



THE HONG KONG  
POLYTECHNIC UNIVERSITY  
香港理工大學

# From green to sustainable shipping

Kee-hung Lai  
Shipping Research Centre  
PolyU

# Questions

- Why green in shipping?
- How to measure green shipping?
- How does the literature discuss sustainability in liner shipping? – a citation network analysis
- How does the industry discuss sustainability – analyses of top liner shipping companies' reports
- Insights from the academic and industry discourse

# Shipping

- Sea transport is essential to global economy as over 90% of the world trade is carried by maritime transport according to the IMO
- An economic way to move goods in large volume around the world
- A carbon-efficient transport mode
  - but significant GHG emissions due to huge industry scale



# Some facts: shipping

- In 2012, about **2.2%** (i.e., 796 million tons) of **CO<sub>2</sub> (GHG)** of the total emission is caused by **maritime shipping**
- An increase in emissions by **50% to 250 %** (based on 2012 levels) is expected **until 2050**, depending on economic growth and energy development<sup>1</sup>
- Other environmental impacts: oil spills, ballast water, exhaust gases, sewage, noise, solid wastes

<sup>1</sup>The Third International Maritime Organization Greenhouse Gas Study, 2014

Due to the ***growing emphasis on environmental protection as part of Corporate Social Responsibility***, shipping firms have begun to recognize the **importance of greening** as they service the global community in international trade

# Voluntary actions from the industry

**MOL**

Mitsui O.S.K. Lines

- R&D projects → improved vessel design
- “ECO SAILING” program



- River Shuttle Container service → feeder ships
- “Eco-speed” program

 Hapag-Lloyd

- Electric fuel injection & valve control in the main engines of ships



**MAERSK**

- Voyage Efficiency System (VES)

**Oriental  
Logistics**

東方物流

- New vehicles comply with Euro IV standard (improve air quality)

# Clean cargo working group

- Mission:

“..measuring, reporting, and evaluating the environmental performance in marine container transport..”

- Help carriers track and benchmark their performance and report to customers on carbon dioxide emissions
- Allow shipper customers to review and compare carriers' environmental performance

# CCWG members

## Cargo Carriers



## Cargo Owners (Shippers) and LSP's



# Question

Apart from monitoring and reducing emissions (e.g, CO<sub>2</sub>, So<sub>x</sub>), what are other aspects of green shipping practices?



## Green shipping practices in the shipping industry: Conceptualization, adoption, and implications

Kee-Hung Lai<sup>a,\*</sup>, Venus Y.H. Lun<sup>a</sup>, Christina W.Y. Wong<sup>b</sup>, T.C.E. Cheng<sup>a</sup>

<sup>a</sup> Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

<sup>b</sup> Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

### ARTICLE INFO

**Keywords:**  
Shipping management  
Environmental  
Maritime studies  
Institutional theory  
Logistics

### ABSTRACT

There have been increasing concerns about the adverse impacts on the environment caused by cargo movement in international trade. Different stakeholders ranging from shippers and carriers to government bodies and international communities have expressed worries about the environmental impacts brought by shipping related activities. The pollution and waste created in the shipping processes have imposed environmental burdens and accelerated resource depletion. The situation is set to worsen in the face of intensifying trade globalization, which has contributed to sustained growth in international shipping activities. To help protect the environment, many shipping firms have taken the initiative to find ways to lessen the environmental damage of their operations while enhancing their performance. The objective of this study is to examine the environmental awareness and the environmental measures taken in the shipping industry. We propose a conceptual framework for evaluating green shipping practices and develop several propositions stating the conditions under which shipping firms would behave in an environmentally responsible manner. We conclude with managerial and policy implications of the conceptual framework to promote green shipping practices in the shipping industry.

© 2010 Elsevier B.V. All rights reserved.

### 1. Introduction

Shipping firms are facing new opportunities and challenges in today's global economy. In particular, public concerns about such environmental issues as resource depletion and pollution caused by shipping activities have been growing rapidly in the face of globalization of business activities. Environmental protection and resource conservation have been widely discussed by business and political leaders (e.g., Revkin, 2009; Rosenthal, 2009). There has also been a surge in research devoted to addressing the related issues (e.g., Ostrom, 2008). Playing the role of a transportation intermediary to facilitate trade flows in the global supply chain (Wong et al., 2009a; Yang et al., 2009a), many shipping firms have begun to respond to environmental concerns by embracing green shipping practices (GSPs) to green their operations. GSPs are environmental management practices undertaken by shipping firms with an emphasis on waste reduction and resource conservation in handling and distributing cargoes. Examples of such practices include counting the carbon footprint of shipping routes and using alternative transportation equipment with the aim of reducing environmental damage in performing shipping activities. Many green practices of shipping firms can be observed in

CMA CGM, a leading container shipping group. The firm offers the River Shuttle Container service to transfer goods between main and secondary ports by feeder ships that have a higher carrying capacity than trucks. Using feeder ships to provide shuttle service reduces carbon emission in terms of gram/tonnes-km versus road transportation using trucks. Such use of alternative means of transportation improves services by reducing coordination among different truck operators. This not only enhances the competitiveness of CMA CGM, but also preserves the environment with less emission. So far, such environmental actions by shipping firms are uncommon in the industry and little is known about the motivation behind these environmental management initiatives. This research void is undesirable and hinders the diffusion of GSPs, the adoption of which is beneficial for the ecological modernization of shipping firms, i.e., to improve productivity and contribute to protecting the natural environment.

Upon conducting a cursory search of the literature, we found a serious lack of theoretical attention being paid to understanding why and why not shipping firms undertake GSPs (Lun et al., 2011). Most of the research studies on this subject have focused on investigating the environmental and financial impacts of adopting shipping technologies, such as burning cleaner fuel and running cleaner engines, as well as their links with financial performance (Viana et al., 2009). They have largely confined to examining the extent to which environmentally responsible shipping operations affect firm performance. Although these studies enhance

\* Corresponding author. Tel.: +852 2766 7920; fax: +852 2330 2704.  
E-mail address: [lgtmlai@polyu.edu.hk](mailto:lgtmlai@polyu.edu.hk) (K.-H. Lai).

# Green shipping practice (GSP)- conceptualization

- ◆ Definition:

*Environmental management practices undertaken by shipping firms with an emphasis on waste reduction and resource conservation in handling and distributing cargoes*

- ◆ In a case study of **A.P. Moller-Maersk Group**, we identified 6 dimensions of GSP:

1. Company Policy and Procedures (CPP)
2. Shipping Documentation (SD)
3. Shipping Equipment (SE)
4. Shipping Cooperation (SC)
5. Shipping Materials (SM)
6. Shipping Design & Compliance (SDC)





## 1. Company policy and procedure (CPP)

- **Corporate commitment** to a vision or culture of sustainability in shipping firm
- **Maersk's environmental policy:**  
*“ we will honor environmental commitments by minimizing the environmental impact of our business through constant care (i.e., careful use of resources, optimization of operations and handling of waste streams), and striving continuously for improvement in our environmental performance and pollution prevention across all our activities”*



## 2. Shipping documentation (SD)

- **Documentation** involved in performing **shipping activities** (e.g., booking request, booking confirmation, invoice and remittance advice)
- **Maersk** provides an “*End-to-End EDI Solutions*” to automatically synchronize the sharing of data across its customers and business partners



### 3. Shipping equipment (SE)

- Use of **environmentally friendly shipping equipment** and facilities (*e.g., eco-labeling of resources, supplier's ISO 14001 certification*)
- **Maersk** abandoned the use of CFC and replaced it with other more environmentally friendly types of refrigerants; Maersk uses alternative materials to develop container flooring



### 4. Shipper cooperation (SC)

- **Cooperating with shippers** on environmental objectives (*e.g., working with customers on eco-design in cargo handling and shipments*)
- **Maersk** has collaborated with a number of firms to embark on environmental management initiatives, e.g., The Clean Cargo Working Group



## 5. Shipping materials (SM)

- **Recovering** from **used shipping resources** to reduce costs and improve operation (*e.g., sales of excess equipment and facilities, sales of packaging and cartons*)
- **Maersk** has a company policy on vessel recycling – this requires a vessel to be checked rigorously before it is delivered to a recycling yard



## 6. Shipping design and compliance (SDC)

- To **minimize** the life-cycle enviro. damage of shipping activities by taking **measures** in compliance with regulatory requirements (*e.g., design of shipping activities for re-use*)
- **Maersk** developed the Voyage Efficiency System (VES) to identify the most fuel-efficient route and pursue JIT steady running strategy

To advance knowledge on green shipping, an empirically validated measurement scale for evaluating GSP implementation is useful for shipping firms to understand the concept and their implementation status.

## **Measures for evaluating green shipping practices implementation**

**Kee-Hung Lai and Y.H. Venus Lun**

Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University,

Hung Hom, Kowloon, Hong Kong E-mail: [mike.lai@polyu.edu.hk](mailto:mike.lai@polyu.edu.hk)

E-mail: [venus.lun@polyu.edu.hk](mailto:venus.lun@polyu.edu.hk)

**Christina W.Y. Wong\***

Business Division,

Institute of Textiles and Clothing,

The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

E-mail: [christina.wy.wong@polyu.edu.hk](mailto:christina.wy.wong@polyu.edu.hk)

\*Corresponding author

**T.C.E. Cheng**

Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University,

Hung Hom, Kowloon, Hong Kong E-mail: [edwin.cheng@polyu.edu.hk](mailto:edwin.cheng@polyu.edu.hk)

**Abstract:** Despite the need for environmental management in shipping, there is no extant measurement scale that comprehensively captures green shipping practices (GSP) in shipping operations. In view of this research void, we investigate the construct of and develop a measurement scale for evaluating GSP implementation in the shipping industry. Based on conceptualisation of GSP in an earlier study and survey data collected from 107 shipping firms, we develop, refine, and test a six-dimensional GSP measurement scale specifically for evaluating GSP implementation in the sea transportation context. The six GSP dimensions include company policy and procedure (CPP), shipping documentation (SD), shipping equipment (SE), shipper cooperation (SC), shipping materials (SM), and shipping design for compliance (SDC). We construct two measurement models at first- and second-order levels for evaluating the implementation of GSP and validate them by confirmatory factor analysis (CFA). The empirical findings suggest that both of the measurement models for evaluating GSP implementation are reliable and valid. This study makes a novel contribution to the shipping literature by empirically developing and validating the construct of GSP implementation. Practically, we contribute a validated measurement scale useful for shipping companies to evaluate the strengths and weaknesses of their greening efforts and identify areas for improvement.

**Keywords:** shipping; environmental management; construct measurement;

# Sustainable shipping – literature discussion

- Examine the literature discussion on sustainable shipping from a holistic perspective in liner shipping context
- Track the scale and scope of sustainable shipping research over time, based on a sample of 253 papers
- Employ citation network analysis to construct an objective starting point

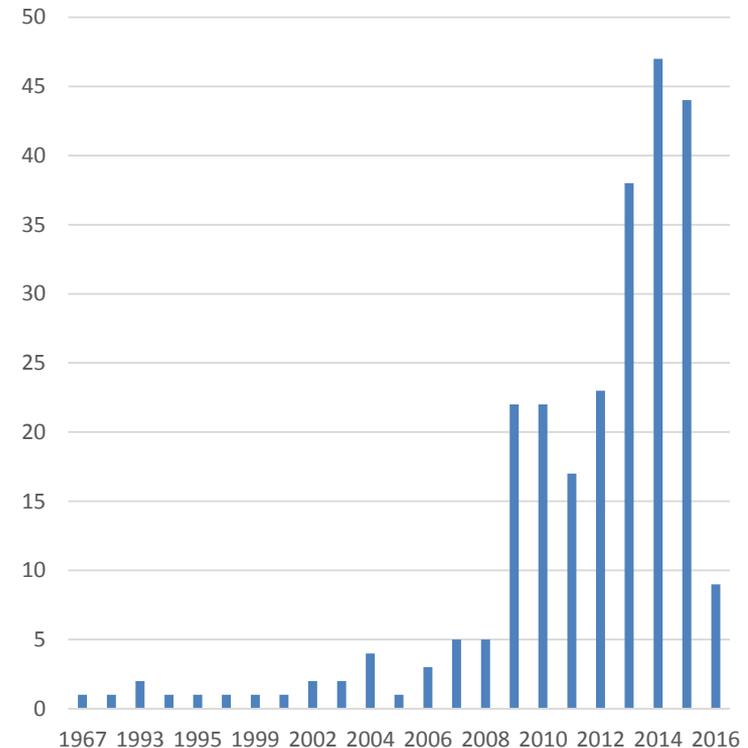
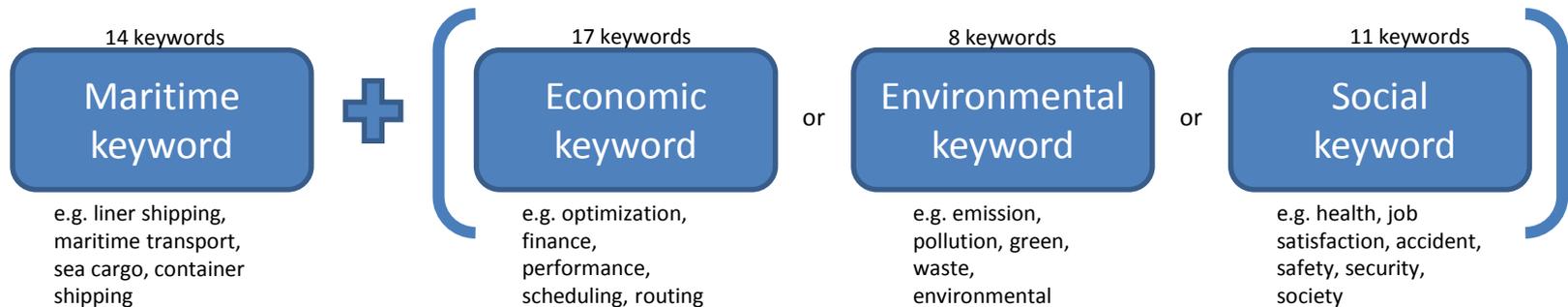


Figure: Overview of publications over time (data until February 2016)

# Citation network analysis – search string



- Extracted from Web of Science
- Any article with a maritime and at least one sustainability keyword in title, abstract or keywords was eligible for the data set
- Keywords chosen based on experience and prolific articles, improved in iterative process
- Over 750 initial hits
- Filtering on “transportation” retained 253 articles

# Citation network analysis - data sample

- Modelled as network
  - Publications are nodes
  - Citations are arcs
  - Unconnected papers were removed
- Descriptive analysis and clustering
  - Clustering identified four main research domains
  - Central domain divided into three sub-domains

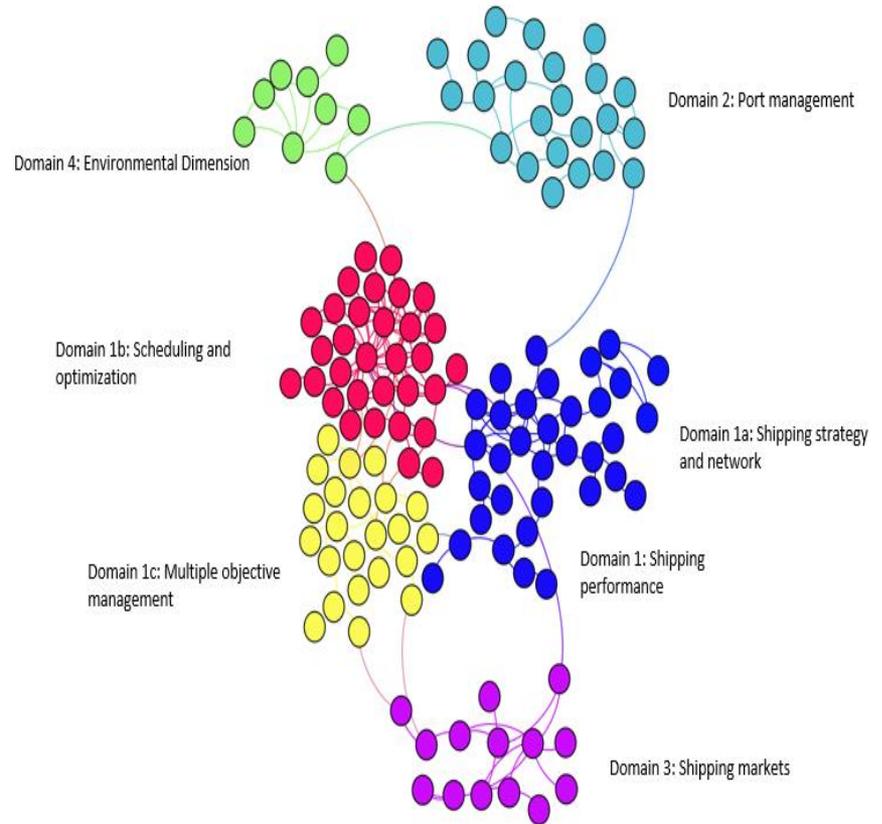
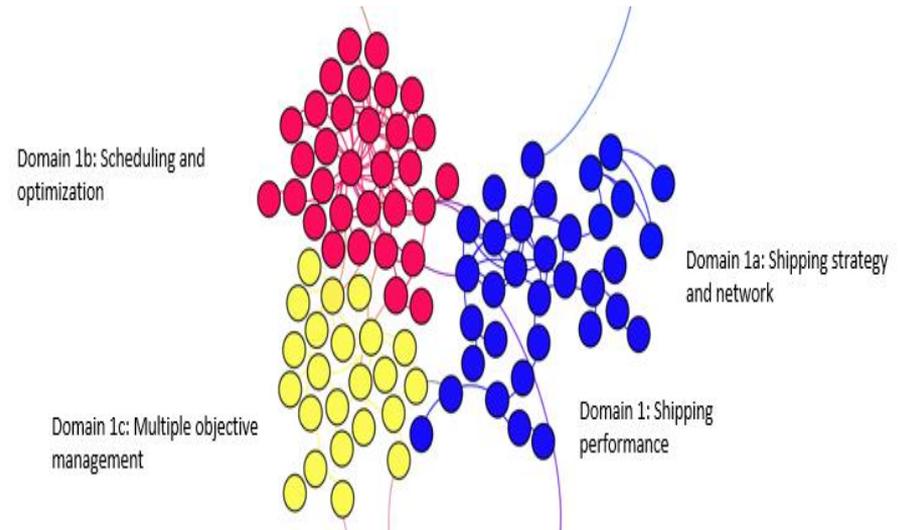


Figure: Research domains as identified via citation network analysis and clustering

# Citation network analysis - findings

- Shipping performance
  - Shipping strategy and network
    - Central to shipping performance
    - Implications on sustainability performance (e.g. empty container repositioning)
  - Scheduling and optimization
    - Discusses core issues of economic sustainability
    - Reflects strong cost pressures in industry
  - Multiple objective management
    - Efforts to address multiple issues, e.g. slow steaming
    - Potential to move towards a more holistic understanding of sustainability, but economic considerations are prevalent



## Shipping strategy and network

- 34 articles
- Economic focus

## Scheduling and optimization

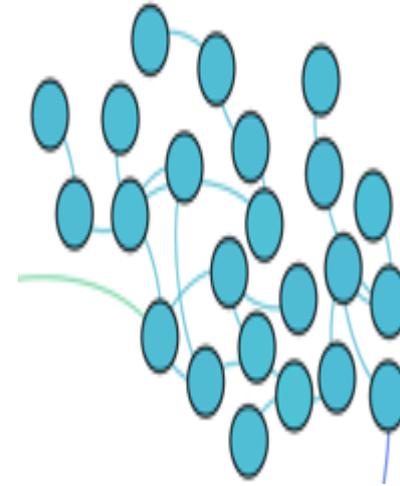
- 32 articles
- Economic focus

## Multiple objective management

- 23 articles
- Economic focus with environmental implications

# Citation network analysis - findings

- Port management
  - Includes research on liner shipping supply chain partners
  - Studies show a strong regional geographical focus
  - Recently, increased efforts regarding social and environmental impacts of port operations



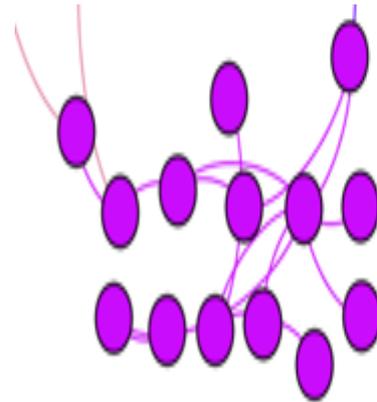
Domain 2: Port management

## Port management

- 23 articles
- Predominantly economic focus

# Citation network analysis - findings

- Shipping markets
  - Discusses shipping markets and their economic impact on a global scale
  - Studies interplay between maritime economics and society
  - Includes discussion on safety, security and quality management, as well as maritime piracy



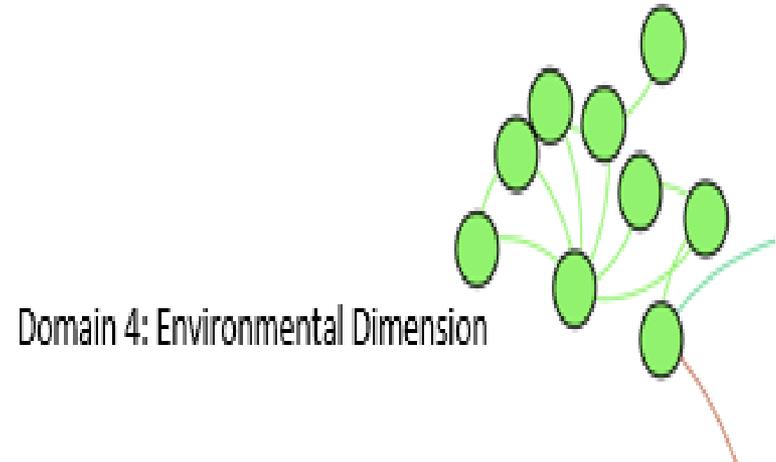
Domain 3: Shipping markets

## Shipping markets

- 14 articles
- Economic focus with social implications

# Citation network analysis - findings

- Environmental dimension
  - Includes papers focusing on green shipping practices (e.g. bunker levies, CO<sub>2</sub> schemes)
  - Focus still lies on operational efficiency of liner shipping
  - Distinct enough to position itself from the predominantly economic discussion



## Environmental dimension

- 9 articles
- Environmental focus embedded in operational considerations

# Citation network analysis - conclusion

- Scale
  - Literature has developed significantly
  - Authors are branching out to discuss new topics
- Scope
  - Economic considerations are central and the most regarded
  - Environmental aspects are increasingly discussed
  - Social dimension of liner shipping is currently least regarded

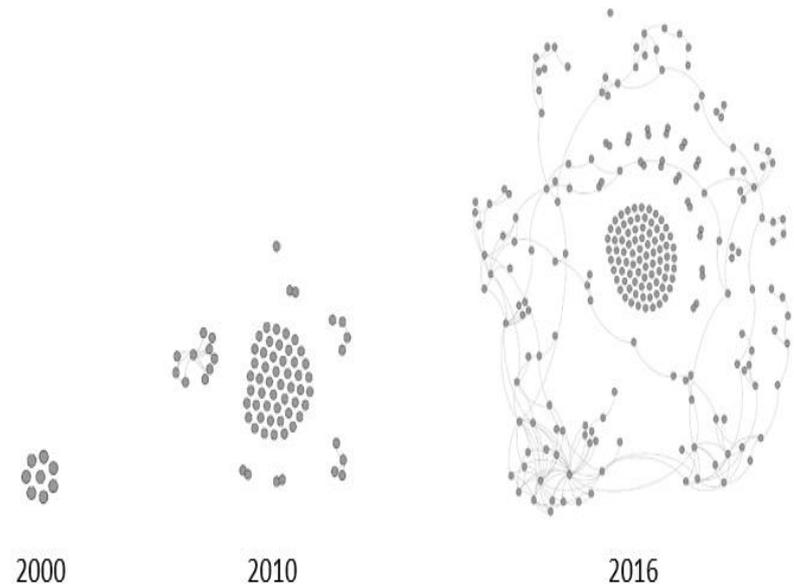


Figure: Development of scale and connectivity of literature from 2000 to 2016

# Sustainable shipping – industry discussion

- Examine sustainable shipping based on the reporting by ten largest liner shipping companies
- They are subject to three types of institutional pressures to communicate their sustainable shipping practices, namely
  - Coercive
  - Normative
  - Mimetic

# An Institutional Perspective on the Diffusion of Social Sustainability and its Discourse in Liner Shipping Operations\*

Markus Vejvar, Kee-hung Lai and Chris K.Y. Lo  
*The Hong Kong Polytechnic University, China*

Even though sustainability in maritime transport is increasingly emphasized by researchers and practitioners, social sustainability in this context remains underexplored. Based on neo-institutional theory, we formulate three propositions to conjecture how coercive, normative and mimetic isomorphic pressures affect the social sustainability discourse in the liner shipping operations context. We apply a qualitative content analysis approach to the sustainability communications of the top ten biggest companies, in terms of fleet size, in the liner shipping industry. We conclude that while normative pressures generated through shared expectations and social obligations and coercive pressures stemming from laws and regulations certainly shape the social sustainability discussion within the industry, there are no distinctive results on the effect of mimetic pressures on the social sustainability discourse. Based on these results, we also point to potential future research fields.

- Institutional theory
- Social sustainability discourse
- Isomorphism
- Liner shipping
- Content analysis
- Diffusion

Markus Vejvar holds a bachelor's degree in business, economics and social science and a master's degree in supply chain management from the Vienna University of Economics and Business. He is currently a doctoral student at the Department of Logistics and Maritime Studies of The Hong Kong Polytechnic University. His research interest lies in sustainability in shipping and transportation management.



[markus.vejvar@connect.polyu.hk](mailto:markus.vejvar@connect.polyu.hk)

\* This article was presented at the CSR in the International Shipping Industry workshop hosted by the Copenhagen Business School in May 2016. The authors would like to thank the discussants Michael Zhang and Hans Krause Hansen for their suggestions, as well as all other participants for their comments in the group discussion, most notably Helen Sampson and René Taudal Poulsen, who went out of their way to provide feedback; the combined comments have helped to significantly improve the quality of our work. We would also like to thank Peter Lund-Thomsen for organizing the workshop, and Henrik Sornn-Friese from CBS maritime for hosting it. This article is a learning outcome by the first author for his Guided Study I subject at The Hong Kong Polytechnic University.

# Sustainable shipping – industry discussion

- Qualitative content analysis of biggest container lines (fleet size)
- Secondary data over 10 years:
  - Sustainability reports
  - (ISO) certifications (ISO 9001, ISO 14001, ISO 26000; OHSAS 18001)
  - Awards
  - Voluntary group memberships (e.g. CCWG, Trident alliance)
  - Other documents and company communication

Rnk	Operator	Teu	Share	Existing fleet	Orderbook
1	APM-Maersk	3,086,730	15.0%		
2	Mediterranean Shg Co	2,680,153	13.0%		
3	CMA CGM Group	1,792,566	8.7%		
4	COSCO Container Lines	1,549,985	7.5%		
5	Evergreen Line	936,902	4.5%		
6	Hapag-Lloyd	924,068	4.5%		
7	Hamburg Süd Group	650,109	3.2%		
8	Hanjin Shipping	613,811	3.0%		
9	OOCL	599,303	2.9%		
10	MOL	554,477	2.7%		

Source: Alphaliner (2016)

# Findings

- Companies become increasingly aware of the importance of sustainability reporting
  - 7 out of 10 companies issue regular reports, compared to 3 out of 10 in 2005
  - A trend towards more detailed reporting, both in scale and scope
  - Yet, some of the biggest companies (MSC, CMA CGM Group) do not report
  - Social sustainability is not well regarded – many companies mostly focus on environmental implications

# Coercive pressures

- Examples
  - Laws and regulations (IMO, ILO, maritime labour convention, governments)
  - Pressures from supply chain partners (e.g. alliances, ports and terminals, freight forwarders)
- Findings
  - Strongest source of coercive pressures is still regulatory framework
  - Reporting leaders share practices with laggards; little coercive pressures within alliances

# Normative pressures

- Examples
  - Shared expectations about business practices from customers and society
  - Consultants, expert recommendation, maritime education and academics
- Findings
  - Companies seem to feel the social expectation to issue sustainability reports and respond in kind
  - Language and style used in the reports is becoming increasingly homogeneous

# Mimetic pressures

- Examples
  - Reaction to organizational uncertainty
  - Particularly smaller companies tend to copy market leaders' successful paths
- Findings
  - Lack widely accepted practices for smaller companies to simply imitate the market leaders' (some market leaders report, some do not)
  - Need a holistic sustainability framework for companies to figure out what to do

# Summary

- Overall, the industry discussion is developing and maturing
- However, some companies lag behind
- Furthermore, many sustainability reports are confined to environmental reports
- A holistic sustainability framework and unified reporting standards can help their reporting
- A need to assess the discrepancy between sustainability reporting and the actual sustainability efforts as they might be white-washing their efforts

# Concluding remarks

- Not just green shipping, but sustainable shipping receives increasing attention in academia and practice (at least top liner shipping companies)
- Attention is biased towards the green aspect, the social dimension is less focused on
- Need for further research on the conceptualization, adoption, diffusion, and performance implications of sustainable shipping to promote awareness and instill confidence in related practices