<b>Time Frame</b>
1	Exploratory	Interviewing	26	July 2011- February 2012
2	Calibration	Calibration	N/A	November 2011- December 2012
3a	Validation	Focus Group	15	25 November 2011
3b	Validation	Delphi survey	11	June 2012- September 2012
3c	Validation	Focus Group	17	12 September 2012
3d	Validation	Interviewing	1	5 December 2012

Table 4-4 Summary of the research phases

To summarise and explain briefly Table 4-4, an extensive literature review was conducted of the factors affecting costs, connectivity and risks for the UK maritime container sector. Additionally, a content analysis was conducted, supplemented by a comprehensive literature review of the indices existing in the maritime transport sector. The aforementioned actions in Phase 1 comprised the exploratory part of the research. The data for Phase 1 were collected via in-depth, face-to-face interviews with the industry experts. More details on how the in-depth face-to-face interviews were conducted are provided in Section 4.10.1. The in-depth face-to-face interviews were

centred on a mind map (Figure 4-2) that the researcher constructed after refining the factors affecting maritime container transport costs, connectivity and risk with the use of brainstorm sessions. The mind map helped the researcher to collect the weights of each factor according to its importance with the BA method, as described in Section 4.8.

Following this exploratory part, the confirmatory part of the research starts with the second phase of data collection. In that phase, the researcher, with the use of secondary data, generated the proposed index; that is, the quantitative part of the research effort. The index was developed with the combination of the weights (primary data), as delivered by industry and academic experts for each factor, and the actual measurements of the factors tracked over the period examined (secondary data). The period considered the baseline for the index generated is the first quarter of 2010, which was the starting period for this research.

Before launching the index in the UK market, the researcher applied four validation phases to test the findings. These verified that what was developed by the researcher concurred with the experts' expectations.

Prior to Phase 3b of the research, in which industry experts validated the proposed index with the use of Delphi survey, a focus group took place (Phase 3a). With the help of the focus group, the researcher was able to test the findings of the in-depth face-to-face interviews with academic experts during the Seamless and Inclusive Monthly Seminar which was organised by Transport Newcastle. The seminar was held at Newcastle University on the 25<sup>th</sup> of November 2011 and academics were invited through the CILT email list. The experts were able to comment on findings demonstrated by the researcher during a presentation entitled: Development of an Index for Maritime Container Transport Costs, Connectivity and Risk for the UK. The insights of the academic experts helped the researcher to refine the mind map and the interview guide used in Phase 3b. Information regarding the focus groups conducted in this research effort is outlined in Section 4.10.3.

Phase 3b used the Delphi survey to validate the factors composing the index, their weights, the overall index and its sources. How the Delphi survey was conducted and its results are demonstrated in Sections 4.10.2 and 5.3 respectively.

After the confirmation of the index with the Delphi survey, a similar procedure to Phase 3b was implemented. The second verification using a focus group was the Phase 3c of

the research, which took place on the 12<sup>th</sup> of September 2012 during the Low Carbon Shipping Conference. A detailed description of the focus group conducted in this research is provided in Section 4.10.3.

The final validation phase (Phase 3d) was conducted on the 5<sup>th</sup> of December 2012. Here, an in-depth face-to-face interview was conducted with an academic expert. The participant is an expert in the field of risk in the maritime sector and has assessed all the risk sources and risk factors captured by the index. The expert was pleased with the sources used for capturing the risk factors and proposed some alterations to the lay-out of risk factors.

The validation of the index through four different stages verifies the success of the index, which was confirmed by the participating experts. That success allows the researcher to launch the index in the UK market.

#### **4.10 Primary Data Collection Methods Used for this Research**

In this section, the methods used for the collection of primary data are outlined. The data are quantitative, but they were collected using the following qualitative methods: in-depth face-to-face interviews, Delphi survey and focus groups. These three methods are demonstrated thoroughly, as it is important to justify and establish the methods used in collecting and analysing the data for a research (Collis and Hussey 2009).

##### ***4.10.1 In-depth interviews (face-to-face)***

Interviews, as stated by Collis and Hussey (2009), is a method for collecting primary data whereby a sample of interviewees are asked questions to find out what they think, do or feel. Interviews can lie between positivist and interpretivist paradigms, depending on the design of the interview, if it is structured or unstructured (Collis and Hussey 2009). There are various interview styles that can be adopted; however, the distinction between styles may be blurred in practice (Broom 2005). They involve different types of preparation, conceptualisation and instrumentation. Each approach has its strengths and weaknesses, and each serves a somewhat different purpose (Patton 2002).

Interviews can be categorised according to their typology to standardised and non-standardised interviews (M. Saunders et al. 2009). This research uses the non-standardised interview style for data collection. That style is segmented as demonstrated below:

- Non-standardised interviews:
  - ✓ One-to-one
    - Face-to-face interviews
    - Telephone interviews
    - Internet and intranet-mediated (electronic interviews)
  - ✓ One-to-many
    - Group interviews: focus groups
    - Internet and intranet-mediated (electronic) group interviews: focus groups.

The non-standardised interviews, according to King (2004), are “qualitative research interviews”. These are used not only to reveal and understand ‘how’ and ‘what’ something has been done, but also to emphasise ‘why’ something has been done (M. Saunders et al. 2009).

Specifically, in-depth face-to-face interviews were chosen as a data collection method for this research because they are useful for extracting the maximum amount of information from both the interviewee and interviewer. Interview dialogue can also probe for responses when more information is needed on particular issues (Patton 2002).

An in-depth interview approach involves outlining with each respondent the basic set of issues to be explored before the interview begins. To achieve that aim, the researcher uses a guide, which, according to Patton (2002), serves as a basic checklist to help the interviewer ensure that all relevant topics are covered.

An in-depth face-to-face interview has a flexible style that helps the researcher to conduct an open dialogue extending beyond the basic parameters set by the interview guide, where the researcher lists the themes and potential questions to ask the interviewee (Bryman 2001). The in-depth face-to-face interviews for this research were conducted with the help of a mind map.

The in-depth face-to-face interviews were chosen for this research for an additional reason, which is the capture of the assessment of the critical elements of good logistics by operators on the ground, as The World Bank suggests in its report *Connecting to Compete* (Arvis et al. 2012). That element is important for someone who wants to develop a measurement for the broad logistic sector, as those are multi-dimensional and are composed from many critical elements, such as process transparency, predictability,

reliability and service quality, which cannot be assessed using only time and cost information (Arvis et al. 2012).

Selecting a sample size for qualitative research is a challenge. While there are numerous sampling strategies available, such as convenience sampling and theoretical sampling, Glaser and Strauss (1967) discuss the idea of theoretical saturation whereby the marginal interview yielded little new information. As stated by Krueger and Casey (2000 p.26): “Saturation is a term used to describe the point when you have heard the range of ideas and are not getting new information”. This is the technique used to determine sample size for the Phase 1 of the research, as demonstrated in Section 4.6.

The in-depth face-to-face interviews were used in Phases 1 and 3d of the research.

#### ***4.10.2 Delphi survey***

##### *General information for Delphi survey*

Delphi was the name of a hallowed site of the most revered oracle in ancient Greece, where Oracles (people through whom a deity was believed to speak) met, held discussions, and gave wise or authoritative decisions or opinions. The modern day Delphi survey was first applied to a strategic planning exercise sponsored by the USA Air Force around 1953 (Dalkey and Helmer 1963). The original design of the Delphi survey was as “a method used to obtain the most reliable consensus of opinion of a group of experts... by a series of intensive questionnaires interspersed with controlled opinion feedback” (Dalkey and Helmer 1963 p.458). Of course, over the years, the usage of the method increased and some modified forms now exist, including: the ‘classical’ (Dalkey and Helmer 1963), the ‘decision Delphi’ (Rauch 1979), the ‘modified Delphi’ (McKenna 1994), the ‘policy Delphi’ (Crisp et al. 1997) and the ‘real-time Delphi’ (Beretta 1996). Keeney (2010) had found 10 main categories of Delphi survey exist, while Mullen (2003) states there are 23 different types of Delphi survey. Table 4-5 demonstrates the characteristics of 10 Delphi surveys as described by Hasson and Keeney (2011).

##### *What is the Delphi survey?*

Delphi survey is a method used to reach consensus amongst the industry experts (Hasson et al. 2000). However, as Hasson and Keeney (2011) demonstrate, not all Delphi surveys could lead to the achievement of a consensus. One example of this is the



policy Delphi that aims to support decisions by structuring and discussing the various existing views for the 'preferred future' (Turoff 1970).

Two of the most popular definitions of the Delphi survey are quoted, to deliver a better understanding of the method. "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone and Turoff 1975 p.3). While Turoff (1970 p.149) states the Delphi survey is: "A method for the systematic solicitation and collation of informed judgements on a particular topic".

From these definitions, it is concluded that the Delphi survey is able to create communication channels between a group of individuals, which solely are able to give an informed response in a specific topic. That response is structured to makes it seem to be a holistic response from the group participating in the research. The facilitator controls the interactions between the participants and he/she is also responsible for the information flow and the filtering of materials relevant to the individuals (Tan et al. 2010).

#### *Why was the Delphi survey chosen?*

The Delphi survey was chosen to gain consensus and collect feedback from the panellists participating in the research. Many methods exist in the literature that are able to achieve consensus and feedback. These can be segmented into informal and formal methods. The informal methods include focus groups, interviews and unstructured group discussion (Jones and Hunter 1995). While formal methods include the nominal group technique, the consensus development conference (Vella et al. 2000) and Delphi survey (Campbell et al. 2000). As Ambrosiadou and Goulis (1999) demonstrate in their research, the most valuable method in situations where there is no optimum standard to measure against, is the Delphi survey. As the development of an index for the maritime container transport sector is a novel idea, thus the Delphi survey was selected for this research.

Another reason for selecting the Delphi survey was due to its application to a wide range of studies, and its ability to generate consensus. One example is the maritime studies (those are described detailed below), while another example where the Delphi survey is used is in marketing. In marketing, Delphi survey has been used to generate consensus for forecasts of the economy and the industry. Such forecasts are generated

with the occasional invitation of a special group of experts, who give their individual estimations and assumptions. These are revised by a company analyst, reconsidered and followed by further rounds of estimation (Kotler et al. 2005).

Some researchers criticise the use of the Delphi survey as being the last refuge for some researchers when they cannot deploy any other scientific method (Linstone 1978). In this research effort, the Delphi survey was chosen for two reasons, which negate the above statement.

The first is that it has the ability to be combined with other methods and techniques. Various examples in which the Delphi survey is combined exist, namely: Banwell et al. (2005) where in-depth, (semi structured) interviews had been used to provide a more detailed description on the subject studied and then modified Delphi survey was used to achieve consensus among the experts. Yu Tien Cheng et al. (2011) integrate the experts opinions from the Delphi survey questionnaires, to generate a mind map of KPIs. Brender et al. (2006) also used the Delphi survey to generate a mind map. The mind map has been updated again during a conference with the use of Delphi survey. The research conducted by Yeung et al. (2009) has employed the Delphi survey for the generation of a PPI as mentioned in Section 4.9. That index has been developed for measuring, monitoring, improving, and benchmarking the partnering performance of construction projects in Hong Kong. The methods and techniques followed by Yeung et al. (2009) follow a similar line as those followed in this research effort. The aforementioned examples are in line with the advice given by Linstone (1978) that the potential user of the Delphi survey “suit the method to the problem, not the problem to the method” (Linstone 1978 p.275).

The second reason was that the Delphi survey overlaps both quantitative and qualitative ideals, as demonstrated by Hasson and Keeney (2011). That characteristic makes it paramount for this study, which uses a mixed method approach. At the design of the questionnaire, as it is demonstrated below, the researcher was able to ask both qualitative and quantitative questions for the index validation.

As the development of an index for the maritime transport sector is a novel approach, the Delphi survey was chosen, as it can be applied in areas where no real knowledge or understanding exists (Brett and Roe 2010). As mentioned before, various Delphi

surveys exists; therefore, a profound review of the maritime transport academic literature revealed studies that used Delphi survey and their characteristics.

### *Delphi survey in maritime studies*

Various researches from the spectrum of the maritime transport use the Delphi survey [see Saldanha and Gray (2002), Cetin and Cerit (2010) and Brett and Roe (2010)].

Saldanha and Gray (2002) used 11 panellists to conduct their two-round Delphi survey. The Delphi survey demonstrated that the participants had a willingness to support multimodal developments. The most important development unveiled was the cooperation between coastal shipping and road haulage.

Cetin and Cerit (2010) conducted another study in which the Delphi survey had been completed by eight experts over two-rounds. The main aim of the research was achieved with the combination of a qualitative analysis of industry experts' opinions and the Delphi survey. The qualitative analysis of the industry experts' opinion included e-mail, fax and face-to-face interviewing. The two-round Delphi survey was applied to the Turkish port business and management experts, in order to share their comments and opinions on the concept of port effectiveness.

A structured approach was followed by Brett and Roe (2010) in their three-round Delphi survey, which was used to reach a consensus amongst a panel of 37 experts. The experts were relevant to the Irish maritime transport sector. The consensus proved that a potential exists for the development of a small maritime cluster in the Dublin area. The structured approach kept the size of the Delphi survey in a reasonable size. That size can minimise the dropout rates which are mainly caused by extensive questionnaires and the repetitive nature of the Delphi survey (Brett and Roe 2010).

From the aforementioned researches, it is concluded that, in the maritime transport sector, a small number of industry experts participate in Delphi surveys. This is due largely to the fact that the experts in that field are few in number (Cetin and Cerit 2010). The rounds of the Delphi survey range between two and three and the types used are the 'classical' Delphi survey and the 'modified' Delphi survey. This research follows the modified Delphi survey approach, as it can combine face-to-face interviews, two focus groups and the Delphi survey. The latter two have been used in order to validate the weights, the factors, the sources and the data composing the index, while the prior has been used to generate them and validate the sources and the factors. The following

section demonstrates the advantages of the modified Delphi survey type chosen for this research.

#### *Choice of the modified Delphi survey type*

Due to the various types of Delphi survey available, some studies have raised the fact that more research is needed to enhancing rigour of the Delphi survey. One example where critic for the method is demonstrated is in the study conducted by Hasson and Keeney (2011). Van Zolingen and Klaassen (2003 p.329) have created the following guidelines to ensure the reliability of the Delphi survey:

- Applicability of the method to a specific problem
- Selection of respondents and their expertise (the panel)
- Design and administration of the questionnaire
- Feedback
- Consensus
- Group meeting.

The above guidelines are in line with the following four explicit characteristics of Delphi survey which are usually the same, regardless the procedure which the research follows (Rowe and Wright 2001 p.126):

- Anonymity
- Iteration
- Controlled feedback
- Statistical 'group response'.

As mentioned before and demonstrated in Table 4-5 which summarises the characteristics which some Delphi survey types have, various types of Delphi survey exist. The Delphi survey type that fulfils the guidelines and characteristics set by Rowe and Wright (2001) and Van Zolingen and Klaassen (2003) and is the most relevant method for this research is the modified Delphi survey. This method allows, for example, the combination of a systematic review and interviews to develop the first round of the Delphi survey (Hasson and Keeney 2011). According to Keeney et al. (2011), the modification takes place usually by replacing the first round with face-to-

face interviews or focus groups. As a result, the use of less than three rounds usually takes place (Keeney et al. 2011). The Delphi survey can lead the industry experts in a consensus. That consensus creates the validation of the index developed. The final reason why modified Delphi survey was chosen is because it enables the researcher to conduct face-to-face interviews and focus groups in the first round. By using the face-to-face interviews, the relationship between the interviewee and the interviewer increases. That creates a possibility of continuing commitment of the participant with the research (Keeney 2010). That commitment has yielded a 100 percent response rate in some studies. It also provides participants with a better understanding of their role in the research, what is asked from them and the nature of the research (Keeney 2010). Additionally, the focus group has refined the findings of the in-depth face-to-face interviews and delivered outcomes that were tested with the help of the modified Delphi survey. To summarise the benefits from the use of the modified Delphi survey:

- Usually an improved response rate is observed (Keeney 2010)
- Provides solid knowledge in work which has been developed previously (Tan et al. 2010)
- Saves time, as fewer rounds are required for the completion of the Delphi survey in comparison with the typical (Keeney et al. 2011). Of course, the overall time needed with the combined technique is more. For example, this research has used the method in combination with in-depth face-to-face interviews and a focus group, which were more time consuming than a first round of the typical Delphi survey.

#### Choice of the sample

As Gordon (2012) notes, the key to conducting a successful Delphi survey lies in the participant selection. Each participant is an expert in the area where the researcher has its research interest (Keeney et al. 2011). The title experts is related to “a panel of informed individuals”, as defined by McKenna (1994 p.1221). Thus, studies using the Delphi survey should use only individuals with knowledge of the topic investigated. For that reason the population which is approached for the Delphi survey should come after consideration (Keeney et al. 2011). As the researcher has to ‘employ’ only experts for the research, a small number were used, as not many experts exist in the field. An example of a research conducted with a small number of experts participating is the research conducted by Cetin and Cerit (2010), where only eight experts were employed.

<u>Design type</u>	<u>Aim</u>	<u>Target panellists</u>	<u>Administration</u>	<u>Number of rounds</u>	<u>Round 1 design</u>
Classical	To elicit opinion and gain consensus	Experts selected based on aims of research	Traditionally postal	Employs three or more rounds	Open qualitative first round, to allow panellists to record responses
Modified	Aim varies according to project design, from predicting future events to achieving consensus	Experts selected based on aims of research	Varies, postal, online etc.	May employ fewer than 3 rounds	Panellists provided with pre-selected items, drawn from various sources, within which they are asked to consider their responses
Decision	To structure decision-making and create the future in reality rather than predicting it	Decision makers, selected according to hierarchical position and level of expertise	Varies	Varies	Can adopt similar process to classical Delphi
Policy	To generate opposing views on policy and potential resolutions.	Policy makers selected to obtain divergent opinions	Can adopt a number of formats including bringing participants together in a group meeting	Varies	Can adopt similar process to classical Delphi
Real time/ consensus conference	To elicit opinion and gain consensus	Experts selected based on aims of research	Use of computer technology that panellists use in the same room to achieve consensus in real time rather than post	Varies	Can adopt similar process to classical Delphi
e-Delphi	Aim can vary depending on the nature of the research	Expert selection can vary depending on the aim of the research	Administration of Delphi via email or online web survey	Varies	Can adopt similar process to classical Delphi

Technological	Aim varies according to project design, from predicting future events to achieving consensus	Experts selected based on aims of research	Use of hand-held keypads allowing responses to be recorded and instant feedback provided	-	Can adopt similar process to classical Delphi
Online	Aim varies according to project design, from predicting future events to achieving consensus	Experts selected based on aims of research	Implementation of the technique on any online instrument such as a chat room, or forum	Varies	Can adopt similar process to classical Delphi
Argument	To develop relevant arguments and expose underlying reasons for different opinions on a specific single issue	Panellists should represent the research issue from different perspectives	Varies	Varies	Can adopt similar process to modified Delphi i.e. first round involves expert interviews
Disaggregative policy	Constructs future scenarios in which panellists are asked about their probable and the preferable future	Expert selection can vary depending on the aim of the research	Varies	Varies	Adoption of modified format using cluster analysis

Table 4-5 Types of Delphi survey designs

Source: Hasson and Keeney (2011 p.1697)

The number and representativeness of participants affect the potential for ideas as well as the amount of data to be analysed. To provide representative information, some studies have employed over 60 participants (Alexander and Kroposki 1999) while others have involved as few as 15 participants (Fiander and Burns 1998). Turoff (1975) demonstrates that the number of the panellists is highly dependent on three factors, namely: the topic area, the time and the available resources. As a result, Delphi survey studies varying from seven to 1,000 panellists exist (Turoff 1975). The larger the

sample size, the greater the generation of data, which, in turn, influences the amount of data analysis to be undertaken. This leads to issues of data handling and potential analysis difficulties, particularly if employing a qualitative first round approach. Another issue with the panel size is that when it increases, the reliability does likewise. This is based on the belief that a larger group reflects the opinion of the population. Of course, the above acceptance is questioned due to the fact that when a sample increases more variation can exist (Hasson and Keeney 2011). In the Delphi survey, non-representative and knowledgeable people are needed, in comparison with the public opinion poll, which is a statistically-based study requiring representative participants of a larger population (Gordon 2012).

The Delphi survey generates results according to the knowledge and cooperation of the panellists. The panel considered for the Delphi survey should fulfil the following requirements:

- Knowledge and experience of the subject studied
- Capacity and willingness to participate
- Sufficient time to participate
- Effective communication skills (Adler and Ziglo 1996).

In this research project, the criteria followed for the selection of experts are stated below:

- Being in a management position or above
- Working in the maritime container transportation business or being consultant or government representative in position related to the maritime container transportation sector
- Having sufficient time to participate.

Usually, studies related to the maritime transport sector, which have applied the Delphi survey, face difficulties in merging many panellists. This occurs due to the limited number of experts with sufficient time to participate (Cetin and Cerit 2010). The Delphi survey samples used in some maritime transport studies had a range of eight to 37 experts, as demonstrated above.

The commitment of participants to complete the Delphi survey process is often related to their interest and involvement with the question being examined. Therefore, a fine



balance must be struck in selecting experts who will be relatively impartial. So that the information obtained reflects current knowledge and/or perceptions, yet also have an interest in the research topic (C. M. Goodman 1987). Moreover, if individuals are to be affected directly by the decision, they are more likely to become involved in the Delphi survey process. Thus, this method is exposed to both researcher and to subject bias. As participants know the group's responses, they may change their views in line with what others are saying. In contrast, this has also been perceived as an advantage of the Delphi survey in that this is what brings panellists towards group consensus. The researcher must be aware of when to stop collecting data and what the definition of 'consensus' is in relation to the study's findings (Williams and Webb 1994).

As the researcher found, the consensus among the experts was achieved easily; hence, the validation of the index was halted at 11 responses. These were sufficient according to previous studies discussed to obtain consensus. The 11 responses were received after sending 17 questionnaires to experts, providing a response ratio of 62.5 percent, which was higher in comparison with that of other maritime transport studies. For instance, the response ratio achieved by Brett and Roe (2010) for the first round it was 57.8 percent. Even though the researcher had more contacts for industry experts, they were not used as he tried to prevent the exposure of the index to many people who could probably be interested to use/develop it on their behalf. The experts selected for the Delphi survey and why are demonstrated in Section 7.3.

#### *Determination of consensus*

A Delphi survey is able to transform opinion into group consensus (Hasson et al. 2000). That can be achieved through the Delphi survey rounds. As Keeney et al. (2011) demonstrate the Delphi survey rounds continue up to a point where a consensus for all or some items, as required, is reached. Of course, it is not a necessary requirement that the results of a Delphi survey will achieve a general consensus. But it is a useful measurement of the agreement between the panellists (Saldanha and Gray 2002). In any case, the research should not make any attempt to force panellists for a consensus (Fitch et al. 2001) that should come during the process.

In maritime studies, two ways of measuring the consensus have been found. The first is the statement that if a factor reaches a level of consensus and above then consensus has

been achieved. The level of consensus could be found from the Table 4-6 which was published from Brett and Roe (2010 p.8).

Low consensus	70-79%
Medium Consensus	80-89%
High Consensus	90-100%

Table 4-6 Consensus ranking

Source: Brett and Roe (2010)

With that manner of calculation, consensus is achieved when it reaches 70 percent or more; hence, the factor examined is not entering the subsequent round (if needed) (Brett and Roe 2010). The second mode of finding consensus is through the average percentage of majority opinion, which is calculated from the Equation 4.1 according to Saldanha and Gray (2002 p.84):

$$General\ consensus = \frac{(majority\ agreements + majority\ disagreements)}{total\ opinions\ expressed} * 100\% \quad (4.1)$$

The equation is used to measure consensus for asking the panellists if they agree or disagree with the factor examined. As in this research, only three questions were examined; thus, the ranking of consensus from Brett and Roe (2010) was followed as insufficient data exist to support the second way of finding consensus.

In practice, the Delphi survey presents a set of statements to a panel of experts. These are derived from the literature or a preliminary enquiry and ask the panellists to agree or disagree with them (Saldanha and Gray 2002). If they fail to reach to a consensus as a group, they are asked to give reasons that are converted in new statements for further testing (Saldanha and Gray 2002). In this research, the statements which lead to further research arise from the acceptance of the factors that occur and from the percentages awarded to them.

#### Process of the Delphi survey

After a thorough study of the literature, the right type and combination of Delphi survey with other techniques which fit for the purpose of this research are demonstrated in this section.

The steps of the Delphi surveys are as follows, in conformity with Rowe and Wright (2001 p.126).

a) Moderator defines elements to be estimated.

- b) Moderator determines the expert group. The suggested group size is between five and 20 experts.
- c) Each expert prepares estimation.
- d) Moderator presents estimations anonymously. Moderator presents estimation result in the iteration as statistical summary of group response, mean, median of each estimation or average of all estimations.
- e) Moderator organises next iteration (return to step c).
- f) Moderator ends the iteration cycle when the estimations of the group become stable or converge to single point estimation.

As some authors state, the characteristics of the Delphi surveys can vary even within the same Delphi survey type; for instance, the number or rounds, the level of anonymity and feedback given, as well as the inclusion criteria, sampling approach or method analysis (Hasson and Keeney 2011).

There are no formal universally-agreed guidelines on the use of the Delphi survey (Keeney et al. 2011). Hence, the modified Delphi survey was followed in this research, based on knowledge obtained from other studies and the guidelines set earlier in this section.

The first action for the completion of the Delphi survey was the design of a well-designed questionnaire, for which various approaches exist, namely: open, structured, semi-structured or explorative approach (Brett and Roe 2010). The structured approach can keep the Delphi survey at a reasonable size to minimise the dropout rates caused mainly by extensive questionnaires and the repetitive nature of the survey (Brett and Roe 2010). This research follows the structured approach, as the questionnaire is addressed to managerial level experts who have limited time. The combination of the structured questionnaire and the modified Delphi survey achieved high response ratios. By using one-to-one in-depth face-to-face interviews in the first round of the modified Delphi survey, the anonymity of the experts was ensured. This is one of the basic principles of the Delphi survey. At the same time, the researcher was able to extract the largest amount of information from every industry expert through face-to-face interviews.

The second round of the Delphi survey was conducted via e-mail. In those the average figure of the weights was demonstrated and feedback for index, its factors and its sources was obtained via e-mails and phone calls, in some cases, from the experts. The responses were collected anonymously by these ‘experts’, as indicated by Hasson et al. (2000).

An essential part of the Delphi survey is the follow-up of non-respondents. This can happen in a variety of ways; for example, follow-up letters phone calls or e-mails (Keeney 2010). Some studies, such as the one conducted by Yeung et al. (2008), sent a reminder through an e-mail to remind the panellists who had not responded to the researcher. The e-mail was followed up by a phone call. The researcher used the follow-up e-mails to increase the participation of the industry experts in the research. All the experts sent a response after the second email. Some of them were willing to participate while some others were not.

The feedback was analysed and found that consensus exists in the factors composing the index, its weights, the overall index and the sources composing it.

Critique for the Delphi survey:

Rowe and Wright (1999), after conducting a systemic review of empirical Delphi survey studies, conclude that there is no “consistent evidence that the technique outperforms other structured group procedures” (Rowe and Wright 1999 p.353).

Keeney (2010) has developed a list of advantages and disadvantages for the use of the Delphi, as outlined in Table 4-7.

<b><u>Advantages</u></b>	<b><u>Disadvantages</u></b>
Versatile method	No universally agreed guidelines
Relatively inexpensive	Potential for lack of methodological rigour
Simple method to use	True anonymity?
Confidentiality of responses	Lack of evidence of reliability and validity
No geographic restrictions	No pilot testing reported in literature
Protects participants’ anonymity	Lack of consideration of ethical implications
Avoids ‘group think’	Time commitment from participants
Cost-effective	Potential for low response rate
‘Two heads are better than one’	

Table 4-7 Advantages and disadvantages of the Delphi survey

Source: Keeney (2010 p.234)

Despite the drawbacks of the method, the Delphi survey has been applied to this research due to the fact that it is a valuable method which could achieve consensus on issues where none previously existed (Keeney 2010).

#### *Delphi survey and focus group:*

Finally, as demonstrated in this section, in-depth face-to-face interviews, focus groups and Delphi survey could co-exist within the same research process. In this research, the Delphi survey was used as the linking part of the other methods used for the extraction and verification of the primary data obtained. The following section demonstrates how the two focus groups were conducted for the verification of the findings.

#### ***4.10.3 Focus Group***

As mentioned in the previous section, focus groups and Delphi survey were combined to generate results in other researches. Wilkinson (2004 p.178) states: “Focus groups can be used as a stand-alone qualitative method, or combined with quantitative techniques as part of a multi-method project”. As it was understood, focus groups can be combined with various methods and techniques to generate feedback.

Focus groups were used in Phases 3a and 3c of this research, as Table 4-4 illustrates, in order to validate the findings of the research and assess the weights generated from the face-to-face in-depth interviews conducted in Phase 1. However, before giving more details about what a focus group is and why the research was selected that method, clarification between group interview and focus group was attempted.

Sometimes confusion exists between group interviews and focus groups, as some academics consider focus groups as a form of a group interview (Bryman 2012). The researcher wants to state three main differences existing between group interviews and focus groups, as stated by Bryman (2012).

- Focus groups are ‘focused’ on one theme or topic, which they attempt to explore in-depth, while group interviews often provide a broad coverage of a topic.
- Group interviews sometimes are conducted by the researcher with a number of individuals simultaneously, so the researcher could save money and time. Focus groups are not designed for that reason.
- Researcher, who is conducting a focus group, is steadily interested in how the participants are discussing as members of a group and not as individuals. Thus,

the researcher is interested for the final build up of the conversation amongst the participants.

As it is clear, focus groups and group interviews have some fundamental differences. Focus groups were chosen for four reasons. Firstly, all the above reasons described from Bryman (2012) which separate focus group from group interviews are applied to this study. This research did not attempt to save money and time, but it was interested in the final outcome of the conversations between the participants, which gave the final shape of the index. That was achieved due to the ‘focused’ examination of the proposed index. Secondly, other maritime transport sector studies use focus groups to assess the relative importance of weights. One example is the study conducted by Lagoudis et al. (2006). The third reason confirms that focus groups are able to promote self-disclosure between participants. This characteristic helped the researcher to discover the participants’ conceptions of the proposed index (Krueger and Casey 2000). The final reason why this research chose to use focus groups in Phases 3a and 3c, is, according to Collis and Hussey (2009 p.155), to “obtain feedback on the findings of research in which the focus group members participated”. That characteristic is one of four that Collis and Hussey (2009 p.155) demonstrate regarding focus groups; namely:

- “Develop knowledge of a new phenomenon
- Generate propositions from the issues that emerge
- Develop questions for a survey
- Obtain feedback on the findings of research in which the focus group members participated”.

After justifying why this research chose to use focus groups for Phases 3a and 3c, some definitions are provided, followed by the guidelines used when a focus group is conducted.

Focus groups have been broadly used in market research, but, in accordance with Bryman (2012), it had been used recently in other disciplines as in social research. Collis and Hussey (2009 p.155) define a focus group as: “A focus group is a method for collecting data whereby selected participants discuss their reactions and feelings about a product, service, situation or concept, under the guidance of a group leader”. A similar definition is provided from Kitzinger (1995 p.299) “...is particularly useful for exploring people's knowledge and experiences and can be used to examine not only

what people think but how they think and why they think that way”. While Bryman (2012 p.501) provides a descriptive definition for focus group: “The focus group method is a form of group interview in which: there are several participants (in addition to the moderator/facilitator); there is an emphasis in the questioning on a particular fairly tightly defined topic; and the accent is upon interaction within the group and the joint construction of meaning”. Focus groups are used by both interpretivists and positivists before or after a survey, according to Collis and Hussey (2009). That means that pragmatists can also use focus groups in their research. Focus groups could be also used as an exploratory or explanatory survey of results (Kitzinger 1995). For this research, the focus group method was used as explanatory in order to verify the outcomes produced from previous phases of the research.

The size of a focus group is an issue to be considered thoroughly. According to academic statements, there is no rule of thumb for the size of a focus group. “Focus groups technique is a method of interviewing that involves more than one, usually at least four, interviewees” (Bryman 2012 p.501). The typical size of a focus group is six to 10 members, in keeping with Morgan (1998). That statement contradicts the findings of Bryman (2012), which state that the size of the focus group could be more than 10 people. More than 10 participants are difficult to control and they limit each person’s opportunity to share insights and observations, as Krueger and Casey (2000) state. Because, in the focus groups conducted, the number of participants were above 10 people and because the researcher wanted to manage the group without losing any of the valuable insights or observations which the participants had. Thus, he collected their responses with the use of a tape recorder and the assistance of a second interviewer who was taking notes. Figure 4-4 demonstrates the moderator and the second interviewer (Prof. Mangan) during the focus group conducted in Phase 3c of the research. As M. Saunders et al. (2009) demonstrate, a moderator could capture all the ideas with a tape recorder or a second interviewer who will keep notes. But they are recommending using both; a tape recorder and a second interviewer who takes notes, as that will permit the interviewer to focus on managing the process (M. Saunders et al. 2009). The moderator is concerned primarily with directing the discussion, keeping the conversation flowing, and taking a few notes. Although, the notes of the moderator are not so much to capture the total interview, but to identify some key ideas.

Conversely, the assistant takes comprehensive notes, operates the tape recorder, handles the environmental conditions and logistics, and responds to unexpected interruptions. At the end of the discussion, the moderator may ask the assistant if he/she wants to ask any additional question or follow up on anything.

Studies, such as the present one, are 'recruiting' more interviewees for their focus groups. The explanation of the 'over-recruitment' is that they try to control the 'no-shows'. The 'over-recruiting' strategy is sometimes recommended by various academics; for example, Wilkinson (1998 p.188).

Focus groups combine interviewing and observation, while the interaction of the group can bring fresh data (Collis and Hussey 2009). Anyone who has knowledge of the topic being examined can potentially participate in focus groups (Bryman 2012). The selection of people participating in the group should be taken through horizontal selection, which will help merge people with similar status and work experience (M. Saunders et al. 2009). In conformity with Krueger and Casey (2000), the selection of participants is based on certain characteristics related to the topic being discussed, while the participants share their views without any pressure to reach to an agreement. Hence, the researcher during the focus group adopted the role of the moderator, as he has in-depth knowledge of the discussed topic and his aim is not to have a unified response for weights and factors composing the index. Those characteristics concur with those demonstrated by M. Saunders et al. (2009), who stated that a focus group moderator must; a) keep the group between the boundaries of the topic which is discussed and b) generate interest and encourage discussion without leading the group to specific opinions.

Focus groups are considered inexpensive and, therefore, they are used widely for the examination of industrial, economic and social problems. As the results are yielded from only a small number of people, focus groups have to be managed appropriately (Collis and Hussey 2009). To cover all the ideas existing in a specific subject studied and reach saturation the researcher had to conduct three to four focus groups with one type of participant and check if he or she is receiving any new information (Krueger and Casey 2000). A similar notion to saturation is suggested by Calder (1977); when a moderator reaches the point when he or she is able to predict with a great accuracy what the next group will state, enough focus groups have been conducted. This research conducted only two focus groups. Their number was lower than those proposed from



the literature as they were combined with other methods. Focus groups sometimes are combined with other data collection techniques (Kitzinger 1995). That gives the ability to use less focus groups, in comparison with the solely use of focus groups for data extraction. As the results of the second focus group demonstrate, there was no need for an additional one, as saturation had already been reached.

Four options exist for the design of a focus group. As stated by Krueger and Casey (2000), these are: a) single-category design; b) multiple-category design; c) double-layer design; and d) broad-involvement design. This research followed the broad-involvement design in order to capture perceptions from everyone involved in UK maritime container transport. Broad-involvement design was used in studies with widespread public interest (Krueger and Casey 2000). In broad-involvement designs, a focus group was conducted among selected participants, who represented/covered the whole industry (Krueger and Casey 2000).

For the accomplishment of the focus groups, the following guidelines were followed to overcome any potential issues.

A neutral setting is preferable, while if the seating layout in the room could be in a circular fashion, so everyone could face inward and has equal distance from the central point of the circle could be preferred for the group interview (M. Saunders et al. 2009).

If one or two people dominate the conversation, the moderator should try to reduce their contribution and engage more people by directing some questions specifically to one person or generally to the rest of the participants. Torrington (1991) gives some examples of possible questions:

‘What do you think, Simon?’

‘What do other people think about this?’

‘What do you think about Steve’s suggestion / statement?’

The outline of how the two focus groups were conducted by the researcher, is given epigrammatically below:

- A presentation was given to the participants about the research, without influencing their thinking.
- Participants were asked if the mind map covered their perceptions of cost, connectivity and risk of the maritime container sector. If perceptions were not

covered, participants were asked to add any factor they thought that the mind map should include. They were also asked if any factors were irrelevant to the subject to indicate them, so the researcher could exclude them from the mind map.

- General discussion regarding the index and how they would like to see the index to be developed.



Note: from left to right; researcher's supervisor, moderator, expert.

Figure 4-4 Photo of the moderator, researcher's supervisor and one of the 17 experts participated in the second focus group (Phase 3c) conducted during the Low Carbon Shipping Conference (12/9/2012)

The strategies are followed to encourage participation in the focus groups; tips used by the moderator to conduct the focus group and a final check list appear in Appendix F.

Finally, noted from the literature, the focus groups work well with the Delphi survey.

The Delphi survey requires a group of people who are either interested or involved in the research idea to generate and select a more specific research idea (Robson 2002).

The combination of those two methods helped to reach consensus amongst the experts and to validate the primary data of this research. The overall index was generated with the compilation of the primary and secondary data of the factors composing it. As a thorough description and justification of how the primary data were collected and generated, the next step of this research is to describe the secondary data used.

#### **4.11 Secondary Data Used for this Research**

The primary data collected for this research were supported by many secondary data. For this research effort, secondary quantitative data are vital as they support and generate the index. The availability of those data has to be taken into deep consideration, according to Xin (2000). As it is logical that, without the actual measurements of the factors, the index cannot be generated. Hence, the baseline chosen fulfils the requirement that most of the factors are able to be nominated with a value. This index captures 24 first layer factors as illustrated in Figure 5-5. This is a task that has never taken place before and would offer great contribution, as stated by J. Korinek (2011, pers. comm., 25 March).

The data were obtained from various sources, such as the OECD, the DfT, Clarksons, Containerisation International, Drewry Maritime Research and various organisations, ports and freight forwarding managers. The researcher has access to some of the most well-established databases, such as the Clarksons' database, the DfT database, the OECD database and Containerisation International database. Access to other databases, such as Alphaliner, was partially achieved. However, due to the expensive annual subscriptions, the researcher could not have full access to every database, related to containerisation.

The secondary data were normalised as described in Section 4.7. The normalised data with the primary data generated the index. Of course the index in order to be created some formulas were taken in consideration, as described in the following section.

#### **4.12 Constructing the Index**

This section provides the typology used for the construction of the index of maritime container transport costs, connectivity and risk of the UK. It also provides the typology for the normalisation of the data as described in Section 4.7. Prior to the quotation of the formulae used, the definition of a weighted index is proffered.

##### ***4.12.1 Defining a weighted index***

The definition of an index is given by Collis and Hussey (2009 p.279): "is a statistical measure that shows the percentage change in a variable from a fixed point in the past". The figure for every index (known as the relative) is the simplest form of index number. The value of the index number at the base time-point is always 100 (Collis and Hussey 2009).

This research is generating a weighted index, which is also defined by Collis and Hussey (2009 p.283) as: “A weighted index number is an index number constructed by calculating a weighted average of some set of values, where the weights show the relative importance of each item in the data set”. The importance of each factor was captured by the application of the BA weighting method. According to Collis and Hussey (2009), researchers who calculate weighted index numbers should not forget to keep them constant for the base time-point. Since the weighting may alter substantially over a long period of time, it is advisable to use weighted index numbers with fixed weights over short periods. The weights are constant for the base time-point in this research, but they are reviewed regularly. That is taking place due to the fact that, as Cullinane and Wang (2009) demonstrate, maritime transport can change faster and easier than inland transportation. So, for this research, the weights used for the creation of the index should be reviewed regularly. The level of that frequency has been identified by experts as every five to 10 years, as discussed in Section 4.8.

#### ***4.12.2 Typology used for index calculation***

The baseline for this research is the first quarter of 2010 which has the value of 100. That period has been chosen as most of the factors captured by the index are reported only after then. The formula for calculating the fluctuation of a factor is given in Equation 4.2.

$$F_{i(t)} = (P_{i(t)} / P_{i(0)}) * 100 \quad (4.2)$$

where  $P_{i(t)}$  is the actual measurement of factor (i) at quarter (t), and  $P_{i(0)}$  is the actual measurement of factor (i) at baseline period (Q1 2010).

Due to the fact that the index is composed of 68 different factors, it is logical that some have a reverse meaning of the principal factor under which they exist. For instance, an increase in costs is something that is translated as a negative fact for the index but, under cost sub-index, the factor reliability exists, as demonstrated in Figure 5-5. When the factor reliability increases, it is good for the container industry; therefore, in order to achieve unanimity amongst the factors and the sub-indices, some have to be modified by ‘reversing’ their values. The modified factors can be calculated as presented in Equation 4.3.

$$Y_{i(t)} = 100 - (F_{i(t)} - 100) \quad (4.3)$$

where  $Y_i$  is the modified value of the factor (i) at quarter (t) and  $F_i$  is the percentage of factor (i) at quarter (t).

After demonstrating how the factors could be normalised, they can be inserted in the index, by multiplying each of them with their assigned weight as Equations 4.4, 4.5 demonstrate. With Equations 4.4 and 4.5 the generation of a value for each factor was achieved.

$$I_{i(t)} = F_{i(t)} * W_i \quad (4.4)$$

$$\text{or } I_{i(t)} = Y_{i(t)} * W_i \text{ (when the modified formula is considered)} \quad (4.5)$$

where  $I_{i(t)}$  is the value composed, after the multiplication of the weight of each factor with the percentage change of each factor (or modified factor) at (t) quarter.  $F_{i(t)}$  is the percentage change of factor (i) at (t) quarter compared with its baseline (Q1 2010).  $Y_{i(t)}$  is the modified value of the factor (i) at (t) quarter.  $W_i$  is the weighting of factor (i).

However, in this research, an attempt was made to determine separately the value of the cost, connectivity and risk components. Thus, a better understanding of costs, connectivity and risks development will be reached over the years. As a result, three sub-indices were created, which measure individually the cost, connectivity and risk components respectively. These are calculated using Equations 4.6, 4.7, 4.8.

$$SI_{\text{cost}(t)} = \sum_{j=1}^n (I_{j(t)}) \quad (4.6)$$

$$SI_{\text{con}(t)} = \sum_{j=1}^n (I_{j(t)}) \quad (4.7)$$

$$SI_{\text{risk}(t)} = \sum_{j=1}^n (I_{j(t)}) \quad (4.8)$$

where  $SI_{\text{cost}(t)}$  is the percentage value of the sub-index cost for the (t) quarter examined and  $I_{j(t)}$  is the percentage change of factor (i) at (t) quarter, multiplied with its weight. Additionally, the  $SI_{\text{con}(t)}$  is the percentage value of the sub-index connectivity for the (t) quarter examined and  $I_{j(t)}$  is the percentage change of factor (i) at (t) quarter multiplied with its weight. Finally,  $SI_{\text{risk}(t)}$  is the percentage value of the sub-index risk for the (t) quarter examined and the  $I_{j(t)}$  is the percentage change of factor (i) at (t) quarter multiplied with its weight.

To demonstrate the percentage change of each of the sub-indices, Equations 4.9, 4.10, 4.11 were used.

$$SI_{\text{cost}(t)} \% = \frac{SI_{\text{cost}(t)}}{SI_{\text{cost}_0}} * 100 \quad (4.9)$$

$$SI_{\text{con}(t)} \% = \frac{SI_{\text{con}(t)}}{SI_{\text{con}_0}} * 100 \quad (4.10)$$

$$SI_{\text{risk}(t)} \% = \frac{SI_{\text{risk}(t)}}{SI_{\text{risk}_0}} * 100 \quad (4.11)$$

where  $SI_{\text{cost}(t)} \%$  is the percentage change of the value of the sub-index cost for the (t) quarter compared with the baseline (Q1 2010),  $SI_{\text{cost}(t)}$  is the percentage value of the sub-index at the (t) quarter examined and  $SI_{\text{cost}_0}$  is the percentage value of the sub-index at the baseline (Q1 2010). Additionally, for the calculation of the connectivity sub-index the  $SI_{\text{con}(t)} \%$  is percentage change of the value of the sub-index connectivity for the (t) quarter compared with the baseline (Q1 2010),  $SI_{\text{con}(t)}$  the percentage value of the sub-index at the (t) quarter examined and the  $SI_{\text{con}_0}$  is the percentage value of the sub-index at the baseline (Q1 2010). Finally, for the risk sub-index  $SI_{\text{risk}(t)} \%$  is the percentage change of the value of the sub-index for the (t) quarter compared with the baseline (Q1 2010),  $SI_{\text{risk}(t)}$  is the percentage value of the sub-index at the (t) quarter examined and  $SI_{\text{risk}_0}$  is the percentage value of the sub-index at the baseline (Q1 2010).

After calculating each sub-index, an attempt was made to combine Equations 4.9, 4.10, 4.11 in order to generate the overall index. As mentioned briefly above, some factors have a reverse meaning with the sub-index into which it is compiled. The same phenomenon is observed for the sub-indices, as connectivity has a positive meaning when its value increases, while both cost and risk sub-indices have a negative meaning when their values increase. As a result, some formulae used for the generation of freight indices have been taken in consideration and a study has been made to find out which fits better in this research. The same philosophy was followed by Xin (2000) for the creation of the CCFI.

Equation 4.12 was chosen for this research, as both equations (4.12, 4.13) were tested with actual data, and found that Equation 4.12 suits better this research requirement. Additionally, Equation 4.12 was chosen for the generation of the index, as it is dimensionless. This characteristic combines well with the fact that the factors used for the index generation are weighted and normalised in order to have reasonable

fluctuations. As the fluctuations of the factors participating in the index generation are reasonable, a dimensionless equation (as Equation 4.12) is used.

$$\text{Index} = \frac{SI_{\text{con}}(t)}{SI_{\text{cost}}(t) + SI_{\text{risk}}(t)} \quad (4.12)$$

$$\text{Index} = \frac{SI_{\text{con}}(t)}{SI_{\text{cost}}(t) * SI_{\text{risk}}(t)} \quad (4.13)$$

As Equation 4.12 was selected, it is understood that the equation is not delivering a value of 100, which is the target figure of the baseline. Equation 4.12 delivers a value of 100 only if the three sub-indices are aggregated, as the sum of their weights gives the figure of 100. For that reason, the Equation 4.14 is used to track the fluctuations of the overall index since the first quarter of 2010 in a scale of a 100.

$$\text{Actual Overall Index}_{(t)} = (\text{Index}_{(t)} / \text{Index}_{(0)}) * 100 \quad (4.14)$$

where Actual Overall Index<sub>(t)</sub> is the change of the index at the (t) quarter examined, expressed in a 100 scale. The baseline of the index is 100. The Index<sub>(t)</sub> is the value of the Equation 4.12 at the (t) quarter, while Index<sub>(0)</sub> is the value of the Equation 4.12 at the baseline (2010). A truncated version of the spreadsheet used for the index creation is placed in Appendix G.

After reviewing all the theory assisting the development of the index, the next step is to generate the index. At this stage, the index was generated quarterly until the fourth quarter of 2011. In other words, only eight measurements of the index exist (Q1 2010-Q4 2011), as demonstrated in detail in Chapter 5, where the results of this research are placed.

### 4.13 Conclusion

To summarise, this section provides an overview of the available philosophies, approaches, strategies, choices, time horizons and data collection methods and techniques. It also provides justification of the methods chosen for the index creation, which were selected amongst a plethora of methods available to generate each parameter the index has to consider. As mentioned, some parameters are more important than others for the creation of an index; thus, more attention was paid to them. That attention was applied with the detailed review of the methods available for generating those parameters. After the application of all the methods and techniques, the researcher

achieved to generate and verify the outcome of this research, which was the proposed index. The outcome is demonstrated in the following chapter.



## **Chapter 5. Results**

*“What gets measured gets done”.*

Eivind Koling, CEO, Maersk Line (The Journal of Commerce 2011c)

## **5.1 Introduction**

Chapter 4 discussed the methodology selected for and applied to the generation of both the primary data and the overall index. In Chapter 3, a comprehensive list of indices used in the maritime sector and specifically the factors found to be affecting costs, connectivity and risks were considered. Thus, this chapter follows on from these to present the results of this research. Those results are not limited only to the overall index, but also extend to include those collected by the researcher for the primary data, their sources and the secondary data used for the index creation.

## **5.2 Results from In-depth Face-to-face Interviews**

For this research, 28 in-depth, face-to-face interviews were conducted from May 2010 to February 2012. The first two interviews were conducted in the early stages of the research on the 13<sup>th</sup> of May 2010 and on the 16<sup>th</sup> of March 2011. Both interviews were conducted with Prof. Martin Stopford at Newcastle University. During the interviews, the researcher tested the early findings of the research. These early findings were also validated via three telephone conversations on the 24<sup>th</sup> and 28<sup>th</sup> of February 2011 and on the 18<sup>th</sup> of July 2011. An earlier e-mail communication with the British International Freight Association (BIFA) helped the researcher to clarify some aspects prior to conducting interviews with industry experts. The key points of the interviews were for testing the early findings and generating the weights with the aid of a mind map. The first interview, in which the mind map was assessed by industry experts, took place on the 21<sup>st</sup> of July 2011, after which, 26 face-to-face interviews were conducted, from which 22 industry experts had individually filled the mind map with weights assessed according to their perception of the relative importance of each factor. In addition to these face-to-face interviews, four telephone interviews were conducted with other industry experts and another e-mail was sent to the Chamber of Shipping for their additional guidance on the field of the research.

The main findings prior to, as well as during, the interviews conducted, for weights extraction, can be grouped into the following. The index itself can have different weights assigned to its component factors according to what itself is trying to capture. Such a variation could arise from the following factors:

- a) Product characteristics (e.g. general cargo vs. refrigerated cargo)
- b) Container flow (e.g. exports vs. imports)

- c) Industry group (e.g. shippers vs. carriers)
- d) Country characteristics (e.g. Ireland exports perishable products, so time is more important factor and will have higher weight).

Thus, to overcome those potential obstacles, the interviewer asked the participants to share their views on the average box transported in and out of the UK. For capturing a representative view of the various industry groups who participate in the maritime container transportation, a representative equal sample was selected for this research, as presented in Figure 4-3. By taking these precautions, the researcher overcame the possible issues that may arise from questioning the validity of the Prime Index. Another important finding was that if this research wants to generate a meaningful and valuable index, it must make contact with the ‘major’ players in the industry, as they have the more extensive knowledge, experience and expertise. For that reason, only managerial-level representatives from well-established and large industry firms participated in this research.

Of course, various aspects related to the index were discussed during the interviews. One of those was the preferred publication frequency of the index. As illustrated in Figure 5-1, 18 of the 26 experts interviewed gave their views on that subject. Even though many of the experts (seven) said that the index should be published annually, and six (four and two who initially said that the ideal frequency was monthly but practically said that it would prefer a quarterly publication) stated that the index should be published quarterly. Taking into consideration two responses for biannual and three responses for monthly generation of the index, the researcher considered the quarterly generation of the index to be the most appropriate and the experts who participated in the focus groups (Phase 3a and 3c) agreed.

After generating the average figures of the weights used for determining the Prime Index, the index itself was generated in Phase 2 of the research. Subsequent to Phase 2, four more validation phases followed in which the index, its sources and its weights were tested with the participation of two focus groups, a Delphi survey and an in-depth face-to face interview.

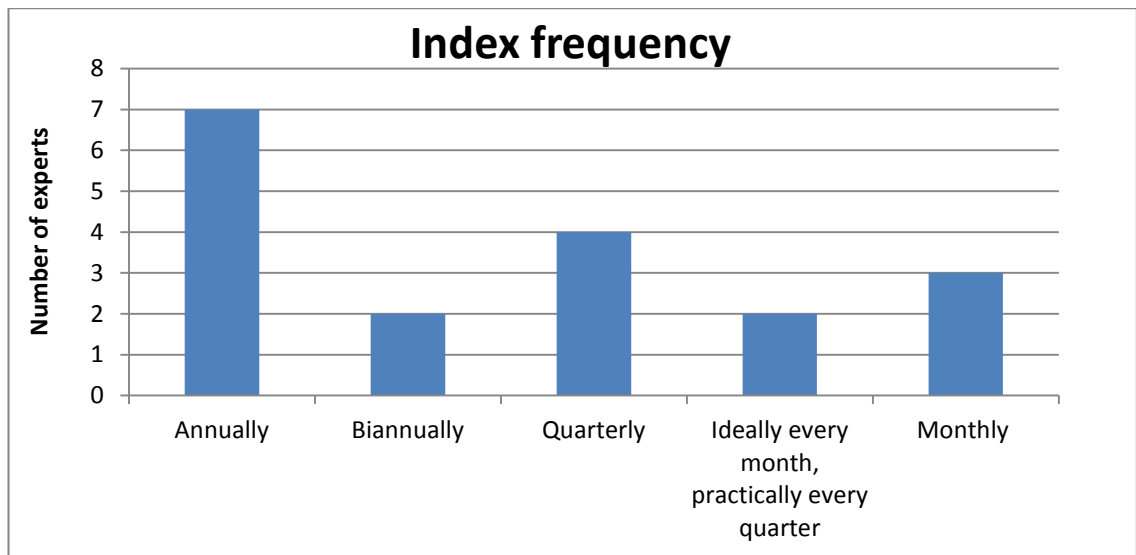


Figure 5-1 Index frequency according to industry experts

Phase 3d uses one in-depth face-to-face interview to validate the risk factors and sources. The interview was conducted on the 5<sup>th</sup> of December 2012 and for nearly two hours the academic expert shared his insights solely for the risk branch of the index. The outcome of the interview was that the sources used for the creation of the index are currently the best available. The expert has suggested a change of the lay-out for the risk factors. The biggest proposed changes were: A) the separation of the factor human error and political risk into two different branches named; 1) human risks and 2) political risks; and B) the rename of port-related risks as maritime-related risk to incorporate both port and vessel-related risks.

The following section demonstrates the results generated by the Delphi survey.

### 5.3 Results from the Delphi Survey

The Delphi survey was conducted in two parts during Phase 3b of this research. This was chosen to achieve improved responses from experts and protect the data from participants' exploitation, as Section 7.3 presents. The first part was to validate the weights for the index, while the second was to validate the sources used to generate the factors. Both the weights and sources are highly important parameters for the creation of a robust index.

#### Delphi survey used for weights validation

The response ratio of the Delphi survey used for weights validation was 62.5 percent. This was higher than the various ratios observed in other maritime studies. For instance,

the Round 1 response ratio achieved by Brett and Roe (2010) was 57.8 percent (the subsequent ratios of Rounds 2 and 3 were even lower, as is usually the case).

The high response ratio can be explained by the benefits of two techniques (namely face-to-face interviews and focus groups practiced prior to the Delphi survey and use of a structured interview guide) applied by research, as mentioned in Section 4.10.2.

The questions asked to panellists were:

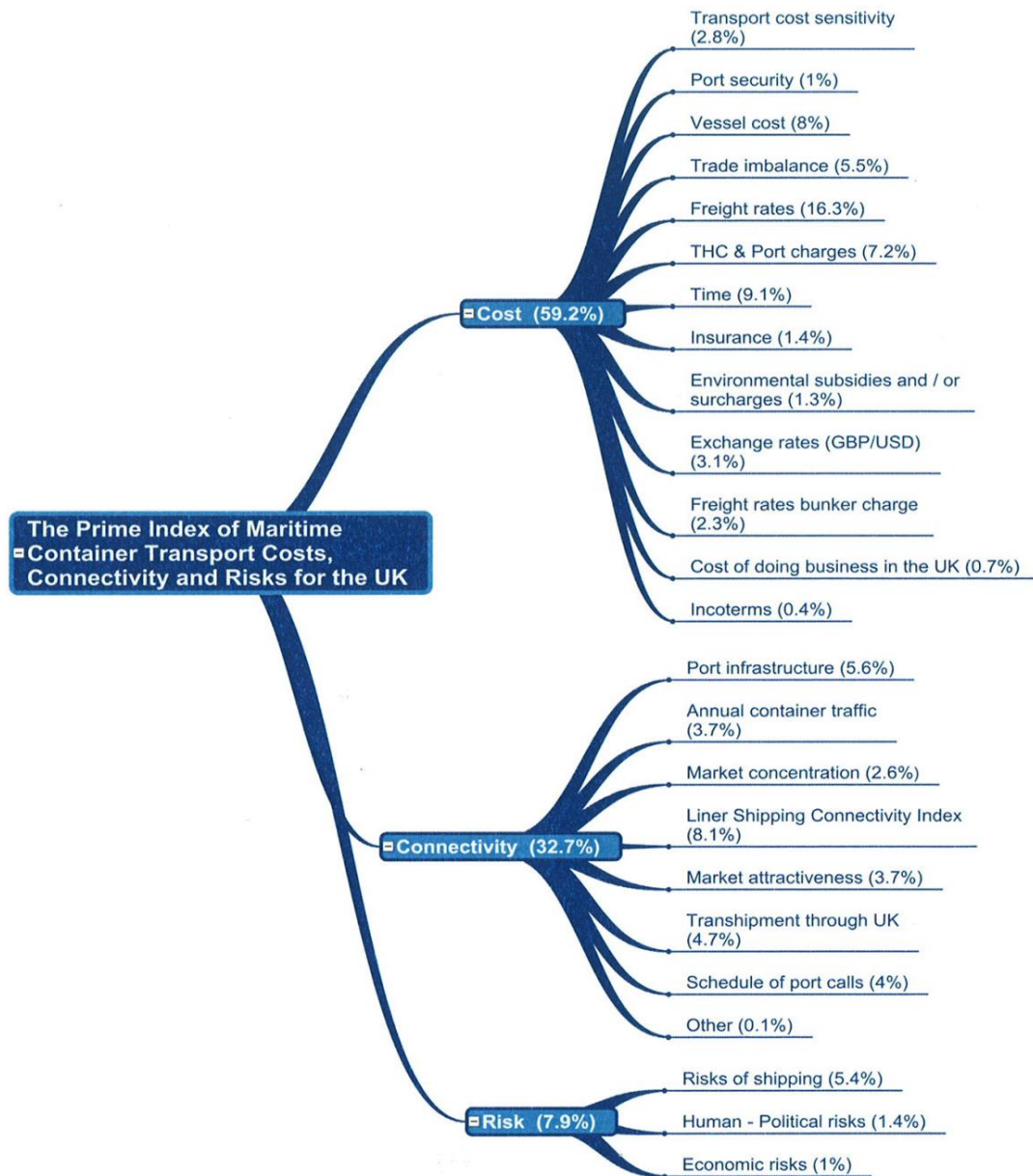
- What is your overall impression of the index?
- Are there any factors missing?
- Do the weights look correct?

The first two questions resulted in a consensus of opinion that the index was perfect and that they could not think of any missing factors. The response to the third question had 70 percent support, with most of the panellists answering that they considered the weights to be correct. The third question had low support due to some proposed changes to the weight figures. This was expected, as the third question captured all of the weighting for the factors comprising the index.

When examined in detail, 70.8 percent of the factors examined had a 100 percent consensus. In detail, all the cost factors had a consensus of 100 percent apart from the exchange rates, which had a consensus of 94 percent. Only three connectivity factors did not have a consensus of 100 percent those were namely; port infrastructure, market attractiveness and schedule of port calls which had a consensus of 92, 93 and 95 percent respectively. Thus, all the cost and connectivity factors were placed on the high consensus ranking (Brett and Roe 2010). The three risk factors, namely; risks of shipping, human-political risks and economic risk each had 89 percent support. That percentage level ranks them in the medium consensus 'area', but those figures are 'placed' between the medium and high consensus area.

The mind map and the questionnaire used for the Delphi survey are given in Figure 5-2. As described in Section 3.2.1, some additional questions generated a valuable input of a prediction of where the UK container sector will probably be in 2050. The sources were tested with the use of another mind map, which is presented in Figure 5-3.

## The Prime Index of Maritime Container Transport Costs, Connectivity and Risks for the UK



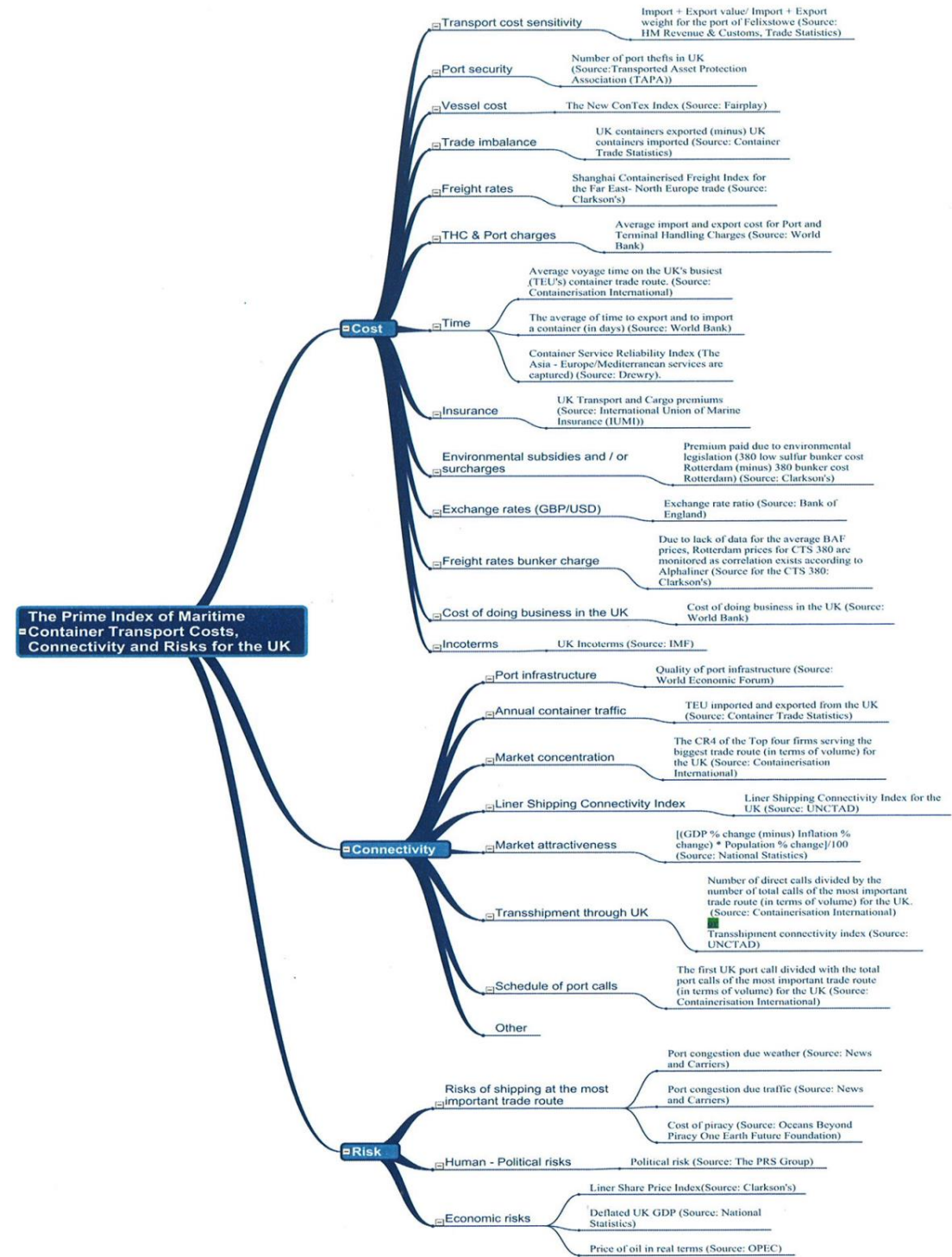
### Questions for the phone call:

- What is your overall impression of the index?
- Are there any factors missing?
- Do the weightings look correct?
  - o For example exchange rates (3.1%) are more important than insurance (1.4%)?
  - o Cost (59.2%) is more important than Risk (7.9%)?
- How do you foresee the UK container sector in 2050?
  - o Size of vessels?
  - o Route networks?
  - o Vessel speed?
  - o Vessel power sources?
  - o Ports?

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Figure 5-2 Mind map and questions used for weights validation in Delphi survey

# The Prime Index of Maritime Container Transport Costs, Connectivity and Risks for the UK



## Questions for the phone call:

- What is your overall impression of the index?
- Are there any factors missing?
- Do the sources capturing them well? If not do you have any alternatives in your mind?

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Figure 5-3 Mind map and questions used for sources validation in Delphi survey

### Delphi survey used for sources validation

Experts participating in sources validation agreed, 100 percent, that the sources used for the extraction of the factors measurements were the best available. There was also 100 percent agreement that no relevant factor was missing and that the overall index was considered reasonable. The sources validation part was embedded in the previous part where the selected weights were tested, as most questions were considered to be similar. After demonstrating the positive results that verified the assignment of weights and the sources used by this research, the focus group technique which was used twice to verify the overall index, is discussed below.

#### **5.4 Results from Focus Groups**

Two segmented focus groups were used once during this research for the validation of the overall index, as described in Section 4.9. The first focus group (15 participants), which was applied in Phase 3a of this research, tested the index amongst academic experts. While the second focus group (17 participants) tested the index amongst both industry and academic experts in Phase 3c.

In both focus groups the same approach was followed. A short presentation of the research was delivered to the participants, which was then followed by 30-40 minutes of dialogue. In both focus groups, the moderator was the researcher, while Prof. Mangan adopted the role of the second interviewer. Prof. Mangan was also taking notes while a tape recorder was capturing the full conversations between the moderator, the participants and the second interviewer. The only difference between the two focus groups was that, at the second focus group, two copies of a poster were used. The poster was composed of the mind map of the index with its weights. The poster is presented in Figure 5-4.

The overall outcome of the first focus group was that the index was satisfactory, covering a broad range of factors and that may be an issue for this research effort. The mechanism used by the index for its creation was logical to the participants.

The outcome of the second focus group was that the overall index also appeared satisfactory. The sub-indices were considered as having the right analogy, as the cost should be an important factor for the overall index. A comment was made during the second focus group that more factors may have to be considered if the index is to be

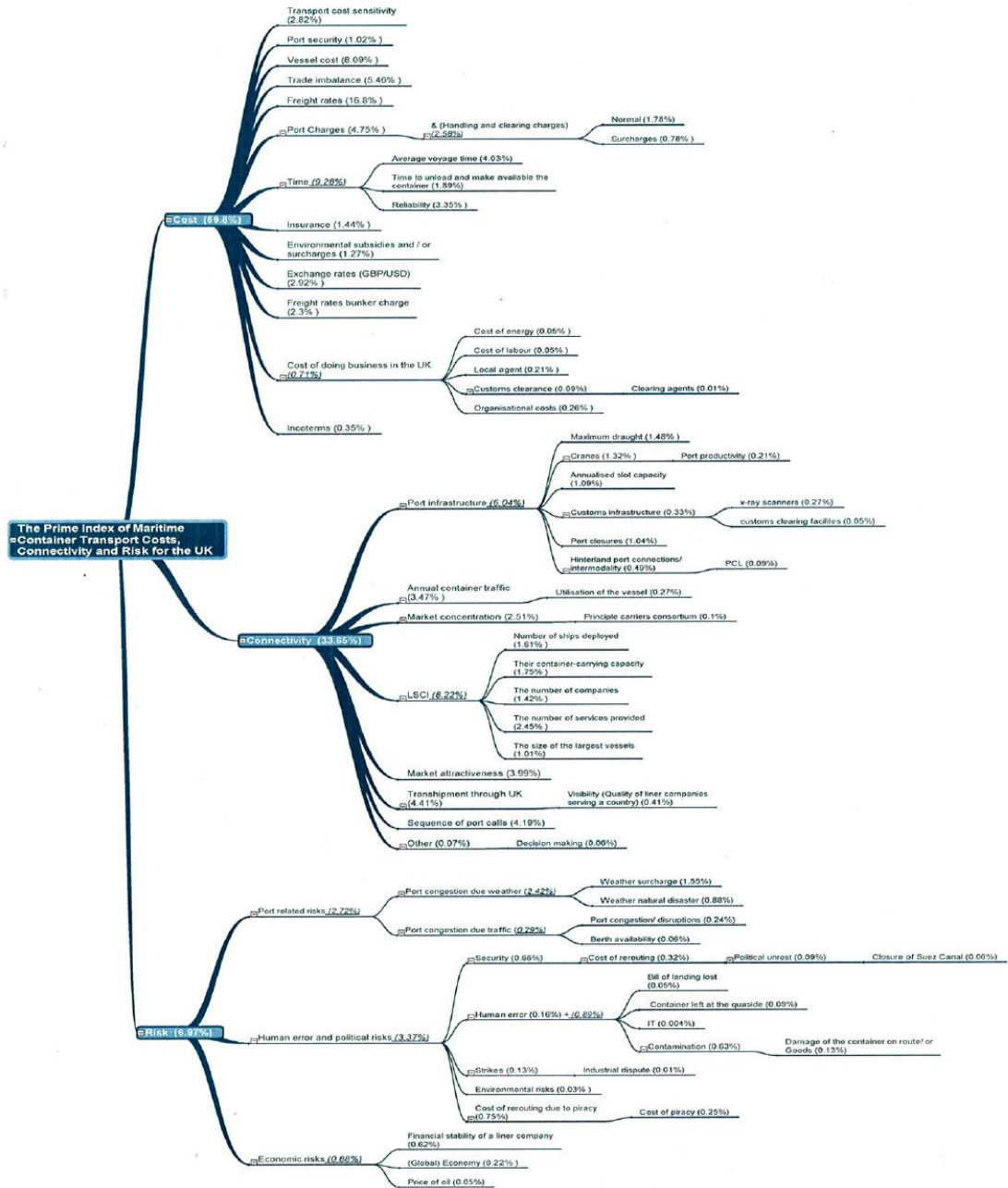


applied to other countries; for example, the port state control. As the UK ports are private, that factor is not applicable, but it may be an issue in other countries.

The final mind map used for the index generation is given in Figure 5-5. As observed, the layout of the risk factors is slightly different from the mind map used in Phase 3c, as a validation phase for risk factors was conducted with an academic expert in Phase 3d.

After demonstrating how the primary data were generated and collected, the next step was to demonstrate how the secondary data was validated and selected. This is discussed in Section 5.5.

## The Prime Index of Maritime Container Transport Costs, Connectivity and Risks for the UK



### Key information for the index:

- The weights multiplied by the actual measurement for each factor will generate the index.
- 28 face-to-face interviews with industry experts have been conducted for weights extraction using the mind maps.
- Delphi technique was used for validation of weights and factor sources.
- Data for factors are collected from well established sources (e.g. CI, Clarkson's, CTS, Drewry, Fairplay, UNCTAD).

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12 September 2012

Figure 5-4 Poster used for the second focus group (Phase 3c)



## 5.5 Secondary Data Sources

The data that compose this index are collected from various sources, after a thorough study of the available sources in order to choose those which comply with the purpose of the research. Some of them are related purely to the maritime transport sector (e.g. The Quality of Port Performance), while others are related to other sectors (e.g. Cost of Doing Business in the UK). The final list of data sources composing the Prime Index is given in Figure 5-6. As observed in that list, 38 measurements are used for the index generation, while eight factors were missing at the time from that list. The missing factors comprise 2.16 percent of the overall index. Some missing factors, for example the factor port congestion, were not available since the creation of the index (Q1 2010); therefore, missing factors have a value of 100 and, when data becomes available again, their fluctuations will be captured.

The number of measurements required for the index generation is, however, smaller than the number of factors actually composing the index, which is 68 factors. This is because some factors, for example the Port Infrastructure compiled from 10 sub-factors, can be tracked by a single measurement, which is the measurement of the Quality of Port Infrastructure. This ranks countries according to the perception of business executives for their country's port facilities. In 2012, 144 countries were ranked and the UK took the 12<sup>th</sup> position (Schwab and Sala-i-Martin 2012). The latest measurement is released annually by the World Economic Forum.

Another example of five sub-factors that are not directly relevant to the maritime sector and that are captured by, or encapsulated within, one measurement is the Cost of Doing Business in the UK. This measurement has been generated annually from The World Bank since 2004 and compares regulations that exist for domestic SME firms in various economies. For 2013, the report compared 185 worldwide economies, in which the UK economy ranked 7<sup>th</sup> (The World Bank 2013).

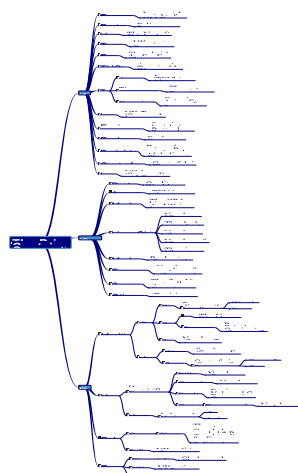


Figure 5-6 Detailed list of sources contributing to the Prime Index

The sources used to generate the Prime Index are not only derived from previously combined data used to generate other indices. One example where the original data set is used rather than the overall index (which could replace the five sub-factors composing it) is the data comprising the LSCI. The LSCI is a maritime-related index capturing five factors, as described in Section 2.9. It uses equal weighting in its calculations in order for it to be generated. As the experts suggested, each sub-factor of the LSCI should have a different weight according to its relative importance; therefore, the overall LSCI was not selected for use in this research; however, its raw data were applied to the Prime Index, as they were provided by the UNCTAD. If the philosophy of using different weights for each factor was followed for the generation of the LSCI, the ranking of the countries will probably be affected. As the ranking of countries will then differ, other outcomes will be outlined by the corresponding results for the maritime connectivity of each country within the global maritime container network. In order to gain a better understanding of the differences that could exist between the factors comprising the LSCI, the weights generated from experts (taken from Figure 5-5) were adjusted as they were solely generated for the LSCI. The experts' proposed and the adjusted weights are presented in Table 5-1.

<b>Factors</b>	<b>Weights as derived from experts' (Figure 5-5)</b>	<b>Adjusted weights</b>
Number of ships deployed	1.6	19.5%
Their container-carrying capacity	1.73	21.2%
The number of companies	1.41	17.2%
The number of services provided	2.43	29.8%
The size of the largest vessels	1	12.2%
<b>Total</b>	<b>8.17</b>	<b>100%</b>

Table 5-1 Experts' weights and adjusted weights for LSCI

As can be seen from Table 5-1, some factors are nearly 2.5 times more important than others (the number of services provided against the size of the largest vessels). Of course, those outcomes cannot be generalised, as they capture only the views of the UK experts. However, they provide a good indicator of possible improvement for the LSCI. Certainly, the weights could be generalised if research could be extended to other countries.

Some factors can be measured in various ways; for example, Transshipment through UK. As this dilemma emerged for several other factors, the researcher deliberately chose the data generated by a well-established institution/organisation/company and

which had been constantly available since 2010, as this was the baseline that was selected for this research. Subsequently, the industry experts agreed with the researcher's choices, as demonstrated in Phase 3b of this research.

Transshipment through UK is measured in this research by the number of direct port calls divided by the number of total port calls for the most important trade route (in terms of volume) for the UK. The source of these figures is Containerisation International. Transshipment through the UK could possibly be captured in additional three ways:

- 1) The transshipment connectivity index, which is published by the UNCTAD
- 2) By using trade and maritime traffic data for the calculation of transshipment as Rigot-Müller et al. (2012) used in their research
- 3) By tracking the ship arrivals by type and deadweight for the UK ports with data provided from the DfT.

However, the three ways described above were rejected for the following reasons:

- 1) The data that provided from UNCTAD to measure transshipment (transshipment connectivity index) is not constantly available. (The transshipment index is published in the report Global Enabling Trade, which has been published from the World Economic Forum since 2008. Unfortunately, the index figure for 2010 which is the baseline for this research is missing. So, it is hard to include that measurement in the Prime Index).
- 2) The calculation conducted by Rigot-Müller et al. (2012) to measure transshipment through the correlation of trade and traffic is not appropriate for containerised traffic. That calculation works very well for bulk and wet material transshipments. However, the unitised traffic is the last form of maritime traffic which is identifiable from that method. This method, therefore, 'embeds' many errors revealed by the lowest correlation observed between the trade and traffic data, in comparison with the other modes of maritime traffic.
- 3) The final way of possibly calculating the transshipment with the aid of data from the DfT, was not applied in this research as the three classifications that are provided from DfT are in terms of dwt. From that form of classification, it is not easily understood which vessels are feeders and which are not. The researcher had tried to match the classifications with others provided from well established

ship broking houses, as for example Clarksons, but unfortunately no identifiable match was obtained. Thus, due to the fact that the vessels are not able to be categorised as feeders or not, this research cannot track their changes over the years.

As described above, various information sources were reviewed and only the relevant ones were chosen for this index. The criterion for the sources selection was not only in their relevance, but also if they capture accurately what is needed for each factor of the index. Thus, a thorough examination was undertaken before their selection. As proof of the criteria set for selecting the sources, composing the index was subsequently confirmed by the experts, no alteration was recommended.

The range of information sources used for the generation of the proposed index was broad, as detailed below.

Organisations: The World Bank, Bank of England, International Monetary Fund (IMF), World Economic Forum, United Nations Conference on Trade and Development (UNCTAD), Yale University, Columbia University, Joint Research Centre, One Earth Future, National Statistics, HM Revenue & Customs.

Non Government Organisations: International Union of Marine Insurance (IUMI), Organisation of the Petroleum Exporting Countries (OPEC), Transported Asset Protection Association (TAPA).

Private companies: Hamburg Shipbrokers Association (VHSS), Container Trade Statistics (CTS), Clarksons, Containerisation International (CI), Drewry Maritime Research, Lloyd's Loading List, Fairplay, Moody's, Fitch, S&P.

The high quality of the index developed was reflected in the quality of the institutions, organisations and private companies named above. Of course, the overall approach of this research effort combines the robust approach followed and high quality data used to generate the Prime Index. The index outcome and representation are demonstrated in the following section.

## **5.6 The Prime Index of UK Maritime Transport Costs, Connectivity and Risks**

After reviewing, evaluating and considering all the methodological background material and literature presented in the previous chapters to support the index creation, a synopsis of the initial idea used for generating the index is displayed. The Prime Index



was designed in a similar pattern to that used for the well-established index of the World Bank, the LPI. “The [LPI] components were chosen based on recent theoretical and empirical research and on the practical experience of logistics professionals involved in international freight forwarding” (Arvis et al. 2012 p.7). This approach helped to generate this new indicator, which was described by the experts as being the most comprehensive index existing so far in the maritime container transport sector, in conformity with their knowledge. The index was generated by multiplying the weight of each factor by the percentage change of the factor since 2010. The sum of all the measurements for all the factors generates the Prime Index and its three sub-indices. A detailed review of how the index was developed can be found in Section 4.12.

The overall index (the Prime Index) has been broken down, as described in previous sections, into its three main sub-indices, namely; cost, connectivity and risk. These measurements have been tracked since 2010, which is the chosen baseline for the index and its three sub-indices. The index and its sub-indices are displayed in Figure 5-7. The Prime Index has fluctuated by nearly  $\pm 20$  percent over the last two years (2010-2011), while on the third year (2012) of this study its fluctuations were more volatile as some data were absent or provisional. Through experience when all the data will be collected and when the final data will be placed in the index, then its fluctuations will be less volatile. Through the study of the index over the years an understanding will be developed considering the containerised trade, in terms of containerised cargo entering and exiting the UK in terms of cost, connectivity and risk. As observed, those three sub-indices are not inter-related in any way, as each one responds to changes differently. According to Figure 5-7, connectivity is the factor with the smallest fluctuation, while risk has the largest. Cost seems to have similar trends with the Prime Index. That could be explained due to large percentage that the costs factors have in contributing to the Prime Index. As illustrated in Figure 5-5, cost factors comprise 59.49 percent of the Prime Index. Cost and risk are quantified on the right axis of the graph as they were effectively reversed. This has occurred due to the opposite impacts, as is discussed in detail in Section 4.12, which costs and risk have in comparison with connectivity on the Prime Index.

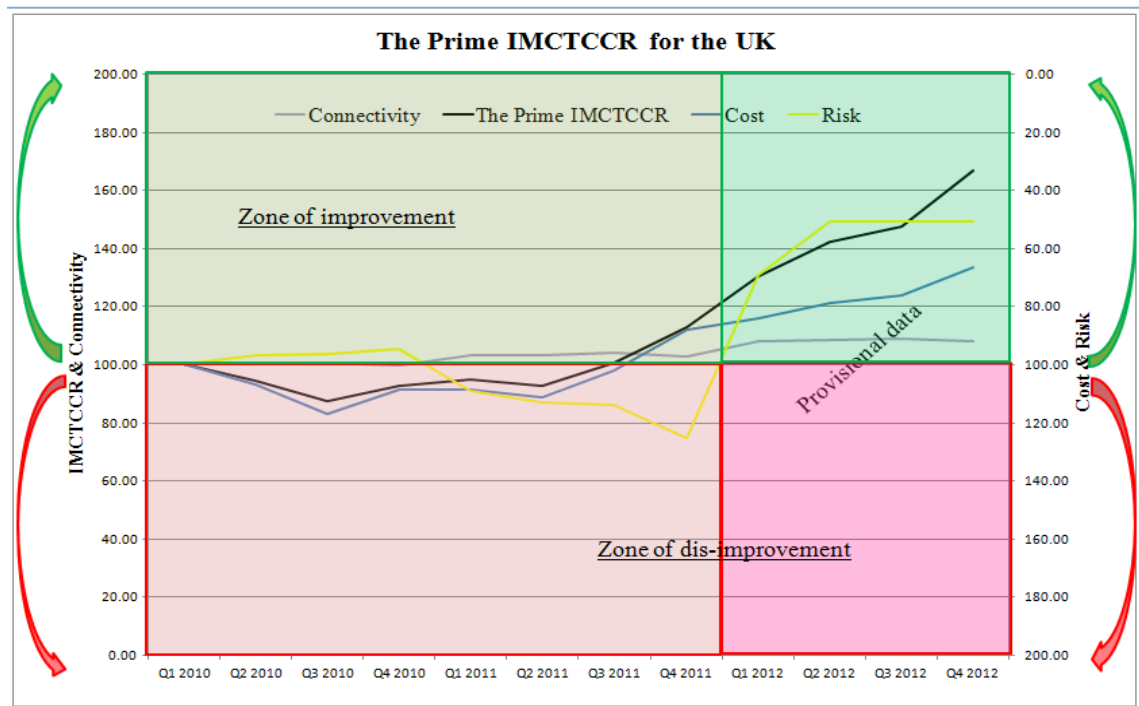


Figure 5-7 The Prime Index of maritime container transport costs, connectivity and risks for the UK and its separate sub-indices; cost, connectivity and risk

Figure 5-7 is deliberately segmented into two zones; a zone of improvement (green) and a zone of dis-improvement or degradation (red). These two graphical zones were generated by the researcher to illustrate clearly whether or not the Prime Index and the sub-indices are improving, in comparison with their commencement baseline (Q1 2010). This effect is taking place as some sub-indices have a reverse meaning; therefore, an improvement happens when the indices are within the zone of improvement (green), while the reverse is the case when the indices are within the zone of dis-improvement (red).

As Figure 5-7 illustrates, after the Q3 of 2011, the Prime Index had improved in comparison to its original baseline. That improvement was caused largely by an improvement in the connectivity since the Q1 of 2011 and in cost since the Q3 of 2011. Risk improved for the first four quarters, but it deteriorated between the Q4 of 2010 and the Q4 of 2011, then it was improved tremendously according to the provisional data.

The Prime Index captures the combined costs, connectivity and risks that exist between the UK and China, and the researcher presents the overall index by placing only those two countries in a map (Figure 5-8). In this map, the UK is placed in the middle while China is considered to be moving according to the average yearly figure achieved by the

UK. Thus, if the Prime Index is improved, China might move closer to the UK; as costs and risks will be reduced while connectivity will be increased in absolute terms. The opposite is considered to be the case when the Prime Index reduces. A similar representation method was followed by Gouvernal and Slack (2012) to represent container freight rates.

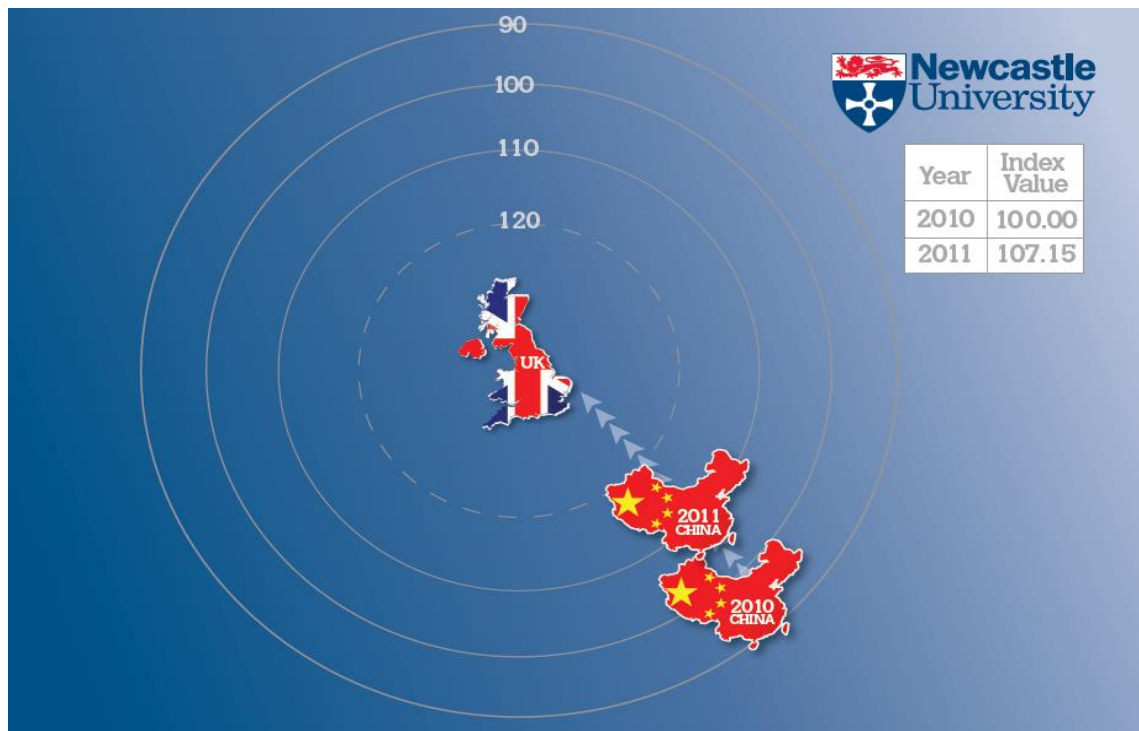


Figure 5-8 Graphical representation of an interpretation of the Prime Index outcomes

Figure 5-8 demonstrates only the annual fluctuations of the Prime Index as the graph was designed to be kept neat. The insert of eight figures (one for each quarter) would probably cause confusion to the reader, as it is observed in Figure 5-8 the yearly improvement of the Prime Index for 2011 in comparison to its baseline (2010) was 7.15 percent.

## 5.7 Conclusion

This section provides an overview of the results found during the research. The results were arranged according to the various phases followed during this research in order to systematically generate the Prime Index. The mind maps used to verify weights, factors, sources and the overall index were also discussed and demonstrated in this chapter. The Prime Index was demonstrated after displaying a justification of some secondary sources used for its generation. The next chapter will provide a discussion of the results found in this research.

## **Chapter 6. Discussion**

*“The goal is not to predict what or when – but instead be prepared and able to respond in an informed and planned manner to minimize the impact of a disruption”.*

Steven Culp, Global Managing Director, Accenture Risk Management

(World Economic Forum 2012 p.10)

## **6.1 Introduction**

Following the review of the existing body of knowledge contributing to the development of the index and the results found within this research, this chapter provides discussion of the main components of the index and its results. For this discussion, a searching critique of pure reason against the index is applied to provide the validity of the index. Following this, the relationship of the findings of the goals and questions set by the research and a consideration of the research applications will be discussed. The discussion will continue with a critique applied to the index before the chapter ends with some concluding comments.

## **6.2 Relationship of the Findings to the Research Problem**

The research problem of this study, which was presented in Section 1.4, was interpreted by the development of a Prime Index to be used in the maritime transport container sector. The index enables tracking, at suitable intervals, of changes in costs, services availability and risks of the UK maritime container transport sector. Therefore, the problem was addressed by the specific research questions set and the precise aims and objectives established in Section 1.4.2.

## **6.3 Consideration of the Research Implications**

As this research is new to the maritime container transport sector and nothing similar exists currently in the industry and academia, a thorough review and a close consideration of all the possible aspects was undertaken. These aspects were tackled by an extensive literature review and methodology selection, as discussed in earlier chapters of this thesis. These chapters justify the selections made as the best available at the time of the development of the index. The detailed approach was considered and justified as this research attempts to become the norm for the development of other indices relative to the maritime transport sector. This could be achieved by following the philosophy behind the steps taken in this research for the development of similar specialised indices.

## **6.4 Critique of the Prime Index**

A critique of the Prime Index could extend to all components that synthesise it, but this was avoided for two reasons. First, every choice contemplated during this research was justified; therefore, referring to each choice again would create a sense of repetition. Second, this section could become a verbose part of the thesis, due to the great detail the

research assigned to each part. That could happen due to the huge number of factors found, and the large number of techniques and methods considered for the index creation. Instead, this part of the research provides a critical review of only the main significant parts affecting the index creation. These are discussed in detail below.

#### ***6.4.1 Relevance of the Prime Index to previous work***

Various reports exist in the literature to support the creation and interpretation of indices. Some examples are reports published by well-known institutions, such as The World Bank: “Doing Business” and “Connecting to Compete”. The first report exhibits the Doing Business Index as presented earlier in Section 3.3.4, and the second states the LPI, as demonstrated in Section 3.3.6. Both indices capture a broad range of factors, as does the Prime Index. However, none of the indices found in the literature, so far, covers the maritime container transport sector in as much detail as the Prime Index. The only index involved solely with the maritime container transport sector and measuring more than one factor, as does the Prime Index, is the LSCI, which is discussed in Section 3.3.3. However, the LSCI covers five factors instead of the 68 covered by the Prime Index. This renders the Prime Index the most comprehensive index of the maritime container transport sector developed so far; as discussed by the industry experts during the face-to-face interviews and the following validation phases of the index development (See Section 4.9). The comprehensiveness of the Prime Index was also revealed in a comparison of the Prime Index with the LSCI, in which it captures nearly 14 times more factors than the LSCI.

The following points summarise the benefits of the Prime Index in comparison with existing well-established indices:

- A broad coverage of all factors affecting the maritime container transport sector.
- The use of relative weights helps policy makers to determine which factors are the more important. By having that information, policy makers could allocate their resources to improve them.
- The development of the index from recognised, trustworthy, independent institution ensures that no conflict could exist amongst the data used for the development of the index, as in some similar cases where a broad range of data exist for capturing one factor. This research has carefully chosen the best data for each factor.

- The use of many validation phases in which the factors of the index, the index weights, the overall index and the data sources were used and involved were confirmed as being suitable by industry experts and academics. That double validation process covers all the existing knowledge in terms of practice (industry experts) and theory (academics).
- Equal representation by each of the participants used for index weights and factors generated. Thus, none of the groups that participated in this research was allowed to be prevailed over the others. This aspect ensures the index's neutral view.

As demonstrated above, one of the benefits of the Prime Index is the broad coverage of the many factors affecting the maritime container transport sector. Therefore, an overview of the most important factors affecting the index is given in the following sections.

#### ***6.4.2 How factors affect the Prime Index***

With the mixed method approach and the combination of academics and practitioners for factors verification, this research double checks that all the factors influencing the maritime transportation of a container were considered during this research. Similarly, their relative levels of importance are captured in the assigned weights that every participant nominates to the factors.

As discussed in Section 4.9, the mind map used in Phase 1 (see Figure 4-2) was slightly different from the final one produced in Phase 3d (see Figure 5-5) after the five phases (1, 3a, 3b, 3c, 3d), was used to generate and validate factors. The cost and connectivity factor groups are nearly identical, even though both industry experts and academics had assessed them in five different phases. The group of factors experiencing the largest change in comparison with the initial composition which the mind map had in Phase 1 was the group containing the risk factors. This difference can be noticed through a comparison of Figure 4-2 and Figure 5-5. The change of the factors among the phases of the research can be explained, as being due to the fact that the factors found in the literature review were identified generally as being in the maritime transport sector; while those found in this more specific research were related solely to the liner shipping industry. Therefore, makes sense that factors related to weather and human errors are more important for the liner shipping industry than the average maritime industry.

Moreover, factors such as piracy were assigned smaller importance compared with the publicity existing on the subject within the maritime industry. The above can be easily explained if one considers the characteristics of the liner shipping sector. For instance, piracy is a low importance factor, even though all the vessels serving the North Europe-Asia trade line generally pass through the high piracy risk area of Somalia. This can be illustrated due to the low number of containerships being hijacked so far. Only one vessel has been captured by pirates and it was considerably smaller [1,098 TEU (Wackett 2012b)] than the average vessel [9,434 TEU (Beddow 2012a)] sailing through the Somali regional sea area to serve the North Europe-Asia trade line. Furthermore, the captured feeder vessel, Maersk Alabama, was sailing close to the Somalia Coast, as it was carrying UN food aid destined for Somalia and Uganda (BBC 2009). These two factors led the vessel to be hijacked, while other container vessels are not easily captured for many reasons by pirates. According to the industry experts interviewed, the faster sailing speed of containerships and their higher deck edge height over the waterline give them an advantage to defend passively against pirates, in comparison with the typical dry and wet carriers.

In reverse, factors related to weather risks are important for liner shipping as the containerships must each comply with a specific timetable, as they have specific time slots in a range of ports. Thus, if the vessel loses its slot in port, due to a delay caused by adverse weather conditions, it has to wait until a free slot appears in order to discharge its containers. This, of course, it is not often the case for the wet and dry carriers that usually travel between two ports; the port of loading and the port of unloading. When the container vessel reaches the port and starts its unloading and loading procedure, it is frequently observed that some containers are discharged in wrong ports, have the wrong documents or the containers have been damaged en route. These instances are more frequently observed in the liner sector, than in dry and wet sectors where the vessel usually carries cargo for one customer only. While in the liner sector one vessel can carry up to 16,020 TEU, such as the Marco Polo which is serving the North Europe-Asia trade line on behalf of CMA CGM (Porter 2012). If each TEU has a different consignee, a vessel can theoretically serve up to 16,020 customers. Those two numbers are not comparable and, consequently, the potential for human error is an important factor in liner shipping.



After providing a brief explanation for some of the factors composing the Prime Index, the following section will explain the Prime Index outcomes.

### ***6.4.3 Explanation of the Prime Index outcomes***

The index has fluctuated by approximately  $\pm 20$  percent over the last two years (Q1 2010 - Q4 2011). Those fluctuations were considered to be caused largely by cost factors. As stated in Section 5.6, the cost factors comprise 59.49 percent of the index. Thus, it makes sense, due to the importance of the cost factors within the overall index, for them to have similar trends. The top five most influential factors are demonstrated and analysed herein, namely: freight rates (16.8 percent); time (9.2 percent); LSCI (8.17 percent); vessel cost (8.02 percent); and port infrastructure (6 percent). Three out of the five are cost factors, while the other two are connectivity factors. The combined three cost factors consist of one-third of the overall index. This can explain the  $\pm 20$  percent fluctuation of the index, as since Q1 2010 the maritime container transport sector has tried to match the demand to the supply. This seems to be extremely difficult as the ‘Great Trade Collapse’ led to an extended period of low demand, while the huge vessel order book created due to prosperous years prior to the ‘Great Trade Collapse’ led to record deliveries [in 2011 101 GT (Clarksons 2012f)]. The delayed effects of the large order book, in terms of vessels supply, are observed three years after the ‘Great Trade Collapse’; this was the average time needed for a shipyard to build a vessel. According to Clarksons, 3.5 years was the average time needed from the shipyards to build a ship in 2008 while, in 2012, this had fallen to 1.7 years due to the lowest number of orders placed to them (Clarksons 2013). The mismatch of the low demand with the oversupply of available traffic led the freight rates to sink to extreme low levels. Spot freight rates of the trade line Shanghai-Europe (base port) reached the lowest point of USD 490/TEU, on the 9<sup>th</sup> of December 2011 (Clarksons 2012e). The Shanghai-North Europe trade line signalled the downturn for all the freight lines, which was reflected a week later when the comprehensive SFCI reached its lowest point on the 16<sup>th</sup> of December 2011 at USD 854/TEU (Clarksons 2012e). Additional information on the freight rates was discussed in Section 3.2.1. Since then, many carriers took various actions to reduce the impact of vessel overcapacity and reflect the low demand for traffic due to the economic recession. One of the actions taken by some of the carriers was to slow down the transit speed of their vessels by applying slow steaming and extra slow steaming operations. As discussed in Section 3.2.1, this caused a direct increase in the average voyage time

factor, but it also had an effect on all of the time factors captured by the index. The aforementioned instances also had an adverse effect on the charter market. That was captured by the fourth factor of the Prime Index (vessel cost) which is tracked from the New ConText Index discussed in Section 3.3.3.

The index is driven largely by the influence of the cost factors, but connectivity and risk factors also play an important role, by composing 33.61 percent and 6.9 percent of the overall index respectively. For instance, two connectivity factors are amongst the top five factors that shape the index. The LSCI is the third most important factor with 8.17 percent, and port infrastructure is the fifth most important factor with 6 percent of the overall index. The LSCI was expected to be at that level of importance, as the factors composing it have been tracked since 2004 from the UNCTAD. As mentioned in Section 2.9, the LSCI provides the opportunity to track the level of connectivity each country has with the global liner shipping network. This research advances the LSCI by giving the opportunity to policy makers involved with the liner sector to track each factor individually according to its importance. By having that information, policy makers could take actions to improve a country's connectivity by improving only a few factors of the LSCI (or the Prime Index when they apply that improvement in other factors of the index). In accordance with the fifth most important factor of the index (port infrastructure), maximum draught for access is a critical factor for port infrastructure, as it has the highest weight. As a result, if policy makers want to improve both the UK connectivity and the overall Prime Index, an increase in maximum draught allowed will be more influential in comparison with an improvement in customs infrastructure. This is because the maximum draught factor represents 1.48 percent, while the customs infrastructure represents only 0.32 percent of the overall Prime Index. In other words, an improvement in access to the maximum draught will be nearly 4.5 times more important or effective than an improvement in customs infrastructure (see Figure 5-5). Of course, the cost of achieving each improvement will vary; for example, port dredging is more expensive than an upgrade of the customs infrastructure. But these are decisions for policy makers, as this research provides only the 'tool' with which they can take informed decisions.

If the UK ports will not increase their draught then the new ULCS, which are increasing their share in the Asia-North Europe trade line as mentioned in Section 3.2.1, will be able to call at only a few UK ports. This reduces the ability of carriers calling directly

more UK ports, as most of them, in order to exploit the economies of scale, are using the ULCS vessels that offer low costs per slot, as discussed in Section 3.2.1. This could have a potentially negative effect on many UK regions, as they will be served with transshipments from other North European ports. As discussed in Section 3.2.3, additional transshipments increase the cost and the total elapsed time needed for a container to reach its final destination. Those two factors are important for the maritime container sector, as discussed earlier herein. Hence, policy makers should not consider each factor as a pure isolated entity, but they also need to think about the accumulative consequences of these factors. In conclusion, this was the rationale behind the design of an index of maritime container transport costs, connectivity and risk, as all of these three factors are linked to each other. Thus, this research has not focused only on the cost side (which is clearly important as the index weights demonstrate), whereas it is not the only factor, or group of factors, existing for the transportation of a maritime container from a country A to a country B.

A factor that it is important to note, even with its current low weighting, is the environmental subsidies or surcharges. As the experts demonstrate that particular factor may not have many current measurements or that its weighting is low in comparison with other cost factors, as illustrated in Figure 5-5, but its importance will increase in the short to medium-term. Thus, further research on the development of an environmental sub-index in the near future may be critical for the progressive evolution of the Prime Index. This evolution would come from the reassessment of the various assigned weights after five-10 years, as stated in Section 4.8 and according to the views of the experts. It could be also captured in a future research project, as discussed in Section 7.4.

#### ***6.4.4 Prime Index importance (usage)***

The principal potential benefits arising from the use of the Prime Index are: anticipation of uncontrollable factors and performance improvement of the maritime container transport sector. Both benefits will emerge by monitoring the evolving figures of the Prime Index in the coming years.

The first benefit of using the Prime Index is that uncontrollable factors would be anticipated based on observable trends; thereby reducing the losses related to the maritime container transport sector may experience in the near future. However, it could also reduce the potential for rapid and large gains, as those noticed during the time

period 2002-2007. In time, the sector will benefit from a stable and slow increase of its profits due to continuous monitoring and improvement of all the known factors related to the transportation of maritime containers. In other words, fluctuations will be reduced, such as those experienced in the sector since the 'Great Trade Collapse'. These fluctuations led the Maersk Line, the largest operator of containerships with a 16 percent global market share, to incur net losses of USD 540m in 2011 (Milne and Odell 2012). Those losses triggered the frustration of senior managers, as the financial results of Maersk Line were unlike those delivered from the other three prosperous sectors from Maersk's portfolio (oil, drilling and ports). Therefore, the Chief Executive, Mr Nils Andersen, stated that Maersk will move away from shipping. He declared in the Financial Times: "we will move away from the shipping side of things and go towards the higher profit generators and more stable businesses" (Milne and Odell 2012). By understanding the uncertainty that exists in the maritime container transport sector, this research could provide a tool which could help to mitigate the risks, reduce the costs and improve the services availability for the UK maritime container transport sector.

The second benefit of this research is that it can help to improve the maritime container transport sector through frequent monitoring. This characteristic is available as the index captures holistically the fluctuations of costs, connectivity and risks factors. However, it also captures individually the cost, connectivity and risk components as these three parameters are sub-branches of the overall index. By monitoring the fluctuations of the index and its sub-branches as mentioned and illustrated in Figure 5-7, each policy maker can see which sub-branches are underperforming or performing better in comparison with the baseline. If the policy makers want to improve the UK scoring on the index, they can focus only on the sub-branches that underperform or have a marginal performance. By identifying those sub-branches, policy makers can consider Figure 5-5, and determine which factors are mostly affecting each sub-branch. Then, they could take appropriate action to improve the performance of the various factors composing the sub-indices. Improving the factors will improve the sub-index. If the three sub-indices can be improved, consequently, the overall index would be improved and it would become easier to move containers in and out of the UK, as the costs and risks will be reduced and connectivity increased.

In conclusion, the research capturing the Prime Index has observed an improvement that reflect the general feeling of industry experts that, since the first quarter of 2010, it has become easier to move containers in and out from the UK.

#### ***6.4.5 What has been captured so far***

As demonstrated in Chapter 5, the Prime Index has improved in comparison with its starting date baseline. As a result, the graphical representation given in Figure 5-8 provides a visual image of the UK and China, which are inter-related for the index creation. This is happening, as the overall performance of the index has been improving. In other words, most of the factors involved in the movement of a container from the UK to China and vice versa have been improved. As those factors have improved, the movement of a container from one country to the other has become less costly and less risky, and more services have been made available.

Summarising this critique of the Prime Index, in accordance with industry experts and academics and the reasons outlined above, it could become a valuable tool for measuring the performance of the UK maritime container transport sector. The first figures delivered from the Prime Index demonstrate that it is able to measure what is taking place in the maritime container transport sector. The index moves in parallel with the perceptions of the industry experts, who deal daily with the transportation of maritime containers. This could serve to indicate the robustness and the quality of the index that has been developed, and which was achieved through a rigorous programme of research and design.

As the level of importance of each factor affecting the maritime transport sector is vague, weights were applied to the creation of the Prime Index. With their application, the importance of each factor for the maritime container transport sector is demonstrated in the following section.

#### ***6.4.6 Use of weights for the Prime Index creation***

As mentioned in Section 4.8, three possible weighting categories exist, from which this research has generated its weights based on public/expert opinion; specifically, the BA method was used for weights extraction. By assigning different weights to each factor according to their relative level of importance, factors with a high weighting are becoming more important for the index; conversely, factors with a lower weighting are diminishing in importance. The level of importance, thus, provides an indication to

policy makers reading the outcomes of the index, about which factor they should focus on to improve the performance of the index. It makes sense that the higher the weights assigned to a factor, the higher the level of its importance and the impact it will have when adjusting the factor to the overall index.

If the research did not extract the weights based on a consensus of public/expert opinion and if it was following the simple equal weights method, policy makers would not have the opportunity to focus and improve the most significant factors considered by the index. Indeed, each factor would otherwise be regarded as having the same weight. By making this distinction, each policy maker involved in the maritime container transport sector could easily monitor and take actions in relation to specific factors composing the index for the benefit of their company-institution-organisation or for the overall UK economy. For example, if the cost is increasing, which is bad for the UK maritime container transport sector, and the cost of port charges increases, ports, carriers and the government could meet and try to find a solution for how to reduce the port charges and thereby their impact on the overall index. In contrast, if connectivity is increased and policy makers want to increase it further, they could consider how they could increase the transshipments volume through the UK. By increasing the volume of transshipments, the UK connectivity rating will be increased and, thus, the overall index will be boosted as a result.

## **6.5 Conclusion**

This chapter provides a discussion of the main parts affecting the index's creation. It does not provide a thorough discussion of all of the factors, techniques and methods used for the index generation as they are extensive. Overall, this chapter has focused on a discussion of the results and providing a constructive self-critique regarding the Prime Index and its components. The next chapter will provide the concluding part of this research.

## Chapter 7. Outcomes

*“A boat is safe in the harbour. But this is not the purpose of a boat”.*

Paulo Coelho, lyricist and novelist (1947-today)

## **7.1 Introduction**

Chapter 7 summarises the research conducted for the thesis, demonstrates its limitations and proposes ideas for further research. By setting the boundaries of the research in Chapter 2, the researcher was able to demonstrate and justify which part of the UK maritime cargo to consider in this research. The Lo/Lo container sector was chosen due to its importance for the UK economy, in terms of value. Also, the definitions of the UK, the maritime transport costs, connectivity and risks are provided in Chapter 2.

Following this, the literature review is provided in Chapter 3, in which the factors affecting the maritime transport costs, connectivity and risks for the UK are demonstrated. Additionally, Chapter 3 demonstrates the indices found after the content analysis and the literature review conducted. Information on how the content analysis was conducted in this research was also discussed in Chapter 3. Finally, Chapter 3 provides a brief introduction to the concepts of total landed costs and Incoterms 2010. These provide the background knowledge required to understand the final part of Chapter 3, which is the mapping of a container journey.

Chapter 4 provides the methodological background of the research, which supports the creation of the index. The review of relative studies is conducted to extract not only the most suitable methods for primary data extraction and generation, but also to normalise the secondary data inserted in the index. As a result, the primary and secondary data combined with the typology in the final section of Chapter 4 created the Prime Index. The novel outcomes of the Prime Index are discussed in Chapter 5. Chapter 6 includes the discussion of the results found from this research through a critique of the index.

## **7.2 Concluding Remarks**

This study took a mixed method, three-phase approach to develop an index covering the UK maritime container transport sector in terms of costs, connectivity and risks (see Table 4-4). The design was open to modification throughout the three-phase approach, prior to which a review of the academic and commercial literature was conducted. The review provided information for collecting any secondary and primary data for the research. After the thorough review of the literature and examination of other existing indices from various sectors, it was concluded that no similar index exists. This index captures each factor affecting costs, connectivity and risks. Moreover, it is the most comprehensive existing in the maritime transport sector based upon principles delivered



by some of the current main indices; for example, the BDI, the Howe Robinson and the SCFI.

An analytical review of commercial and academic literature revealed that 74 factors affect cost, connectivity and risk, while 33 indices exist in the maritime transport sector. The review was followed by a quantitative content analysis conducted with 10 maritime transport related publications, which delivered valuable insights into how maritime indices are both designed and structured. Thus, the content analysis identified an additional 109 indices.

These indices were grouped according to common characteristics into four categories: maritime indices; economic performance indices; environmental indices; and miscellaneous indices. The existence of these categories illustrates the diverse nature of the maritime industry. Two are the main outcomes found through the literature review and the content analysis. The first was that the total 142 indices found from this research revealed that the maritime related indices are using experts' views for weights generation. Those weights are used for index creation. The same approach was followed in this study, as Section 4.8 demonstrates. The second outcome was that 74 factors were found to affect cost, connectivity and risk.

These factors were assessed with the use of the Brainstorm method. The outcome of this exercise was the mind map used in the first phase of this research. This tool was composed of all the factors found from the literature review regarding cost, connectivity and risk factors affecting the UK maritime container transport industry. The factors were clustered according to their relevance to the three main components of the index: cost, connectivity and risk, as illustrated in Figure 4-2.

The mind map was assessed using the BA method via 26 face-to-face interviews with industry experts. The experts covered the spectrum of the maritime container transport sector, as Figure 4-3 shows, providing an equal representation of the views collected through their weight nomination. The second phase of this study uses the average weights responses from Phase 1 and the secondary data used for each factor to compose the Prime Index. The index developed was validated by a focus group of academics in Phase 3a. Thereafter, in Phase 3b, a Delphi survey was carried out to derive a consensus amongst industry experts regarding the factors used for the development of the index, the index weights, the overall index and the data sources used. Finally, in Phase 3c, a

focus group of academics verified the overall index and, in Phase 3d, an in-depth face-to-face interview provided an assessment of the risk factors and sources.

The Prime Index was generated using data from Q1 2010, which comprises its baseline. The outcomes of the index, presented in Figure 5-7, are aligned with the views of industry experts regarding the ease with which to move a container in and out of the UK. As captured in the results section, the overall yearly improvement of the Prime Index was 7.15 percent in 2011, compared with its baseline. An improvement in the overall index demonstrates that the costs and risks of bringing a container in and out the UK have declined, while the availability of services has improved. This information, combined with the knowledge of the level of influence which each factor has to the overall index through the weights nomination, could assist policy makers to improve the overall index by improving only few factors. By ameliorating the factors, the overall index and its components; costs, connectivity and risks could also be improved.

The findings of this study will assist all stakeholders in the UK maritime container transport chain to better understand the impact of change on services, costs and risks. Even with sparse UK-specific data, the UK-Chinese container sector makes up 26 percent of the overall UK containerised trade; therefore, it is a good indication of the trends existing at the UK maritime container sector. Thus, this research focuses specifically on the UK-China route where data exist for all the factors comprising the index.

The proposed index is, therefore, a unique tool for measuring the busy UK-Chinese maritime container transport sector performance. The tool could be applied to other maritime transport sectors as it is a pioneering piece of work.

The index could be replicated in other sectors, but only by experts with a deep understanding of the sector and its idiosyncrasies. As the liner sector has its own particulars, this research has some limitations, as explained in the following section.

### **7.3 Limitations of the Research**

Limitations of this research fall within the following parameters:

- The research boundaries
- Secondary data limitations
- Secondary data sensitivity
- Secondary data quality

- Research choices
- Primary data sensitivity.

As stated in Chapter 2, various boundaries exist in this research. That is the case for precise data, in terms of factors measurements needed to be inserted in the index. Otherwise, if imprecise and inaccurate data were used, then the index would suffer from being unreliable and invalid.

The research boundaries are affected by the existing secondary data limitations. As demonstrated in Section 2.9, data that could capture the 68 factors (number of factors composing the Prime Index, see Figure 5-5) in a UK-centric view do not exist presently. This occurred due to the fact that all the data needed for the 68 factors exist for the UK-Chinese trade; this research focused only on the largest trade transactor in terms of TEU for the UK, which is China. China could provide a good indication for the UK maritime containerised trade as nearly 25 percent of the UK maritime containerised imports and exports were traded with China. One example of a factor that exists only for the UK (North Europe)-Chinese trade and does not exist for the UK centric data is the freight rates. Freight rates are largely important to the index according to their weight, as illustrated in Figure 5-5. As data that could capture UK-centric maritime container freight rates are absent, the most widely used index for freight rates tracking is used; the SCFI, which is discussed in Section 3.3.3. Thus, the UK-Chinese trade has been captured as it contains data for each factor composing the index.

Similarly, data regarding the port security charges are captured only for the port of Felixstowe because port security charges data are absent for the UK. This is because the port of Felixstowe distributes 42.07 percent of the total UK Lo/Lo traffic, as mentioned earlier in Section 2.6. This is a good proxy measurement for the UK maritime container sector. If that figure changes drastically in the next few years with the entrance of the London Gateway [4<sup>th</sup> Q of 2013 (Lloyd's Loading List 2012)] or due to unpredicted circumstances, then will need to be reviewed.

Of course, not all secondary data could be UK-centric. One example is the bunker prices. In conformity with the Seatrade (2012), none of the UK ports is in the top 10 bunkering ports. The top three bunkering ports for 2011 were; Singapore (43.2m tonnes), Fujairah (UAE) (24m tonnes) and Rotterdam (12.2m tonnes) (Seatrade 2012). However, data for UK port bunker prices are absent. Singapore is the largest refuelling port, as

demonstrated from the above figures. Hence, it could be logical to track those prices for the factor freight rate bunker charge, as Singapore serves nearly 3.5 times more vessels than Rotterdam. However, this research is capturing the bunker prices of Rotterdam as the index captures deep sea and short sea shipping for the UK. Due to the proximity of the UK to the Rotterdam port, Rotterdam bunkering prices are tracked in this research.

An additional limitation of the secondary data used for the Prime Index is that they are not always easily obtained; specifically, data relating to the risk factors. For instance, the UK P&I Club (2012) mentions that human error features in 11 percent of main engine manoeuvring failures. This is caused simply by someone from the crew pressing the wrong button, “but it is hard to get that information out of any ship’s officer” (UK P&I Club 2012).

Furthermore to these limitations which are consequence of the choices made in Chapter 2, additional characteristics of the maritime transport sector add more limitations to the research. One characteristic of the maritime transport sector is the difficulty in obtaining secondary data. As Xin (2000) observed, particularly for the maritime container market, it is hard to obtain information that reflect its situation. Thus, real data for fixed tariffs, volumes, etc. are difficult to obtain, as companies keep their data (e.g. rates and volumes) confidential (Xin 2000).

Consequently, the first quarter of 2010 was established as the baseline for the index, as since then accessible and high quality data have existed for most of the factors composing the index. The quality of the data is an significant issue for the development of an index, as if the data from which it is composed are not substantial or robust, the overall index will face reliability and validity issues. As mentioned in Section 5.5, data for some factors, for instance the factor port congestion due to low traffic, are absent; therefore, port congestion does not exist currently in Asia-North Europe ports. When congestion becomes an issue for the liner shipping industry, it will be captured in the Prime Index.

A final secondary data limitation is that some data are reported annually, while others are reported quarterly. As agreed by the experts participating in this research, the Prime Index will be published quarterly. If quarterly figures were available for all factors included in the index, more robust and more sensitive index could be generated, as quarterly observations could be captured opposed to annual fluctuations.

Of course, data sensitivity is not limited to secondary data; it also spreads to the primary data generated by the research. Thus, Phase 3b has segmented the industry experts for testing separately the sources and the weights for two reasons. First, experts as carriers, shippers, port operators and freight forwarders are more experienced with actual daily figures that are relevant to the movement of a container. While consultants and government representatives are more experienced in secondary data and generating various measurements for issues related to the maritime container transport sector. Thus, by segmenting the experts, the questions were less verbose.

This characteristic leads to faster responses that, in turn, result in high response rate, as demonstrated in Section 4.10.2. Second, consultants and government representatives have access to most of the secondary data used in this research to create the index. As the outcomes in that stage were distributed electronically and it was hard to protect them, experts were segmented into low, medium and high safety groups. With that segmentation, the researcher was prevented from sharing the weights with consultants and government representatives who could potentially generate the Prime Index on their behalf. However, their valuable inputs into this research are not excluded as they are participating in sources validation. Thus, sources were double-checked by industry experts to guarantee the robustness of the index.

The research choices are a vague issue, as nothing similar to this study had been developed previously; hence, four verification phases from academic and industry experts were included in this research. If something did not comply with experts' requirements, they could identify it. Due to the fact that negative feedback regarding the index was absent, the researcher proceeded to its completion. One of the most arguable choices for the index creation was that of the equation from which the index is generated. The choice of Equation 4.13 was justified in Section 4.12.2. Of course, it could be claimed that the choice was biased, but since this research followed consistently the same formula to generate the Prime Index, only a tiny difference could be made by using a different formula.

In conclusion, some of the known limitations of this research could be improved, while others could not. Those that could be improved are proposed for further research in the following section.

#### **7.4 Recommendations for Further Research**

Throughout this study, the need for further research on several issues has been noted. A summary of these issues is provided herein.

- The insurance data could be improved.
- Creation of an environmental sub-index for the Prime Index.
- The index could include the inland journey of the container from the port until the DC for the UK.
- Development of the index in other countries.
- Segmentation of the index into imports and exports.
- Segmentation of the index into dry and reefer containers.
- Segmentation of the index into deep sea and short sea containers.
- Segmentation of the index according to the opinions of experts participating in this research.

The insurance data are scarce, as insurance companies consider them to be highly confidential. Insurance data have been found through the International Union of Marine Insurance (IUMI), but they are not timely. Future research could be conducted to provide more timely insurance data. Moreover, the level of importance of the factor insurance is not high, as it captures only 1.43 percent of the overall index. If the percentage was higher, it could be one of the limiting factors discussed in the previous section.

The creation of an environmental sub-index for integration into the Prime Index in the near future may be the case, as the importance of the environmental factors could emerge in subsequent years, as predicted by experts. Therefore, the environmental sub-index could be inserted into the Prime Index when a reassessment of the index and its weights takes place, as mentioned in Section 4.8.

The index could include the inland journey of the container from the port until the distribution center for the UK. Some of the experts interviewed claim that the measurement of the FOB will unveil the overall costs that most UK-based companies pay for container transportation. That holistic approach is something that carriers are examining recently in more detail. As a result, they have started to operate their own logistics companies in order to offer integrated solutions (Hellenic Shipping News Worldwide 2012b).

The extension of the index to capture additional countries could enable comparisons to be made between neighbour countries. This will lead multinational carriers or shippers to compare the best performing country and choose it for their operations. Their choice will be based not only on cost factors, but also on other important factors, as connectivity and risk are explained thoroughly throughout the study. If the index is generated for other countries outside of Europe, other weighting should be applied to the Prime Index, as experts participating in the research, and also in the related literature, have highlighted. For example, the index could be segmented between USA and Europe. Conferences still exist in the USA, meaning that higher weight for freight rates in the USA market should be applied, as the freight rates are higher in comparison with the EU. The lower European freight rates have emerged due to the abolition of the conferences. With conferences, as mentioned on the 17<sup>th</sup> of September 2008 at the Global Shippers Forum, shipping lines were able to “benchmark, discuss, set or fix rates, service terms and/or surcharges” (Ryan 2008). Thus, shippers feel that additional costs are paid due to the presence of the conferences and, therefore, they should be terminated (Ryan 2008). An additional point regarding countries’ characteristics and varying prices paid for containers transportation, is that South Africa and Australia apply surcharges for the use of FEU, because they have infrastructure problems related to the handling of those containers.

As stated in the limitations of the research, the overall trade for the UK is examined; consequently, the index is not segmented into imports and exports. This index is unique and some actions for improvement could definitely be made. However, as something new and unique, the first phase was to create it and leave room for improvement for future studies.

This research conducted the first step in capturing the cost, connectivity and risk factors under one unique index. As revealed in the literature, the actual cost (The World Bank 2012b) is usually higher for a container being imported in the UK than one being exported from the UK. According to the industry experts, some factors could have different weights if they capture imports in contrast with exports. As could be demonstrated if two indices have different weights and measurements, they could probably be two completely different indices. Thus, future research could study whether any difference exists between an index capturing the import costs, connectivity and risks, as well as the export costs, connectivity and risks, for the UK.

With the same logic, segmentation between dry and reefer containers or between deep sea and short sea container could be done as they have different prices. Moreover, some factors may be more important for one category than another.

The difference caused by the various types of containers is caused mainly by cost. For instance, a dry container has a tiny cost per day (TEU USD 3/per day, FEU USD 4/per day), while a tank container costs £25/day. Hence, it is important to have that expensive equipment returned in order to be loaded again. Dry cargo and reefer cargo are two different types of cargo, but this does not necessarily affect rate.

In addition, it is worth mentioning that short sea freight rates include freight rates and THC, while deep sea freight rates do not include THC. Of course there are some exceptions; Norway, Finland and Sweden charge port charges in short sea. Another difference existing between the short sea and the deep sea freight rates is that for short sea containers, the currency is Euros, while it is USD for deep sea. Moreover, in deep sea movements, bunkers are not included, while they are for short sea. Furthermore, deep sea movements insurance is organised under the Incoterms, while it is not in short sea. Thus, the segmentation of an index between short sea cost, connectivity and risks and deep sea costs, connectivity and risks for the UK is logical due to their fundamental differences.

A final form of segmentation the index could probably incorporate will be according to the experts' participated in this research (port operators, freight forwarders, shipping line / agent, government representative / association, consultants, end-customers). Each of these groups could provide different perceptions for each factor; thus, different weights could be generated for each factor. As different weights will be generated, there is the potential for different indices to be generated. Of course, that variation could arise from each separate group; for instance, an end-customer with low value products could assign higher weights to cost factors, while an end-customer with high value products could be more focused on connectivity.

After providing the steps for further research that could be taken to improve this research, the chapter concludes with the following section.

## **7.5 Conclusion**

The final chapter of this thesis provides a summary of the study conducted for the development of an index for maritime container transport costs, connectivity and risks



for the UK. A mixed method, three-phase approach was followed to generate the Prime Index. The index developed is demonstrated, while its benefits are highlighted. The limitations of this research have been noted and used as the basis for developing ideas for future research to improve the Prime Index.

## Appendices

### Appendix A. Port characteristics

Transshipment port selection major criteria	Weight (%)
Physical and technical infrastructures	16.38
Geographical location	35.12
Port management and administration	10.38
Carriers' port cost	38.12

Table 0-1 Importance of major criteria for transshipment port selection as perceived by global carriers in the AHP survey

Source: Lirn et al. (2004)

Top five transshipment port selection sub-criteria of the AHP survey	Weight (%)
Handling cost of containers	24.27
Proximity to main navigation routes	15.12
Proximity to feeder ports	10.26
Proximity to import/export area	9.75
Basic infrastructure condition (water access, eg depth)	8.51

Table 0-2 Most significant sub – criteria for transshipment port selection as perceived by global carriers in the AHP survey

Source: Lirn et al. (2004)

Groups criteria	Carriers (%)	Rank of importance	Ports (%)	Rank of importance	Correlation of weights
Physical and technical infrastructures	16.38	3	23.09	3	0.96
Geographical location	35.12	2	29.60	2	
Port management and administration	10.38	4	14.26	4	
Carriers' port cost	38.12	1	33.05	1	
Variance of weights among major criteria	1.88		0.68		

Table 0-3 Major criteria weight differences between carrier and port surveys

Source: Lirn et al. (2004)

Attributes	Global weight: carriers' survey (%)	Criteria ranking by global carriers	Global weight: ports' survey (%)	Criteria ranking by ports
Handling cost of containers	24.27	1	18.19	1
Proximity to main navigation routes	15.12	2	10.06	4
Proximity to feeder ports	10.26	3	10.50	2
Proximity to import/export area	9.75	4	9.03	5
Port basic infrastructure	8.51	5	10.21	3

Table 0-4 Most significant sub – criteria for transshipment port selection as perceived by carriers and ports

Source: Lirn et al. (2004)

**Appendix B.** Estimates of total freight costs for world imports, by country group

Year	Country group	Estimate of total freight costs of imports	Value of imports (c.i.f.)	Freight costs as % of import value
1990	<b>World total</b>	<b>189.8</b>	<b>3 590.2</b>	<b>5.3</b>
	Developed countries	115.2	2 635.6	4.4
	Economies in transition	10.2	154.5	6.6
	Developing countries	69.0	800.1	8.6
	<i>of which</i>			
	Africa	9.1	97.0	9.4
	America	7.6	127.2	6.0
	Asia	52.3	570.9	9.2
	Oceania	0.5	4.9	9.5
2000	<b>World total</b>	<b>333.4</b>	<b>6 642.1</b>	<b>5.0</b>
	Developed countries	200.8	4 617.7	4.3
	Economies in transition	9.4	120.0	7.8
	Developing countries	126.1	1 904.4	6.6
	<i>of which</i>			
	Africa	12.5	131.0	9.6
	America	19.5	388.9	5.0
	Asia	94.0	1 379.1	6.8
	Oceania	0.5	5.4	9.5
2004	<b>World total</b>	<b>481.8</b>	<b>9 446.6</b>	<b>5.1</b>
	Developed countries	296.3	6 909.1	4.7
	Economies in transition	14.2	259.3	5.5
	Developing countries	173.5	2 877.6	6.0
	<i>of which</i>			
	Africa	21.6	210.3	10.3
	America	19.4	444.1	4.4
	Asia	130.2	2 215.1	5.9
	Oceania	0.8	8.0	10.0
2005	<b>World total</b>	<b>632.4</b>	<b>10 712.2</b>	<b>5.9</b>
	Developed countries	341.1	7 035.7	4.8
	Economies in transition	24.1	317.5	7.6
	Developing countries	259.9	3 359.0	7.7
	<i>of which</i>			
	Africa	24.6	246.9	10.0
	America	19.4	441.1	4.4
	Asia	153.0	2 588.1	5.9
	Oceania	0.8	8.8	9.6

Table 0-5 Estimates of total freight costs for world imports, by country group (Billions of dollars and percentages)

Source: UNCTAD (2007a)

**Appendix C. Results of the Quantitative Content Analysis on frequency of indices mentioned in 10 maritime transport journals**

Index	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist	Total/ Percentage
Baltic Dry Index (BDI)	65	3	4	0	0	0	0	4	18	1	95 24.42%
Energy Efficiency Design Index	20	5	5	2	0	0	0	0	4	0	36 9.25%
Baltic Capesize Index	25	1	0	0	0	0	0	0	4	0	30 7.71%
New ConTex	20	0	0	0	0	0	1	1	3	0	25 6.43%
Baltic Panamax Index	12	1	0	0	1	0	0	0	0	0	14 3.6%
Howe Robinson	9	0	0	0	0	0	0	0	1	1	11 2.83%
Shanghai Containerized Freight Index	6	3	0	0	0	0	0	0	1	1	11 2.83%
Baltic Dirty Tanker Index	4	0	1	1	0	0	0	1	2	0	9 2.31%
Purchasing Manager Index	5	1	1	0	0	0	0	0	0	1	8 2.06%
Boxi Index (Braemar Seascope)	6	0	0	0	0	0	0	0	0	0	6 1.54%
Consumer Price Index (CPI)	0	0	0	1	2	3	0	0	0	0	6 1.54%
Malmquist Productivity Index	0	0	0	1	2	3	0	0	0	0	6 1.54%
Energy Efficiency Operational Index (IMO)	1	1	2	0	0	0	0	0	1	0	5 1.29%
Liner Shipping Connectivity Index	0	0	0	0	0	0	0	5	0	0	5 1.29%
Logistics Performance Index (LPI)	2	0	0	0	0	0	0	3	0	0	5 1.29%
Baltic Clean Tanker Index	2	0	0	0	0	0	0	1	1	0	4 1.03%
Baltic Handymax Index	4	0	0	0	0	0	0	0	0	0	4 1.03%
Baltic Supramax Index	4	0	0	0	0	0	0	0	0	0	4 1.03%

Index	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist	Total/ Percentage	
Freight Rate Index	0	1	0	0	1	0	0	0	1	0	3	0.77%
Baltic Crude Index	2	0	0	0	0	0	0	0	0	0	2	0.51%
Baltic VLGC Index	0	0	0	0	0	0	0	0	2	0	2	0.51%
Cockett Bunker Price Index	0	0	0	0	0	0	0	0	2	0	2	0.51%
Environmental Ship Index	1	0	0	0	0	0	0	1	0	0	2	0.51%
European Freight Forwarding Index	2	0	0	0	0	0	0	0	0	0	2	0.51%
European Liner Affairs Association (ELAA) Aggregate Price Index	0	0	0	0	0	0	0	0	1	1	2	0.51%
HSBC China Purchasing Manufacturing Index	1	0	0	0	0	0	0	0	0	1	2	0.51%
Human Development Index	0	0	2	0	0	0	0	0	0	0	2	0.51%
LRF (Lloyd's Register Fairplay) Freight Index	2	0	0	0	0	0	0	0	0	0	2	0.51%
Retail Price Index	0	0	0	0	0	1	0	0	1	0	2	0.51%
Riverlake Tanker Index, (ReTI) Index	0	0	0	0	0	0	0	0	2	0	2	0.51%
Standard & Poor 500 Index	0	0	0	2	0	0	0	0	0	0	2	0.51%
Vessel Total CO <sub>2</sub> Index	0	0	2	0	0	0	0	0	0	0	2	0.51%
Argus Far East Index (FEI)	0	0	0	0	0	0	0	0	1	0	1	0.26%
AXS Marine Capesize Coal Index	0	0	0	0	0	0	0	0	1	0	1	0.26%
AXS Marine Capesize Iron Ore Index	0	0	0	0	0	0	0	0	1	0	1	0.26%
Baltic Gas Index	0	0	0	0	1	0	0	0	0	0	1	0.26%

Index	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist	Total/ Percentage	
Baltic International Tanker Routes	1	0	0	0	0	0	0	0	0	0	1	0.26%
Bentler-Bonett Nonnormed Fit Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Capital Link Maritime Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
Centrality Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Chicago Board Of Trade (CBOT) synthetic Futures Basket Index	0	0	0	0	1	0	0	0	0	0	1	0.26%
Clarksons Container Time- Charter Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Clarksons Liner Share Price Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Clarksons Tanker Share Price Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
CLSA Index	0	0	1	0	0	0	0	0	0	0	1	0.26%
CO <sub>2</sub> Maintenance Index	0	0	1	0	0	0	0	0	0	0	1	0.26%
Comparative Fit Index (CFI)	0	0	0	1	0	0	0	0	0	0	1	0.26%
Concentration Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Congestion index	0	0	0	0	0	1	0	0	0	0	1	0.26%
Corporate price service index	0	0	0	0	0	1	0	0	0	0	1	0.26%
CRSP Value Weighted Index of AMEX, NASDAC and NYSE firms	0	0	0	0	1	0	0	0	0	0	1	0.26%
Crude Oil Index	0	0	1	0	0	0	0	0	0	0	1	0.26%
Damage Stability Index	0	0	0	1	0	0	0	0	0	0	1	0.26%

Index	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist	Total/ Percentage	
Disparity Index (or inter-regional disparity index)	0	0	0	0	0	1	0	0	0	0	1	0.26%
DJ Euro Stoxx 50 Index	0	0	0	0	1	0	0	0	0	0	1	0.26%
Doing Business Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
Dow Jones Commodity Spot index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Ellison-Glaeser Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Environmental Performance Ship Index (RINA)	1	0	0	0	0	0	0	0	0	0	1	0.26%
Fearnley's Coal Index	0	0	0	0	0	0	0	0	1	0	1	0.26%
Ferry-specific efficiency Index	0	0	0	0	1	0	0	0	0	0	1	0.26%
Foreland Diversity Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
FTAS World Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
FTSE ST Maritime Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
General Freight Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Gini Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
GL's 'Fuel Saver' analysis ships' CO <sub>2</sub> index	0	0	1	0	0	0	0	0	0	0	1	0.26%
Global Interest Rate Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Global Logistics Business Confidence Index (est. 2/09)	0	0	0	0	0	0	0	1	0	0	1	0.26%
Green Rating Composite Index (from Bureau Veritas)	0	1	0	0	0	0	0	0	0	0	1	0.26%
Harpex Index	1	0	0	0	0	0	0	0	0	0	1	0.26%

Index	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist	Total/ Percentage	
HHI (Hirschman-Herfindahl Index)	0	0	0	0	0	1	0	0	0	0	1	0.26%
IHS Global Insight Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
Incident Possibility Index (IPI)	0	0	0	1	0	0	0	0	0	0	1	0.26%
Incremental Fit Index (IFI)	0	0	0	1	0	0	0	0	0	0	1	0.26%
International Monetary Fund (IMF) Export Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Iron Ore Index	0	0	0	0	0	0	0	0	1	0	1	0.26%
Lerner Index	0	0	0	0	1	0	0	0	0	0	1	0.26%
Liner Freight Rate Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
LRF (Lloyd's Register Fairplay) Demolition Price Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
Maurel-Sedilot Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Morgan Stanley Capital International (MSCI) Asia Pacific Telecom Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Morgan Stanley Capital International (MSCI) World Stock Market Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
NASDAQ Composite Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
New Exports Index	0	0	0	0	0	0	0	0	0	1	1	0.26%
OOCL CO <sub>2</sub> Index	1	0	0	0	0	0	0	0	0	0	1	0.26%
Pearson Correlation Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Political risk index	0	0	0	0	0	1	0	0	0	0	1	0.26%



Index	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist	Total/ Percentage	
Prevalence Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Price index of freight services	0	0	0	0	0	1	0	0	0	0	1	0.26%
Productivity index (for container port terminals)	0	0	0	0	0	1	0	0	0	0	1	0.26%
R.S. Platou Dry Bulk Freight Index	0	0	0	0	0	0	1	0	0	0	1	0.26%
R.S. Platou Chemical Tanker Index	0	0	0	0	0	0	0	0	1	0	1	0.26%
Rural Access Index	0	0	0	0	0	0	0	1	0	0	1	0.26%
Scale effects index	0	0	0	0	0	1	0	0	0	0	1	0.26%
Ship Index	0	1	0	0	0	0	0	0	0	0	1	0.26%
Spatial Concentration Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Spill Propensity Index (SPI)	0	0	0	1	0	0	0	0	0	0	1	0.26%
Stock Exchange Composite Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Sudden Cardiac Arrest Association Index	0	0	1	0	0	0	0	0	0	0	1	0.26%
Tanker Market Index	0	0	0	0	0	0	1	0	0	0	1	0.26%
Technical change index	0	0	0	0	0	1	0	0	0	0	1	0.26%
The Rightship Operational Index	0	0	0	0	0	0	0	0	1	0	1	0.26%
Total factor productivity (TFP) index	0	0	0	0	0	1	0	0	0	0	1	0.26%
VIX Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
Workboat Composite Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
World Scale Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
World Stock Market Index	0	0	0	1	0	0	0	0	0	0	1	0.26%
WS Index	0	0	0	1	0	0	0	0	0	0	1	0.26%

Index	Fairplay	Seatrade	Ship Management International	Maritime Policy and Management	Maritime Economics & Logistics	Journal of Transport Economics and Policy	R.S. Platou Monthly Report	UNCTAD Transport Newsletter	Lloyd's List	Lloyd's Shipping Economist	Total/ Percentage	
<b><u>Grand Total/</u></b>	204	18	22	38	12	17	3	18	51	7	389	
<b><u>Total Percentage</u></b>												100%

Table 0-6 Results of the NCA on frequency of indices mentioned in 10 maritime transport journals

**Appendix D.** Methods and techniques found in the literature for weights generation

<b><u>Methods/ Techniques</u></b>	<b><u>Researchers</u></b>
Suggest that the utility theory can be used in order to provide a measurement of accessibility of container ports.	(Cullinane and Wang 2009)
Data Envelopment Analysis (DEA) method, measures the port performance.	(Valentine and Gray 2001) and (Wu et al. 2010)
Multi-Attribute Utility Theory (MAUT) (can be applied with focus groups)	(Lagoudis et al. 2006)
Stochastic Frontier Analysis (SFA) demonstrates that is used for parametric data (countable data) [(SFA) is a widely used tool in estimating port terminal efficiency in the form of relative indices to the frontier].	(Woo et al. 2008), (Di Vaio et al. 2011) and (Sohn and Jung 2009)
AHP & Delphi survey	(Lirn et al. 2004)
PROMETHEE Method	(Castillo-Manzano et al. 2009)
Analytical investigation of marine casualties at the Strait of Istanbul with SWOT & AHP method	(Arslan and Turan 2009)
Using the AHP ranking process, which doesn't rank the best, but identifies factors that have the greatest impact on a distribution linkage model	(P. C. Wong et al. 2008)
DEA & sensitivity analysis	(Lin and Tseng 2007)
Benchmarking analysis technique	(Pardali and Michalopoulos 2008)
Decision-making theory	(Wiegmanns et al. 2008)

Table 0-7 Methods and techniques used from various academics for weights generation

## **Appendix E.** Overview of researcher's actions

In this section an overview of the researcher's actions during the previous years is given. The researcher has attended some conferences, which were relevant to his research interests, during his studies. Those are the following:

- 1) **12<sup>th</sup> March 2010, Newcastle upon Tyne, UK. Conference entitled:**  
Changing Age: Ageing and Mobility Seminar.
- 2) **15<sup>th</sup> April 2010, London, UK. Conference entitled:**  
FREIGHTWISE final conference.
- 3) **10<sup>th</sup> –11<sup>th</sup> June 2010, Newcastle upon Tyne, UK. Conference entitled:**  
1<sup>st</sup> UK Marine Technology Postgraduate Conference.
- 4) **19<sup>th</sup> October 2010, Hull, UK. Conference entitled:**  
East Coast Modal Shift Forum.
- 5) **17<sup>th</sup> December 2010, Newcastle upon Tyne, UK. Conference entitled:**  
Marine Newcastle.
- 6) **20<sup>th</sup> January 2011, London, UK. Conference entitled:**  
2nd Annual Marine Money London Ship Finance Forum.
- 7) **12<sup>th</sup> April 2011, Newcastle upon Tyne, UK. Workshop entitled:**  
LRN/CILT Agribusiness supply chain and transport workshop.
- 8) **7<sup>th</sup> – 9<sup>th</sup> September 2011, Southampton, UK. Conference entitled:**  
16<sup>th</sup> Conference of the Logistics Research Network (L.R.N.).
- 9) **30 September 2011, Stanford-le-Hope, Essex, UK. Forum entitled:**  
Introduction to London Gateway – the game changer and new enabler of supply chain optimisation.
- 10) **17 November 2011, Morgan Stanley, 20 Bank Street, Canary Wharf, London, UK. Forum entitled:**  
CFDA Global Container Freight Forum.
- 11) **26<sup>th</sup> January 2012, London, UK. Conference entitled:**  
3<sup>rd</sup> Annual Marine Money London Ship Finance Forum.
- 12) **17<sup>th</sup> – 18<sup>th</sup> April 2012, London, UK. Conference entitled:**  
The 14<sup>th</sup> Global Liner Shipping Conference: Sustainability and Survivability.

- 13) **5<sup>th</sup> – 7<sup>th</sup> September 2012, Cranfield, UK. Conference entitled:**  
17<sup>th</sup> Conference of the Logistics Research Network (L.R.N.).
- 14) **24<sup>th</sup> January 2013, London, UK. Conference entitled:**  
4<sup>th</sup> Annual Marine Money London Ship Finance Forum.

The researcher has also presented his work at the following conferences / seminars:

- 1) **Internal conference of the School of Marine Science and Technology, Newcastle University, Postgraduate Research Conference 20<sup>th</sup> – 21<sup>st</sup> May, Newcastle upon Tyne, UK, 2010**  
The presentation was entitled: **Development of an Index for Maritime Costs and Connectivity.**
- 2) **15<sup>th</sup> European Logistics Association (E.L.A.) Doctorate Workshop, 16<sup>th</sup> – 18<sup>th</sup> June, Nantes Saint – Nazaire, France, 2010.**  
A sponsored place had been offered to the candidate from the E.L.A. committee, in order to present his work which was entitled: **Developing an Index of Maritime Costs and Connectivity.**
- 3) **15<sup>th</sup> Conference of the Logistics Research Network (L.R.N.), 8<sup>th</sup> – 10<sup>th</sup> September, Harrogate, UK, 2010.**  
A sponsored place was offered to the candidate from the L.R.N. committee, in order to present his work and which was entitled: **Developing an Index of Maritime Costs and Connectivity for the UK.**
- 4) **Internal conference of the School of Marine Science and Technology, Newcastle University, Postgraduate Research Conference 23<sup>rd</sup> of May, Newcastle upon Tyne, UK, 2011**  
The presentation was entitled: **Development of an Index for Maritime Transport Costs and Connectivity of the UK.**
- 5) **2<sup>nd</sup> UK Marine Technology Postgraduate Conference (MTPC), Southampton University, 9<sup>th</sup> – 10<sup>th</sup> June, Southampton, UK, 2011.** The presentation was entitled: **Development of an Index for Maritime Transport Costs and Connectivity for the UK.**
- 6) **Transport Newcastle: Seamless and Inclusive Monthly Seminar, Newcastle University, 25<sup>th</sup> November 2011, Newcastle upon Tyne, UK, 2011.** The presentation was entitled: **Development of an Index for Maritime Container**

**Transport Costs and Connectivity for the UK.** During the seminar views from academic experts regarding the Prime Index were collected.

- 7) **Internal conference of the School of Marine Science and Technology, Newcastle University, Postgraduate Research Conference 21<sup>st</sup> May, Newcastle upon Tyne, UK, 2012**

The presentation was entitled: **Development of an Index for Maritime Container Transport Costs and Connectivity for the UK.**

- 8) **3<sup>rd</sup> UK Marine Technology Postgraduate Conference (MTPC), Strathclyde University, 7<sup>th</sup> – 8<sup>th</sup> June, Glasgow, UK, 2012.** The presentation was entitled: **Development of an Index for Maritime Container Transport Costs and Connectivity for the UK.**

- 9) **2<sup>nd</sup> Low Carbon Shipping Conference, Newcastle University, 11<sup>th</sup>-12<sup>th</sup> September, Newcastle upon Tyne, UK 2012.** The presentation was entitled: **Development of an Index for Maritime Container Transport Costs, Connectivity and Risks for the UK.**

The candidate has also attended the following modules delivered from the school of Marine Science and Technology (Newcastle University) which were relevant to his research interest.

- 1) Feb - Jun 2010: Marine Transport and Economics (Module Leader: Prof. Ian Buxton).
- 2) Oct - Jan 2011: Marine Transport Business (Module Leader: Prof. Ian Buxton)
- 3) Oct - Jan 2011: Maritime Logistics (Module Leader: Prof. John Mangan).
- 4) Feb - May 2011: Design and Analysis of Marine Transport Systems (Module Leader: Prof. John Mangan).

He has also attended the following 15 workshops, which were presented in Figure 0-1. The workshops attended have given to the candidate 71 credits out of 60 (for the first year), 43 out of 40 (for the second year) and 40 out of 20 (for the third year).

The workshops and the conferences were selected by the candidate, according to the needs which the project had.

Module Title	Workshop	Date	Time	PGRDP Credits	Venue
SAgE PGRDP	SCHOOL VALIDATED PGRDP CREDITS	31/10/2009		10	2009-10 (10)
SAgE PGRDP	IT for Researchers: Excel 1 - Producing Charts	16/02/2010	13.30	5	Fayol Cluster, 2nd Floor, Armstrong Building
SAgE PGRDP	PhD management: Managing Your PhD	18/02/2010	9.30	10	Room 2.21, Research Beehive, Old library Building
SAgE PGRDP	PhD Management: Working Effectively With Your Supervisor	19/02/2010	13.30	5	Room 2.22, Research Beehive, Old Library Building
SAgE PGRDP	Statistics: SPSS	23/02/2010		10	
SAgE PGRDP	Library (Information Literacy): Introduction to EndNote for New Users	04/03/2010		3	Hope Cluster, Robinson Library
SAgE PGRDP	IT for Researchers: Word 2 - Creating Effective Tables and Revising Documents	08/03/2010	13.30	5	Nereid Cluster, 4th Floor, Ridley Building
SAgE PGRDP	Library (Information Literacy): Finding Research Information	09/03/2010	10.00	3	Hope Cluster (Room 161), Robinson Library
SAgE PGRDP	PhD Management: Writing Your PhD Project Proposal	10/03/2010	13.30	5	Room 2.22, Research Beehive, Old Library Building
SAgE PGRDP	Statistics: Design of Experiments	16/03/2010	9.30	15	Nereid Cluster, Room 472, Ridley Building
SAgE PGRDP	Communication Skills: Scientific Writing	19/03/2010	9.30	10	Etal Room, King's Road Centre
SAgE PGRDP	SCHOOL VALIDATED PGRDP CREDITS	31/10/2010		15	2010-11 (15)
SAgE PGRDP	D: Communication and dissemination - Notes from an Editor and a Publisher	09/02/2011	14.00	5	BEDTC.B.32 (L.G.38) Bedson Teaching Centre
SAgE PGRDP	D: Communication and dissemination - Presentation Skills	16/02/2011	9.30	5	Room 2.21 Research Beehive, Old Library Building
SAgE PGRDP	A: Knowledge base (IT) - Data Handling and Spreadsheet Skills (DHSS)	24/02/2011	10.00	4	Dene Cluster, Walton Library, Cookson Building
SAgE PGRDP	A: Cognitive abilities - Practical Statistics I	05/04/2011	09.30	15	Lawn Cluster, 2nd floor, King George VI Building
SAgE PGRDP	D: Working with Others - Leadership	15/04/2011	9.30	10	T12, Third Floor, Stephenson Building
SAgE PGRDP	SCHOOL VALIDATED PGRDP CREDITS	31/10/2011		10	2011-12 (10)
HSS8005: Quantitative Methods	Survey techniques 4 Correlation	21/02/2012	4.00	0	Training Suite
HSS8004: Qualitative Methods	Dealing with the Pragmatics of Mixed Methods Research	19/03/2012	4.00	0	Training Suite
SAgE PGRDP	Additional Credit Award	29/05/2012		6	Credits for Stavros Karamperidis for completing two HASS workshops 2011-2012
SAgE PGRDP	Induction for Continuing PGRs	08/10/2012	13.00	3	Room 2.21, Research Beehive, Old Library Building

Figure 0-1 Previously attended workshops and credits

The researcher had a short interview with Prof. Martin Stopford, director of Clarksons, on 13 May 2010 (to test the accuracy of his early findings) and on 16 March 2011 (in order to discuss the findings of the literature review). He also had some discussions with module leaders at his school when a dilemma or problem had occurred. Those answers and his thoughts were tested on a larger scale with significant input from industry and academic experts through various conversations that the researcher had during various conferences. The purpose of those discussions was to find out if he had used the right information sources and if there were other sources potentially relevant to his project. Feedback for his research was always welcome and in many cases was really contributive.

The candidate had produced, with the invaluable help and guidance of his supervisors, a paper which will be published in the journal of Maritime Policy and Management. The title of the paper is: 'The Use of Indices in the Maritime Transport Sector'. In this paper

the results of a content analysis for the presence of indices in the maritime transport sector and their use are demonstrated. The mentioned content analysis was conducted on 10 maritime journals and reports. The content analysis and its results are presented in this document.



## Appendix F. Information for focus groups

<b><u>Strategies to make people to participate in focus groups:</u></b>
<ul style="list-style-type: none"><li>- “Do not ask from people to commit time to an insignificant topic,</li><li>- Sent personal invitations,</li><li>- Always have follow-ups,</li><li>- Do not ignore the seasonality demands for some audiences,</li><li>- Build on existing social and organisational relationships,</li><li>- Offer incentives,</li><li>- Be clear with the description of the study,</li><li>- Be clear with how is sponsoring the study,</li><li>- Be clear why the study is important” (Krueger and Casey 2000 pp.84–85).</li></ul>
<b><u>Tips for moderators:</u></b>
<ul style="list-style-type: none"><li>- “Moderators’ respect for participants may be one of the most influential factors affecting the quality of focus group results,</li><li>- The moderator interacts informally before the focus group (and possibly after) and shows interest in participants lives and what is happening in their environment. (Everything must be set up and already for the group when the first participant arrives. If you are still fiddling with the recorder or writing on the flip chart, it makes some people uncomfortable. The moderating team then act as hosts!!! You should do what you do when you welcome people to your houses).</li><li>- Moderator has to be an active listener,</li><li>- Moderator has to see moderating as an honour and not as a job!!!</li><li>- The main outcome of the focus group is to gain knowledge from the participants!!!</li><li>- The moderator must have adequate background knowledge on the topic of discussion to place comments in perspective and follow up on critical areas of concern,</li><li>- If you want to run a focus group during lunch, then a good tip is to avoid glass, china, cans, and silverware. Instead, use paper cups and plates with plastic forks and spoons so the tape recording could be ‘clear’,</li><li>- Introduce the tape recorder as a tool which will help you to capture everyone’s comments. Do not try to hide the tape recorder as it creates secretive atmosphere,</li><li>- Build in microphones are not picking up group discussions well. You need an omnidirectional, pressure sensitive remote microphone placed in the centre of a table,</li><li>- Begin the focus group discussion by giving many information and the participants feel more comfortable with the topic,</li><li>- Five seconds pause and probe after participants comments. That allows people to speak and continue the conversation. Probing is a technique to elicit additional information. (Do not talk too much and do not move too quickly from one topic to the other!!)</li><li>- If you have someone who is rambler (uses a lot of words to reach a point, if there any point) then discontinue the eye contact with him and look at your papers or at other participants. The assist moderator should do the same. A statement at the beginning of the focus groups is good to avoid issues like that. (From past experience in groups like this, we know that some people talk a lot, and some people do not say much. It is important that we hear from all of you because you have had different experiences. So if you are talking a lot, I may interrupt you, and if you aren’t saying much, I may call on you. If I do, please do not feel bad about it. It is just my way of making sure we get through all the questions and that everyone has a</li></ul>

- chance to talk,
- Try to restrict the head nodding,
- At the conclusion of the focus group thank everyone for their participation and wish them a safe trip home. If you have the financial ability, provide them with a gift. (A card from the school of Marine Science and Technology?) It is good to conclude your focus group with a final question: “Have we missed anything?”
- BE READY FOR THE UNEXPECTED!!” (Krueger and Casey 2000 pp.97–115).

**Final check list:**

- “Tell who has access to the results,
- Describe the study,
- Describe how the results will benefit participants,
- Give a general promise of confidentiality by the researcher, which means no names are attached,
- Tell how audiotapes will be used. Who will have access to them!!
- Request that the group also maintain confidentiality for each other,
- Explain that the moderator’s role is to guide the discussion and keep it on track,
- Explain that no names are wanted, so please don’t mention names of colleagues,
- Tell them the moderator will summarise key points of the discussion at the end and then ask for help to ensure that we’ve captured the most important points” (Krueger and Casey 2000 p.175).

Table 0-8 Information for focus groups

**Appendix G.** Index components (truncated version)

<b><u>Factor</u></b>	<b><u>Measurement frequency</u></b>	<b><u>Weight</u></b>
<b><u>Cost</u></b>		
Transport cost sensitivity	Quarterly	2.28%
Port security charge	Annually	1.02%
Vessel cost	Quarterly	8.02%
Trade imbalance	Quarterly	5.46%
Freight rates	Quarterly	16.8%
Port and terminal handling charges	Annually	7.03%
Average voyage time	Annually	4%
Time to unload and make available the container	Annually	1.87%
Reliability	Quarterly	3.33%
Insurance	Annually	1.43%
Environmental subsidies and / or surcharges	Quarterly	1.26%
Exchange rates	Quarterly	2.9%
Cost of doing business in the UK	Annually	0.67%
Freight rates bunker charge	Quarterly	2.27%
Incoterms	Annually	0.34%
<b><u>Connectivity</u></b>		
Quality of port infrastructure	Annually	6%
Market concentration	Annually	2.51%
LSCI (Number of ships deployed)	Annually	1.6%

LSCI (Their container-carrying capacity)	Annually	1.73%
LSCI (The number of companies)	Annually	1.41%
LSCI (The number of services provided)	Annually	2.43%
LSCI (The size of the largest vessels)	Annually	1%
Market attractiveness	Quarterly	3.99%
Transshipment through UK	Annually	4.37%
Sequence of port calls	Annually	4.19%
Annually container traffic	Quarterly	3.47%
Other & Decision making	Missing	0.13%
<b><u>Risk</u></b>		
Cost of rerouting due to piracy	Annually	0.75%
Weather surcharge	Annually	1.54%
Security (port)	Annually	0.66%
Contamination	Missing	0.62%
Cost of piracy	Annually	0.25%
Damage of the container on route/ or Goods damage	Missing	0.12%
Container left at the quayside	Missing	0.08%
Bill of landing lost	Missing	0.05%
Weather /natural disaster	Missing	0.87%
Port congestion/ disruptions	Missing	0.23%
Political unrest	Annually	0.09%
Price of oil	Quarterly	0.45%

Environmental risks	Annually	0.034%
Strikes	Quarterly	0.12%
Closure of Suez Canal	Annually	0.06%
Human Error	Annually	0.15%
Cost of rerouting	Annually	0.32%
Financial stability of liner companies	Quarterly	0.62%
(Global) economy	Quarterly	0.215%
Berth availability	Missing	0.06%
IT	Annually	0.004%
Industrial dispute	Quarterly	0.012%

Table 0-9 Truncated version of the index

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