Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Background

- The Singapore Port, as shown in Figure 1, is the world's second-busiest port in terms of total shipping tonnage, transshipping one fifth of the world's shipping containers and half of the world's crude oil.
- For marine planning and port operation management, it is quite important to clarify where the ships come from and where they will go, and find out where the ship traffic speed or density varies greatly and how they evolve over time (Figure 2).
- Specific research on quantitative analysis of the traffic spatial temporal dynamic using big AIS data remains very sparse.

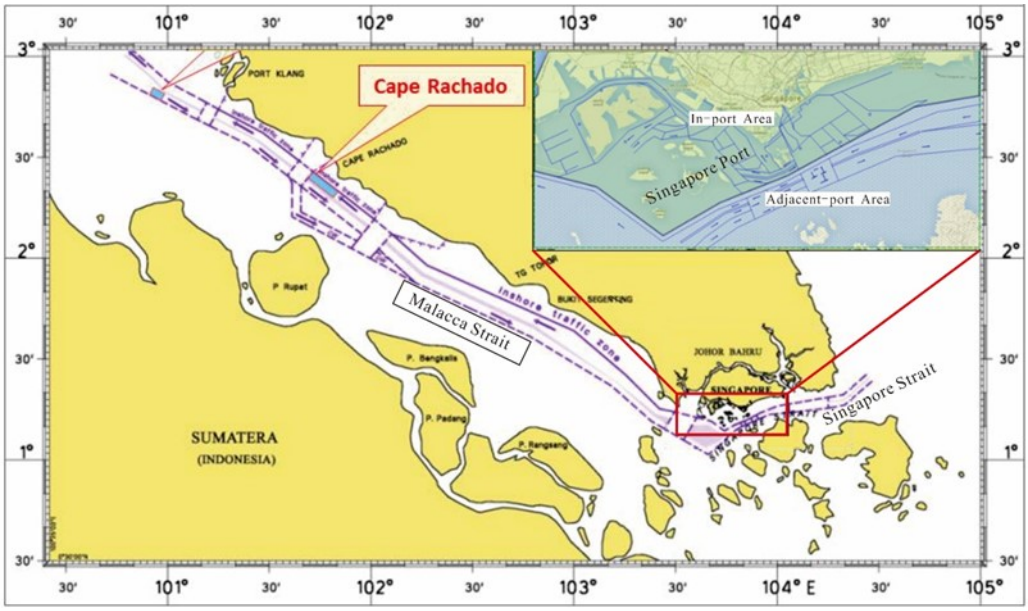


Figure 1. Singapore Port and Singapore Strait

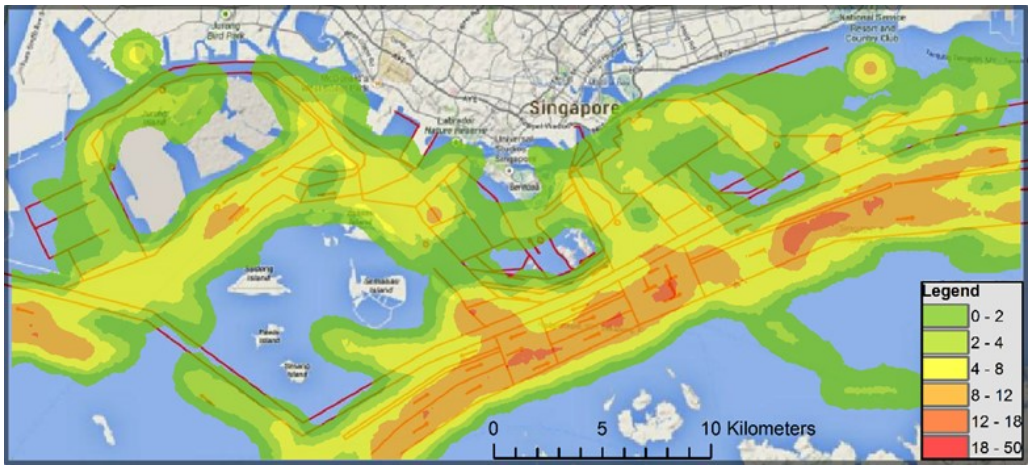


Figure 2. Spatial distribution of speed in Singapore Port (04:00-00:15,October 2,2013)

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Objective and Contribution

- **Objective**
  This study aims to develop a tangible analytical approach for ship traffic demand estimation and traffic state spatial temporal analysis based on AIS data. Investigate the ship traffic spatial temporal dynamic in Singapore using the proposed approach.

- **Contribution**
  - This study develops a ship traffic demand estimation method based on ship navigation activity chain analysis based on GIS data.
  - A ship traffic spatial temporal analysis model is proposed to quantitatively depict the spatial temporal dynamic of ship traffic flow in port waters.
  - Based on the field data analysis, several spatial temporal dynamic features of ship traffic in Singapore Port are found, which can be used to support decision-making for port operators.

Methodology

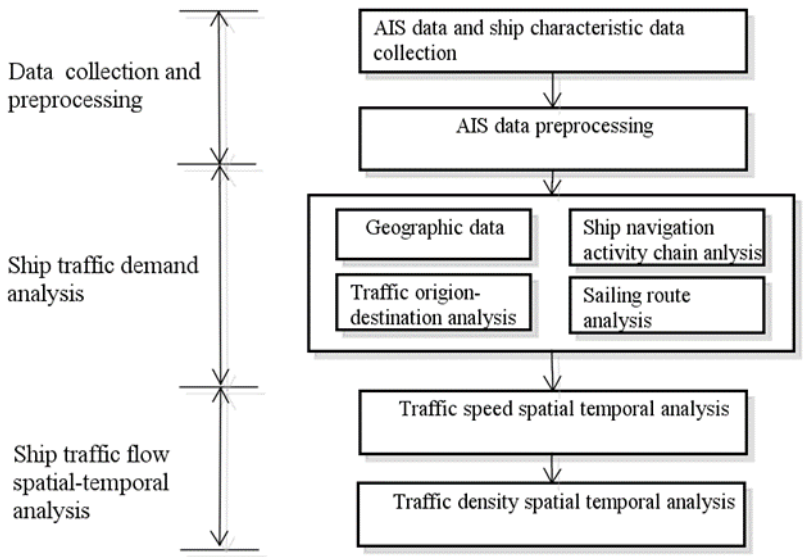


Figure 3. The framework of ship traffic spatial temporal analysis

- **Ship activity chain**

The trajectories of a ship fleet can be descripted by a set $J = \{\mathrm{J}_i \mid \mathrm{J}_i, i = 1,2,\ldots,M\}$, where J_i is the trajectory of ship i, and M is the number of ships. The trajectory of ship i is defined as

$$J_i = \{\mathrm{p}_j^{\,k} \mid p_i^k = (t_k, \mathrm{x}_i^k, y_i^k, \mathrm{u}_i^k)^T, \mathrm{k} = 1,2,\ldots,N\} \qquad \text{Λ1)}$$

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Methodology

where k is the time interval index and N is the total number of time intervals during the analysis period (e.g., if one hour is divided into 12 segments with each equal time interval of 5 minutes, then $N=12$ and $k=1,2,\ldots,12$.), p_i^k is the state of ship i at time t_k , t_k is the time with the index k (seconds), x_i^k and y_i^k are coordinates of ship i at time t_k , u_i^k is the speed of ship i at time t_k .

Activity chain of a ship generally includes two types of activities, namely sailing activity and receiving service activities. The journey of a ship is one trip from one maritime traffic zone (MTAZ) to another traffic zone. The activity of receiving services includes loading goods, unloading goods, waiting in anchorages, replenishing food, water and energy, or others. Thus, activity chain of ship i can be noted by a set as, $A_i=\{\mathrm{T}_i,S_i\}$ where T_i is trip of ship i , and S_i is the receiving service activities of the ship i . T_i is defined as $T_i=\{\mathrm{J}_i(\mathrm{t}_1{}^k,t_2^k)\,|\,k=1,2,\ldots N_T{}^i\}$, where $N_T{}^i$ is the number of trips of ship i , k is trip index. $J_i(\mathrm{t}_1{}^k,t_2{}^k)$ is the kth trip of ship i between time t_1 and t_2 , defined as

$$J_i(\mathrm{t}_1{}^k,t_2{}^k)=\{\mathrm{p}_j{}^i \mid t_1{}^k \le i \le t_2{}^k\} \qquad \text{٨2)}$$

- **The ship OD matrix estimation method**

Step 1: Fetch all records of data from the AIS database. Set $J=\varnothing,\mathrm{OD}=0_{n\times n}$, $TP=\varnothing$.

Step 2: Categorize the AIS records using the MMSID and assort the records according to time. Then create the trajectory set J .

Step 3: Analyze the activities of every ship using the aforementioned method and initialize A , T and S .

Step 4: Iterate all elements in T and create the set of the trips of all OD pairs, namely TP .

Step 5: Create the OD matrix, and the element of OD is calculated by

$$d_{i,j}=|\mathrm{TP}_{i,j}|$$

where $||$ is the operator to calculate the element number of a set.

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Methodology

- **Ship traffic state spatial dynamic model**

The water areas are divided into m row and n column cells. The spatial weight matrix is as follows,

$$W=[w_{ij}]_{K\times K}=\begin{bmatrix} 0 & w_{12} & w_{13} & \cdots & w_{1n} \\ w_{21} & 0 & w_{23} & \cdots & w_{2K} \\ w_{31} & w_{32} & 0 & \mathrm{L} & w_{3K} \\ \mathrm{M} & \mathrm{M} & \mathrm{M} & \mathrm{O} & \mathrm{M} \\ w_{K1} & w_{K2} & w_{K3} & \cdots & 0 \end{bmatrix} \qquad (3)$$

where i, j are respectively the row number and column number, $w_{ij}=1/d_{ij}$, d_{ij} is the distance between the centroid of cell i and cell j, and K is the number of cells.

The global spatial Moran's I index measures the spatial pattern of the ship traffic state. Given a set of ship traffic state values and an associated position, it evaluates whether the spatial pattern is clustered, dispersed, or random. It is calculated as,

$$I=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}\times s_{ij}}{\sigma^2\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}}=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}\times(x_i-\bar{x})(x_j-\bar{x})}{\sigma^2\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}} \qquad (4)$$

where, $\sigma^2=\frac{1}{n}\sum_{i=1}^{n}(x_i-\bar{x})^2$ is the variance, s_{ij} is the difference of observation i and j, W_{ij} is the spatial-temporal weight matrix, x_i is the attribute value of observation I and $\bar{x}$ is the mean of the attribute value of all observations.

We also create a the local Moran's index model to find the hotspots of high speed or density, or find the water areas where ship speed or density varies greatly. The local Moran's index is calculated according the following formula,

$$I_i=\frac{(N-1)(x_i-\bar{x})\sum_{j=1}^{n}w_{ij}\times(x_j-\bar{x})}{\sum_{j=1,j\neq i}^{n}(x_j-\bar{x})^2} \qquad (5)$$

where, I_i is the local Moran's I of the i th observation, N is the number of the sample number, w_{ij} and $\bar{x}$ have similar meanings as that in formula (4), and x_i, x_j are the ship traffic density or the traffic speed.

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Analysis Results

- **Ship traffic demand**

As shown in Figure 4, the study area is divided into traffic zones according to their functions. The traffic ODs are shown in Figure 5. Headways of majority traffic zones follow exponential or shifted exponential distributions (Table 1), and headways of minority traffic zones follow Weibul distribution or Lognormal normal distribution.

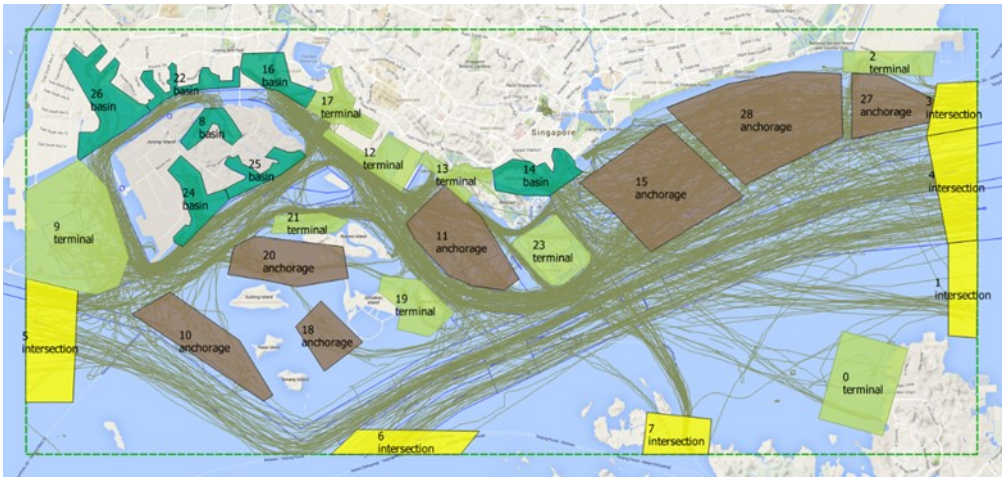


Figure 4. Traffic zones in study area

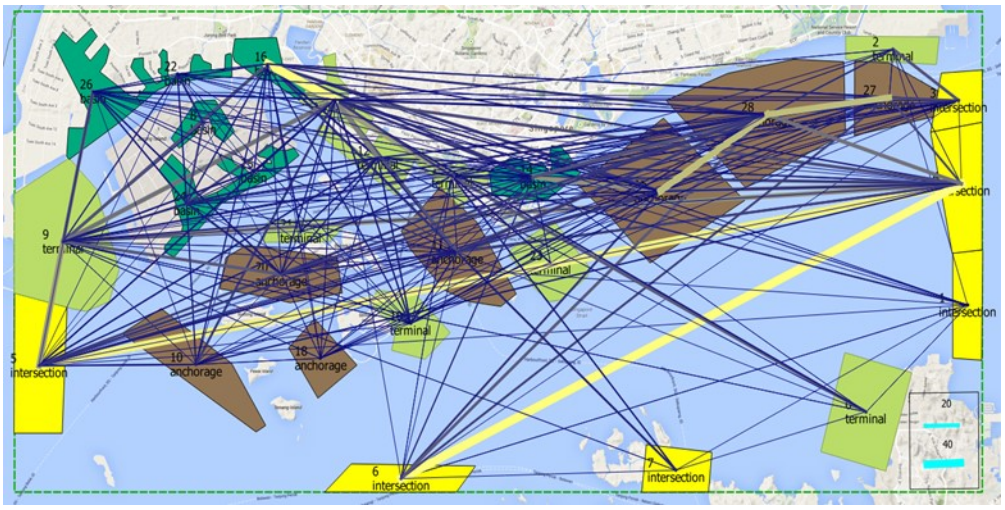


Figure 5. Ship traffic OD graph

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Analysis Results

Table 1. Ship head distribution

ID	Sample size	Mean	StDev	Skewness	Distribution name	parameters	Fitness test P-Value
G4	536	8.052	8.060	1.889	2-Parameter Exponential	η =8.067 s =-0.015	0.139
A4	597	7.227	6.990	1.937	2-Parameter Exponential	η =7.240 s =-0.012	0.015
G5	212	19.722	25.534	2.664	3-Parameter Weibul	α = 0.806 β =17.471 γ =-0.026	0.062
A5	501	8.615	8.828	2.004	2-Parameter Exponential	η =8.632 s =-0.017	0.013
A6	36	233.750	219.822	1.713	Lognormal	σ = 0.917 s =5.079	0.936
G6	372	11.555	12.143	2.121	2-Parameter Exponential	η =11.586 s =-0.031	0.220
A7	103	37.956	55.095	4.087	2-Parameter Exponential	η =38.328 s =-0.372	0.050
G7	96	41.984	53.012	2.923	2-Parameter Exponential	η =42.426 s =-0.442	0.108

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Analysis Results

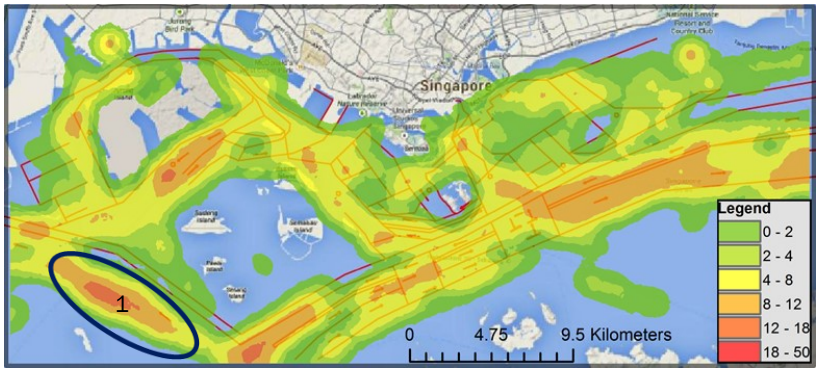
- **Traffic spatial temporal dynamic**

According to Table 2, traffic speed are clustered in port waters. It can also be found that the spatial distribution patterns of traffic speed of both daytime and nighttime are quite similar, which are highly clustered.

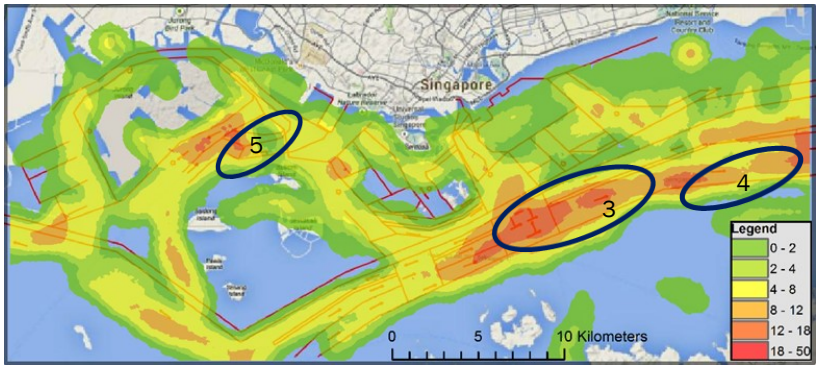
Table 2. Global spatial autocorrelation test

No.	time	z-score	p-value	Moran's Index		Spatial pattern
1	00:00-00:15	32.670	$<10^{-3}$	0.621		clustered
2	04:00-04:15	33.879	$<10^{-3}$	0.644		clustered
3	08:00-08:15	31.468	$<10^{-3}$	0.598		clustered
4	12:00-12:15	30.133	$<10^{-3}$	0.573		clustered
5	16:00-16:15	30.670	$<10^{-3}$	0.583		clustered
6	20:00-20:15	32.613	$<10^{-3}$	0.620		clustered

According to Figure 6 and Figure 7, there are several hotspots in Singapore Strait. The disturbance areas are anchorages and berths, where there is disturbances of ship traffic flow from perspective of speed stability. The disturbance areas are anchorages and berths, where there is disturbances of ship traffic flow from perspective of speed stability.



00:00-00:15, October 2, 2013

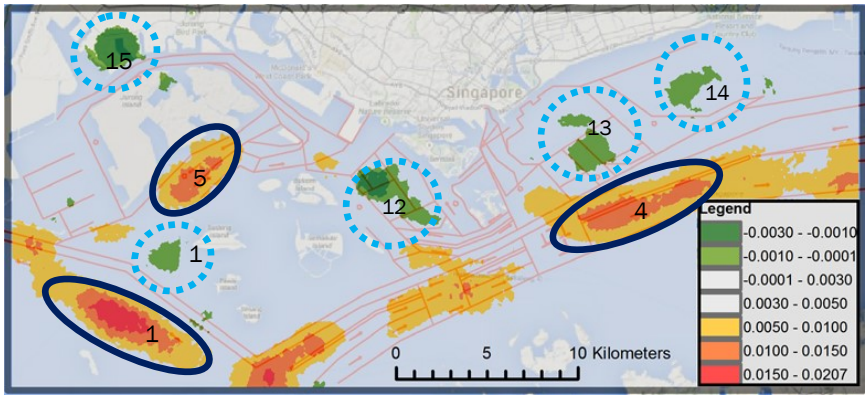


08:00-08:15, October 2, 2013

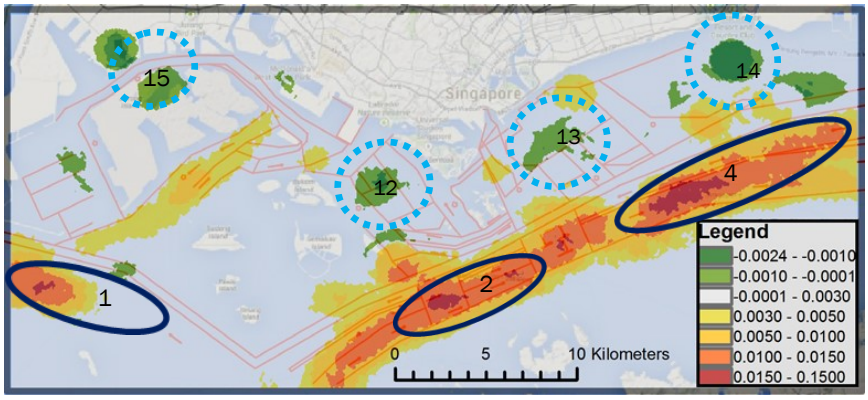
Figure 6. Space distribution of ship speed over time (Knots)

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Analysis Results



00:00-00:15, October 2, 2013



04:00-04:15, October 2, 2013

Figure 7. Local Maron's index of ship speed

The ship accidents data are obtained from Global Integrated Shipping Information System of International Maritime Organization (https://gisis.imo.org). It can be easily found that hotspot areas of ship speed are also hotspot areas of ship accidents (Figure 8).

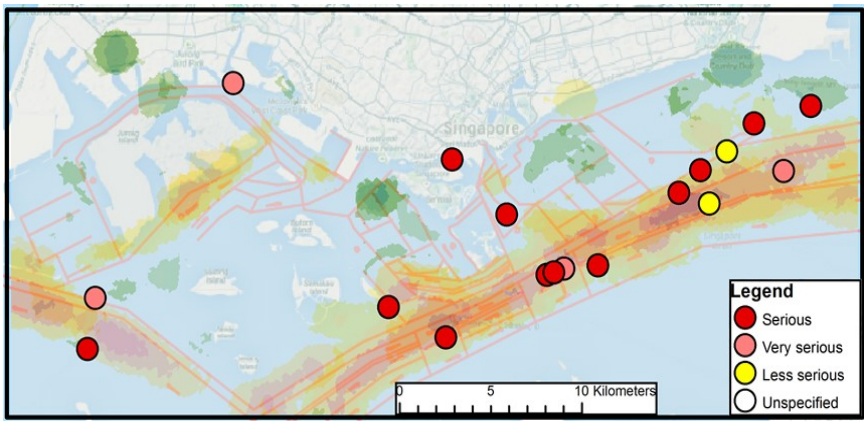


Figure 8 Spatial distribution of ship accidents and ship traffic speed

Research Highlight 1: Big Data Based Ship Traffic Spatial-temporal Dynamic Analysis in Port Waters: A Case Study in Singapore Port, by Dr. Zhang Liye (Track Leader: Professor MENG Qiang)

Conclusion

- Ship Traffic OD in Singapore port was estimated by navigation activity chain analysis of individual ships based on real Big AIS data.
- Both ship traffic OD and ship navigation routes in Singapore Port keep quite stable over time.
- Ship headways can be well depicted by shifted exponential distributions or exponential distributions.
- According to traffic speed spatial analysis, several hotspot areas and disturbance areas were found. It was found that hotspot areas of speed were also hotspot areas of ship accidents, however ship density showed no significant relationship with ship accidents.

Research Highlight 2: Viability of Transarctic Shipping Routes and Their Impact Analysis on Maritime Transportation, by Ms. ZHANG Yiru (Track Leader: Professor MENG Qiang)

Background

Seaborne cargo transport in Arctic waters was previously infeasible due to harsh ice conditions. The continuous retreat of Arctic sea ice (Figure 1) since the 1950s has fuelled speculations of new transarctic shipping routes to be operational soon.

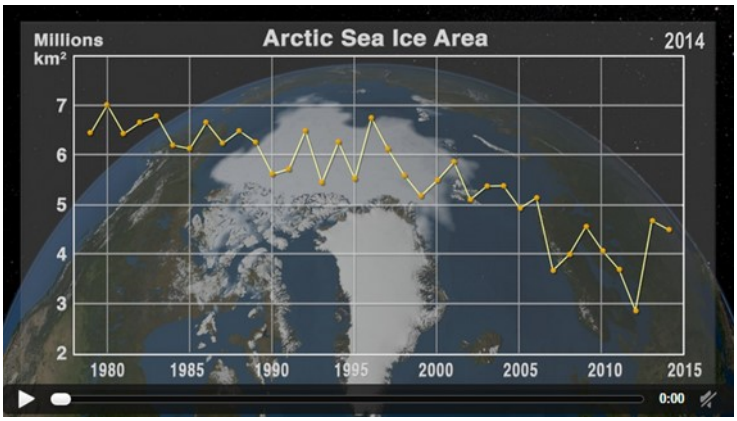


Figure 1

The Northern Sea Route (NSR), Northwest Passage (NWP) and Transpolar Sea Route (TSR) are the three passages of study interest (Figure 2).

Figure 2

In various studies and media releases, the substantial distance reduction of the passages is repeatedly stated (Figure 3). For instance, the distance between Yokohama in Japan and Hamburg in Germany is only 6,600 nautical miles (nm) by way of the NSR, as against 11,400 nm through the Suez Canal; the NWP would reduce the distance from Vancouver/Seattle to Rotterdam (via Panama) from 8,850 nm to 6,950 nm. These imply a 42% reduction and a 21% saving in freight distance respectively. If one uses the TSR across the North Pole, the distance is shortened by yet another few hundreds nautical miles.

Research Highlight 2: Viability of Transarctic Shipping Routes and Their Impact Analysis on Maritime Transportation, by Ms. ZHANG Yiru (Track Leader: Professor MENG Qiang)

Background

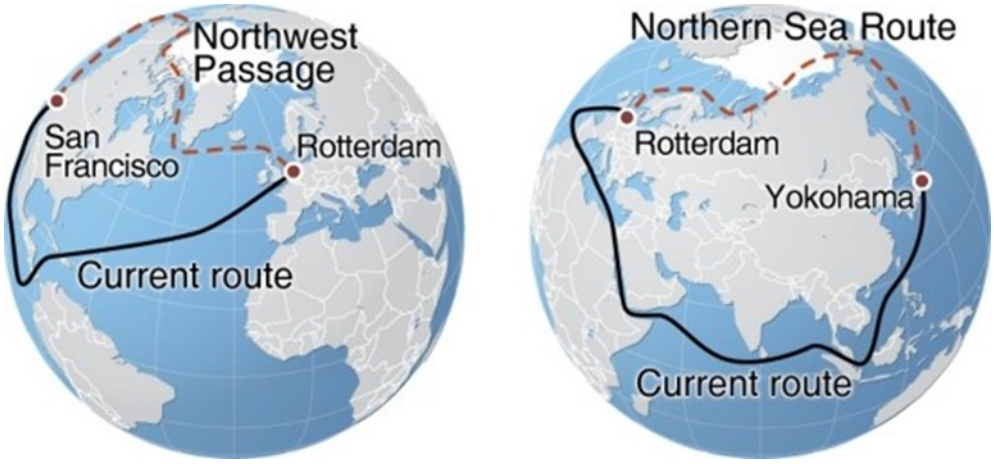


Figure 3

Besides substantial distance reduction, the discovery of new natural resources in the Arctic also stimulates the exploration of transarctic shipping routes. The Arctic contains vast oil and natural gas reserves—the US Geological Survey estimates the Arctic could contain 1,670 trillion cubic feet of natural gas and 90 billion barrels of oil, or 30 percent of the world's undiscovered gas and 13 percent of oil. In particular, Russia Federation (RF) has the largest known natural gas reserves, along with the second largest coal reserves, and the eighth largest oil reserves. RF transports huge amount of energy resources to both domestic and foreign markets, and hence, NSR is naturally attractive to the shipping of the oil and gas.

Singapore has been granted permanent observer status in the Arctic Council since May 2013. Reacting to the new status, Prime Minister Lee Hsien Loong said in a statement: "Singapore is not situated in the Arctic, but developments there – whether the melting of the ice cap or opening of new sea routes – will have important implications for Singapore as a low-lying island and international seaport". Evidently, one of the major reasons for Singapore's active participation in the Arctic is the concern of adverse impact of opening up transarctic shipping routes on the port of Singapore.

Objectives

Our project aims to examine the conditions that makes the transarctic routes viable for shipping and quantitatively evaluate the impact of transarctic shipping routes on the port of Singapore as a premier transshipment hub for containers as well as an oil-and-gas hub. The viability of transarctic shipping routes can be understood from navigation and commercial perspectives. The impact on the port of Singapore can be analyzed by quantifying the shift in shipping market share from traditional shipping routes to trans-Arctic routes.

Viability Analysis

The Arctic ice has been observed to be decreasing in terms of extent and thickness in all seasons due to global warming. Reducing trends indicate longer periods of less and thinner ice cover in the Arctic Ocean and possibilities of increased shipping and extended sailing season.

Research Highlight 2: Viability of Transarctic Shipping Routes and Their Impact Analysis on Maritime Transportation, by Ms. ZHANG Yiru (Track Leader: Professor MENG Qiang)

Viability Analysis

However, the changes are not entirely appealing. There remains a significant, year-to-year variability in sea ice coverage, and uneven distribution of sea ice in different regions continues to pose challenges to navigation. In addition, floating ice in summer will remain a serious threat to ships, and prevalent ice in winter will obstruct passages by most ships. In terms of ice forecasting, current ice models are not comparable and thus there is no 'best' model to refer. We believe that the transarctic shipping routes are at best some seasonal alternatives to the traditional lanes, and sea ice will continue to act as the single greatest obstacle to navigation in the Arctic due to the complexity in ice conditions and its unpredictable nature.

Besides sea ice, unfavorable weather conditions may result in worse and more complicated ice conditions and lower visibility. None of the passages can offer ships a single navigation lane to follow. In practice, ships are forced to use the channel that offers the best ice and navigational conditions at any one time and place. Variations in water depth and narrow straits are key factors that decide which navigation course to set on the NSR. The NWP is difficult to navigate due to its complex geographies. When considering shipping on the TSR, the central Arctic Ocean has no draft limitations, narrow straits or complex archipelago to put constraints on navigation.

On other perspectives, an international legal framework specific to the Arctic region needs to be formally established to ensure safety for ship operating. Polar Code, which covers the full range of design, construction, equipment, operational, training, search and rescue and environment protection matters, is expected to come into effect in 2017. In addition, deficit of large-scale ports and supporting functions and facilities in the Arctic region is commonly criticised by ship operators. Numerous projects by Arctic nations are in the plan or ongoing, but it will require decades to build a comprehensive system as it is along the traditional routes.

The cost competitiveness of the transarctic shipping routes is another main consideration of the shipping companies who are interested in these routes. The commercial transits utilizing the routes are still limited, thus there lacks first-hand real shipping costs as reference. The existing cost models have their diversified assumptions for general portraits, distance travelled, speed of the vessels and etc. Thus, very different conclusions are arrived. Given all the parameters involved, 12 models concluded the transarctic shipping routes were commercially viable; 11 presented some relatively balanced results by concluding the routes were economic favored in some scenarios; and 2 argued that the transarctic routes could hardly be a feasible alternative at present. It may be impossible to draw some unified statements.

Research Highlight 2: Viability of Transarctic Shipping Routes and Their Impact Analysis on Maritime Transportation, by Ms. ZHANG Yiru (Track Leader: Professor MENG Qiang)

Current Ship Traffic Analysis

The number of transits grew rapidly in 2009-2014 with an average rate of 92.6%. However, in terms of absolute numbers, it is quite small (Figure 4) compared to those of the Suez (18,000 transits/year) and Panama (13,000 transits/year).

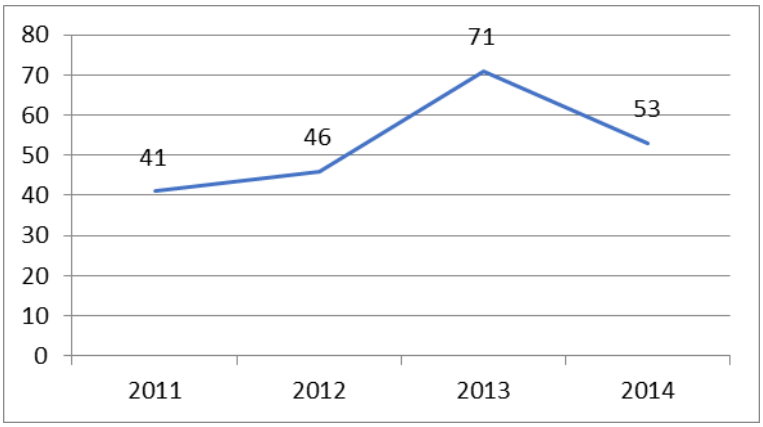


Figure 4: Number of transits over years

The cargo volumes grew in 2011-2013, but dropped in 2014 (Figure 5). Trade along the NSR has begun to take shape, but remained unstable and vulnerable.

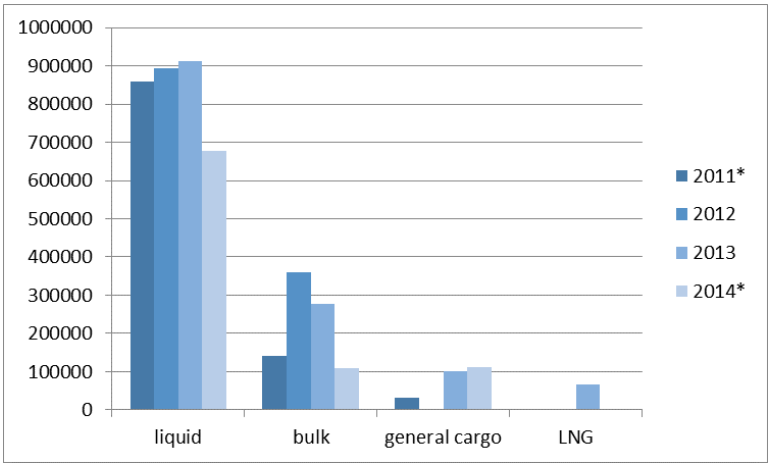


Figure 5: Trade volume (in tons) by cargo type

The navigation season at NSR lasts for around 5 months. During this time period, vessel class of Arc6 or above, can navigate the entire NSR independent. However, the investment for such vessels is huge, thus few shipping companies employ these vessels. Instead, Arc4 and Arc5 are used extensively. Arc5 is the minimum vessel ice reinforcement to traverse the NSR with icebreaker support under any ice conditions, and it can traverse independently under easy and moderate ice conditions. Arc4 can independently navigate in the NSR water under easy ice conditions, and navigate with icebreaker support under easy and moderate ice conditions. The Arc4 and Arc5 vessels could navigate through the NSR only seasonally.

Research Highlight 2: Viability of Transarctic Shipping Routes and Their Impact Analysis on Maritime Transportation, by Ms. ZHANG Yiru (Track Leader: Professor MENG Qiang)

Current Ship Traffic Analysis

Thus far, the transits were dominated by liquid as Russia provides a huge amount of energy resources to both domestic and foreign markets. Fuel transport will remain to be the base-load in NSR transits. Bulk shipping has a rather stable number of transits over the years, while general cargo transits increase over time. These two transportations do not have strict timeline to follow, thus are able to bear the great uncertainties in ice conditions and shipping time. In addition, the goods transported are usually of low value and the profit margin is relatively low. As a result, cost saving is of great importance for shipping companies to seize the gain. Thus, they are more active in exploring the new opportunities at NSR. On the other hand, few containerships have traversed the NSR so far. First, as indicated by the port call data, few transits involve stopovers. Unlike traditional routes, transshipment demand is low on the NSR and port-to-port container demand may not be able to cater the capacity of a ship. Second, ice conditions remain challenging for containerships. One consideration of the shipping line is the reliability of the transportation, and another is related to safety: containerships require high stability due to high stacks of containers on the deck. An expansion in container shipping is unlikely in the near future.

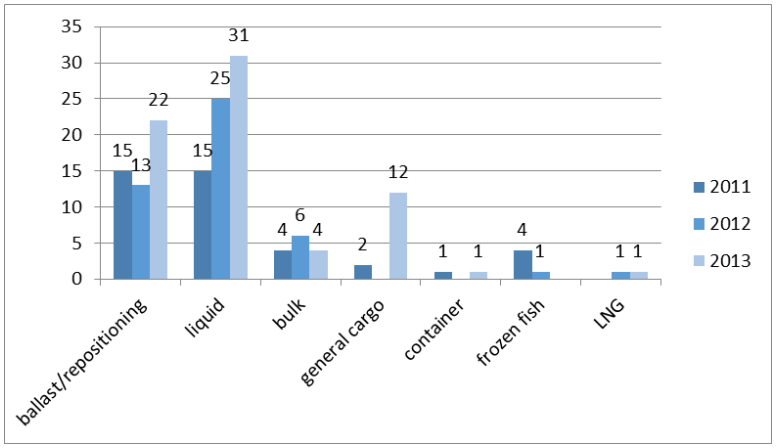


Figure 6: Number of transits by cargo type

The interest of some Asian countries, especially China, Republic of Korea and Japan, is apparent. China, as the world's biggest energy consumer, is eager to purchase more energy from Russia. Except two international transits each in 2012 and 2013, all the rest of the activities in 2011-2013 are destinational. China imports gas condensate from Vitino and Ust-Luga and iron-ore concentrate from Murmansk. Republic of Korea involved in more international transits compared to China. There are 1, 4 and 4 international shipping activities respectively in 2011-2013. Although Japan has the least number of overall transits among three countries, the proportion of international transits is the greatest. And the first LNG transportation in 2012 is from Norway to Japan. This may likely to grow in terms of transit number and trade volume under the Yamal LNG project.

Conclusion and Future Work

We conduct studies on the navigation and commercial features of the transarctic shipping routes by reviewing various existing literatures. We then proceed to analyze the current ship traffic along the NSR to understand the characteristics of real shipping activities there. We would restate some of the important findings and conclusions as follows:

Research Highlight 2: Viability of Transarctic Shipping Routes and Their Impact Analysis on Maritime Transportation, by Ms. ZHANG Yiru (Track Leader: Professor MENG Qiang)

Conclusion and Future Work

- For navigation aspect, future sea ice conditions (and thus navigability) remain uncertain and sea ice will continue to act as the single greatest obstacle to navigation in the Arctic. Firstly, there remains a significant, year-to-year variability in sea ice coverage, and uneven distribution of sea ice in different regions continue to pose challenges to navigation. In addition, floating ice in summer will remain a serious threat to ships, and prevalent ice in winter will obstruct passages by most ships. Besides sea ice, unfavorable weather conditions may result in worse and more complicated ice conditions and low visibility. Complex geographical situations also restrict the size of the vessel that can traverse. Various services and supports should be further developed to ensure a safe navigation.

- As for commercial viability, we review a total of 25 publications and compare the general portraits (e.g. route selected, OD pair and ship type) of the cost models, variables considered in shipping time and shipping cost formulations as well as conclusions. We are aware that different publications had distinctive study interests and hence assumptions varied. These naturally derived multifarious conclusions. More importantly, commercial studies usually relied on subjective conjectures, and navigation and operational reality was often neglected.

- In the ship traffic analysis, the transit data provided by Russia and the port call data obtained through a commercial provider are examined. We believe that real statistics can add value to the viability analysis by identifying key players and exhibiting trade pattern at NSR. Also, maritime sectors can benefit from findings of the ship traffic analysis: the time window of the route, existing cargo flow and potential trade opportunities.

- After these works, we aim to conduct impact analysis of transarctic shipping routes on the port of Singapore in the second year. The discrete choice modelling technique would be adopted to measure the shift in shipping market share from traditional shipping routes to transarctic routes.

Published Technical Papers (with Abstracts)

1. **Beng Wah Ang and Bin Su (2016), Carbon emission intensity in electricity production: A global analysis. *Energy Policy, Volume 94, Pages 56-63.***

Abstract:
We study changes in the aggregate carbon intensity (ACI) for electricity at the global and country levels. The ACI is defined as the energy-related CO2 emissions in electricity production divided by the electricity produced. It is a performance indicator since a decrease in its value is a desirable outcome from the environmental and climate change viewpoints. From 1990 to 2013, the ACI computed at the global level decreased only marginally. However, fairly substantial decreases were observed in many countries. This apparent anomaly arises from a geographical shift in global electricity production with countries having a high ACI increasingly taking up a larger electricity production share. It is found that globally and in most major electricity producing countries, reduction in their ACI was due mainly to improvements in the thermal efficiency of electricity generation rather than to fuel switching. Estimates of the above-mentioned effects are made using LMDI decomposition analysis. Our study reveals several challenges in reducing global CO2 emissions from the electricity production sector although technically the reduction potential for the sector is known to be great.

2. **Bin Su and Beng Wah Ang (2016), Multi-region comparisons of emission performance: The structural decomposition analysis approach. *Ecological Indicators, Volume 67, Pages 78–87.***

Abstract:
Structural decomposition analysis (SDA) has been widely used by researchers to study changes in carbon emissions or aggregate emission intensity over time in a country. These studies may be called temporal-SDA analysis. Similarly, SDA analysis can be conducted by studying variations in carbon emissions or aggregate emission intensity between countries or between regions in a country, i.e. a decomposition analysis conducted spatially. In spatial-SDA analysis, the objective is often to understand the contributions of factors such as emission intensity, Leontief structure, and final demand in explaining the difference in total carbon emissions or aggregate emission intensities between two countries or regions. We review the literature of spatial-SDA analysis and propose a spatial-SDA framework for multi-region comparisons. Both the additive and multiplicative SDA forms are presented in the framework. Using the framework, 30 geographical regions in China are compared and ranked based on their emission performance. This proposed framework can also be used to evaluate other performance indicators in multi-region comparisons.

3. **Xinchang Wang, Qiang Meng, and Lixin Miao (2016), Delimiting port hinterlands based on intermodal network flows: Model and algorithm. *Transportation Research Part E: Logistics and Transportation Review, Volume 88, Pages 32–51.***

Abstract:
This study aims to propose a tangible approach to delimiting the probabilistic hinterland of a port of interest. We first build a geometric model for the probabilistic port hinterland based on intermodal network flows jointly using discrete choice analysis and geographical information of shippers. We further design an algorithm that can efficiently determine the hinterland boundaries using the sample approximation of shippers' choice probabilities. We provide theoretical results that characterize the minimum computational effort required to achieve a certain degree of accuracy in the sample approximation. We also offer two numerical case studies to justify the proposed approach.

Published Technical Papers (with Abstracts)

4. **Shuaian Wang, Qiang Meng, and Chung-Yee Lee (2016), Liner container assignment model with transit-time-sensitive shipment demand and its applications.** ***Transportation Research Part B, Volume 90, Pages 135–155.***

Abstract:
This paper proposes a practical tactical-level liner container assignment model for liner shipping companies, in which the container shipment demand is a non-increasing function of the transit time. Given the transit-time-sensitive demand, the model aims to determine which proportion of the demand to fulfill and how to transport these containers in a liner shipping network to maximize the total profit. Although the proposed model is similar to multi-commodity network-flow (MCNF) with side constraints, unlike the MCNF with time delay constraints or reliability constraints that is NP-hard, we show that the liner container assignment model is polynomially solvable due to its weekly schedule characteristics by developing two link-based linear programing formulations. A number of practical extensions and applications are analyzed and managerial insights are discussed. The polynomially solvable liner container assignment model is then applied to address several important decision problems proposed by a global liner shipping company.

5. **Javed Farhan and Ghim Ping Ong (2016), Forecasting seasonal container throughput at international ports using SARIMA models.** ***Maritime Economics & Logistics.***

Abstract:
Seasonal container throughput forecasts at ports are immensely important to logistics companies, shipping lines, port authorities and shipyards. Such forecasts allow shipping lines and port operators to formulate appropriate short-to-medium strategies in order to maintain competitiveness. Seasonal autoregressive integrated moving average (in short, SARIMA) models can be employed for this purpose to provide reliable seasonal forecasts of container throughput at a given container port. This article explores the use of SARIMA models in forecasting container throughput at several major international container ports, while taking into consideration seasonal variations. First, the SARIMA model development methodology is described. Second, a database consisting of monthly container port traffic data between 1999 and 2007 for international container ports is developed. Short-term container demand forecasting models are then developed for each of the top 20 international container ports for the purpose of monthly container throughput prediction. Through the use of various performance metrics, the effectiveness of the developed SARIMA models for these ports is evaluated. It is found that SARIMA models can produce reliable throughput forecasts at major international ports. Qualitative insights are then drawn, thereby allowing shipping and port operators to make better tactical and operational decisions.

Conference Papers (with Abstracts)

1. **Giulia Pedrielli, Laura Gunarso, Ek Peng Chew and Loo Hay Lee (2016), Urban Consolidation Centre for Improving Shopping Mall Logistics in Singapore.** ***In proceedings of the 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

   Abstract:

   Shopping malls delivery plays an increasingly relevant role in today's urbanized society. Its impact is even more pronounced in Singapore due to its high density of shopping malls. Therefore, improving shopping malls delivery in Singapore has become an important topic in both societal and business/retail levels. At societal level, improvement in shopping malls delivery is necessary to reduce congestion, pollution, and safety problems. At business/retail level, improvement in shopping malls delivery is essential to help retailers meet their increasingly demanding customers' orders (Roca-Riu and Estrada, 2012). On the other end, it is compelling to improve the sustainability of such delivery process by reducing emissions increasing the utilization of trucks (Alexander, Floh, and Teller, 2015), in order to improve the mall logistics, improvement is required at the shopping mall delivery process level.

   This work aims to provide insights on impact and feasibility of applying Urban Consolidation Centre on shopping malls delivery processes in Singapore by using simulation to assess different scenarios. Specifically, this paper aims to first analyze the current shopping malls delivery processes, which involves manufacturers, logistics providers, mall operators, and retailers, and model them into a simulation model. Subsequently, a simulation model on the UCC -delivery system is developed and the results of the two models were compared to assess the impact of UCC.

2. **Chenhao Zhou, Giulia Pedrielli, Liang Hong Lee, Loo Hay Lee and Ek Peng Chew (2016), Data Driven based Clustering and Routing for Third-party Logistics.** ***In proceedings of the 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

   Abstract:

   With the explosive increase of e-commerce in Singapore, it has become a great challenge for the third-party logistics (3PL) to maintain/improve customer satisfaction and operation efficiency. One of the world's leading logistics company in Singapore is now dealing with high volume of deliveries and varying pickups.

   Most of the times, in the real practice, parcels are manually assigned to each vehicle and the vehicle routing is determined by the drivers. The inefficiency derived from such an approach can lead to decreasing service level due to the delivery delays, imbalanced workload between vehicles, etc. Therefore, it urges to have an efficient and effective method to deal with pick-up and delivery.

   This study adds to the current state of the art as it incorporates the historical delivery data and the online traffic data, i.e. Google Maps, to determine the clustering and routing, and eventually proposes an innovative heuristic algorithm. The objective is to develop a route for each vehicle to fulfill all customer demands, within the given constraints, while keeping costs minimal. Cost in the context of this paper is defined as the number of vehicles used, and the total make span of all the vehicles.

3. **Giulia Pedrielli, Vinsensius Albert, Ek Peng Chew and Loo Hay Lee (2016), Hybrid Strategies for Order Picking in a Warehouse for Fashion E-Commerce.** ***In proceedings of the 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

   Abstract:

   E-commerce has become an increasingly relevant business in South East Asia and particularly in Singapore. This research is motivated by the collaboration with one of the main fashion e-commerce companies in Singapore and South East Asia region. As in other businesses, the effective management of the warehouse in terms of supply, location and picking represent key competitive advantages for a company competing in this industry. Fashion products have distinctive characteristics which make them particularly difficult to efficiently manage in a warehouse; this is even more apparent in the case of low-value fashion products.

Conference Papers (with Abstracts)

More specifically, in the case of fashion products we have high variability in the demand in terms of volumes and value, short shelf life and rare replenishment of products where items are usually replaced with new collections. As a result of these characteristics, warehouse management becomes highly complicated due to the difficulty in recognizing highly frequent (stable) items and therefore organize the put-away (i.e., the inventory location) as well as the generation of the picking lists for the pickers.

In such a volatile environment, a single unique picking strategy is unlikely to satisfy the very diverse order profiles characterizing the demand faced by such an e-commerce company.

In this work, starting with a detailed demand analysis and the physical layout of the warehouse, we propose: (1) fast algorithm for generating picklists which consider several aspects such as work balancing and picking time minimization, (2) a family of picking strategies which takes into account the possible order configurations as well as the layout of the current warehouse. In order to assess the performance of the different strategies we propose the use of simulation as a general approach which can be easily extended to more complicated layouts.

4. **Renrong Weng, Javier Loh, Giulia Pedrielli and Loo Hay Lee (2016), Data Driven Newsvendor Problem.** ***In proceedings of the 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

Abstract:
The Newsvendor problem is the traditional inventory problem of determining how many copies of newspaper to order in the face of stochastic and unknown demand. In the typical form of the problem, a one-stage Newsvendor model is established to find the optimal stock level for maximizing its expected profit, based on the assumption that the demand distribution is known in advance. However, practitioners criticize that only a time series of sales data rather than the demand distribution is available in reality. Hence, a data driven analysis is desired to facilitate newspaper demand forecast and newspaper delivery decision-making.

We develop a Censored-Auto Regressive Integrated Moving Average (C-ARIMA) framework to predict newspaper demand and decide the copies of newspaper to order. In the proposed framework, we first remove the outliers using stochastic process control tool, followed by de-trending from the sales time series to get a relatively stationary time series. Furthermore, we propose an augmentation algorithm to adjust the censored demand to estimate the real demand. With the augmented time series, we apply Auto Regressive Integrated Moving Average (ARIMA) model to predict demand and distribute newspapers. In the numerical experiments, we use a realistic case thanks to the collaboration of one of the main news companies in Singapore. Two quantitative metrics regarding potential increasing revenue and availability, which is defined as the percentage of stores with at least one copy left at the end of the day, are proposed to evaluate the performance of our method and the approach currently adopted by the company. The results are promising and they indicate a substantial benefit of the proposed approach, especially in the reduction of the variability of the outcome.

5. **Zhipeng Qiu, Ek Peng Chew and Loo Hay Lee (2016), A Two-Stage Approach for Large Scale AGV Routing in the Automated Container Terminal.** ***In proceedings of 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

Abstract:
AGV routing, as one of typical operational problems in automated container terminal (ACT) is considered as a very complicated one in which each AGV may have multiple routes for the execution of its task and need to traverse a large number of zones associated to the routes. Moreover, to reduce the congestion and avoid conflicts in ACT, a large number of constraints on sequencing among AGVs in these zones especially in junctions should be enforced.

Conference Papers (with Abstracts)

Thus, AGV routing in a large-scale ACT is recognized to be extremely difficult because of its combinatorial nature of integer optimization and the large size of the problem, requiring the effective approaches for its solution. In this study, mixed integer formulation of AGV routing in ACT is first presented. Then, a rule-based two-stage algorithm is proposed to deal with the two major sub-problems in AGV routing in ACT, namely, the route selection based on link direction design and the lane-based scheduling of the AGVs. To verify the effectiveness of the proposed algorithm, test instances in different sizes of networks are given and solved using rule-based algorithm and non-rule-based one. The corresponding comparison between two is also provided. The preliminary results show that the proposed algorithm is promising to obtain relatively good solutions in a reasonable amount of time.

6. **Qitong Zhao, Ek Peng Chew and Loo Hay Lee (2016), Real-time Deadlock-free Routing for AGV System in Container Terminal.** ***In proceeding of 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

Abstract:
The development of the container shipping industry makes the automated container terminal a future trend to remain competitive. Automated Guided Vehicles (AGVs) are one of the most commonly used transporters to transport the containers from the quay side to the yard side to save labor cost and improve efficiency. Therefore, developing an AGV routing system which could avoid collisions, congestions and deadlocks while maximizing the overall throughput become an important issue.
In this study, a two-level zone control approach is used. The overall path network is divided into different kinds of zones (straight zones, L zones, T zones and intersection zones). Each zone has many segments and could hold more than one AGV at the same time. The high level routing layer determines the AGVs' routing from zone to zone and try to reduce the congestion. A MIP model based on the relationship between arrival rate and congestion level is used. The lower level, the inner zone scheduling level, determines the detailed segments schedules inside the zone for the AGVs to traverse across. A heuristic is proposed to route all the AGVs inside the zone after knowing the the enter time and enter point of each vehicle. These two layers are inter-dependent and the results of one layer will influence the other. Then a simulation model is developed to evaluate the design and implementation of the control algorithm in large scale system.

7. **Chenhao Zhou, Zhi Chao Poh, Ek Peng Chew and Loo Hay Lee (2016), Optimal Path Design for Mesh-like Structure in GRID System.** ***In proceeding of 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

Abstract:
Motivated by the city traffic where traffic lights and directed lanes are used to regulate the vehicle movement and reduce conflicts, we re-look at the vehicle routing problem from the path direction perspective. In order to get a good path design efficiently, an innovative heat-map algorithm is proposed. In addition, since the container flows are changing from time to time, the path direction design need to follow the trend of the containers. Thus, a dynamic path direction changing mechanism is proposed and a discrete event simulation model is developed to implement the proposed mechanism and algorithm.

Conference Papers (with Abstracts)

8. **Haobin Li, Chenhao Zhou, Loo Hay Lee and Ek Peng Chew (2016), A Discrete-Event Simulation based Capacity Planning Toolkit for Mega Container Terminal.** ***In proceeding of 6th International Conference on Logistics and Maritime Systems, 20-26 June 2016, Australia.***

Abstract:
Motivated by the demand of evaluating different container configurations and future implementation of simulation optimization, we propose two fidelity discrete event simulation models based on the O2DES framework. Two models are compared by the sensitivity analysis of different scales of container terminals with certain annual throughput. The results showed that there is no significant difference on the BOA, while the simulation speed of the simple model is much faster. The result indicates that the two models can be further developed to determine the optimal terminal configurations.

CMS Research Seminars

1. Evaluating the Solution Performance of IP and CP for Berth Allocation with Time-Varying Water Depth: An Update, by Researcher Dr. Du Yuquan (Track Leader: Professor Meng Qiang)

Seminar Abstract:

This study considers the berth allocation problem (BAP) with time-varying water depth at a tidal river port. Both integer programming (IP) and constraint programming (CP) models are developed. Meanwhile, some hybrid algorithms combining the strength of IP and CP are also designed by leveraging the warm-start mechanism and Benders Decomposition. Numerical experiments find that (a) compared to IP, CP tends to be superior when the restriction of the objective towards decision variables is not tight (e.g. minimum makespan, or minimum total weighted departure delay over large-size instances), when the original feasible domain is smaller (e.g. dynamic arrival compared to static arrival), or when the time granularity is finely set; (b) a simple hybrid CP/IP procedure can significantly improve the optimality proving capability of CP, by paying minor additional computational effort; (c) on the contrary, the highbrow algorithm, Benders Decomposition, fails to improve the computational efficiency and effectiveness.

2. Framework Development of Simulation Platform for Automatic Ship Navigation in Singapore Strait, by Researcher Dr. Yang Jiasheng (Track Leader: Professor Fwa Tien Fang)

Seminar Abstract:

This objective of this proposal is to develop a simulation platform for automatic ship navigation in Singapore strait. The proposed platform mainly includes four modules: GUI platform, control algorithm, navigation and guidance algorithm, and ship dynamic model. With deep research to ship maneuvering in shallow waterways, it is expected that the proposed platform could be used to help marine researchers and engineers to understand ship navigation issues, and develop more effective control and collision avoidance algorithms for ship maneuvering in shallow waterways like Singapore strait.

3. Ship Efficiency Comparison, by Researcher Ms. Zhang Yiru (Track Leader: Professor Meng Qiang)

Seminar Abstract:

The continuous retreat of Arctic sea ice and seemingly appealing cost competitiveness of transarctic shipping routes are expected to boost shipping activities in the region. However, in reality, the number of Arctic transits remains meagre compared with major shipping routes. This study first develops a profit estimation model for containership sailing from an original port to a destination port with container transshipment and a cost estimation model for oil tanker sailing from an origin port to a destination port. The authors then proceed to compare the shipping efficiency between the Northern Sea Route (NSR) and the Asia-Europe shipping route via Suez Canal by using the developed models and real shipping operational data.

CMS Research Seminars

4. Formal Safety Assessment System – Grounding, by Researcher Dr. Li Wenhao (Track Leader: Professor Meng Qiang)

Seminar Abstract:

The Formal safety assessment system project is about to be finished. In this presentation, it presents the overall design of the FSAS including overall logic design and structure design so that the attendees can have a more comprehensive understanding of the system and the project. At the meantime, following the previous presentations for the simulation module of FSAS, in this presentation, the data pre-processing and filtering functions for grounding assessment as well as the grounding assessment module of FSAS will be demonstrated in details.

5. The Influence of Different Pavement Maintenance and Rehabilitation Strategies on User and Environmental Costs , by Researcher Mr. André V. Moreira (Track Leader: Professor Fwa Tien Fang)

Seminar Abstract:

The main goal of this study was to compare the costs for road users and for the environment resulting from different pavement maintenance and rehabilitation strategies. Different strategies led to different conditions of the pavement, and therefore, different rolling resistances for vehicles. Specifically, this study relates the changing of fuel consumption with the variation of pavement roughness. User costs and environmental costs derive directly from the fuel consumption by attributing a monetary price and a rate of CO2 emissions, respectively, per liter of diesel/petrol. When these costs are added to an optimization methodology as objectives, it is observed that more potential optimal solutions are given.

6. Analysis with Automatic Identification System Data of Vessel Traffic Characteristics in the Singapore Strait, by Researcher Dr. Xie Yajuan (Track Leader: Professor Meng Qiang)

Seminar Abstract:

As one of the most important and busiest shipping waterways in the world, the Straits of Malacca and Singapore (SOMS) are unique and vital to Singapore economics development. It can be foreseen that more and more large-sized ships will pass through the SOMS. In our project our aim is to develop models being able to quantitatively analyse the impacts of large ships on navigational accident risks and to simulate the interaction of large ships. However, we need to know the rules between the large ships. We can get the basic rules from some research papers, but those rules maybe incomplete and conditional. In this experiment, we can get the real rules based on DMU simulator, which is a platform for captains to ship in different scenarios. From these experiments we can build the interaction model combined real rules between ships and to simulate more realistic traffic conditions of SOMS in the future. In this research seminar, different experiment scenarios and methods on DMU simulator are introduced and discussed.

CMS Research Seminars

7. Big AIS-Data based Spatial-Temporal Analysis of Ship Traffic in Port Waters, by Researcher Dr. Zhang Liye (Track Leader: Professor Meng Qiang)

Seminar Abstract:

Ship traffic in the water areas of large ports such as Singapore port exhibits the heterogeneous characteristics caused by the diversity of ship types, ships sizes and navigation behaviors. The big ship traffic data extracted from AIS (Automatic Identification System) make it viable to gain deep insight into the heterogeneous ship traffic flow analysis. This study first develops a tangle analytical approach for the spatial-temporal analysis of ship traffic at port waters by means of the big AIS-based ship traffic data. The approach is subsequently applied to analyze ship traffic dynamics in Singapore port waters. The navigation behavior of tug ships in Singapore port is further investigated in view of the unique service role of tug traffic in port waters.

The developed ship traffic spatial-temporal analysis approach includes three modules: ship traffic generation and attraction (GA) analysis, origin and destination (OD) ship traffic demand estimation and ship route choice analysis. The interested port water areas are divided into a number of traffic zones (TZs) according to their functions in the port system, which are considered as origins and destinations of ship traffic. With the function information of TZs, ship characteristics, ship movements as well as the navigation chain of individual ships are extracted by tracking ship trajectories. The ship traffic volume and traffic composition are calculated by the traffic generation and attraction analysis module. The ship traffic demand between an OD pair is estimated based on the navigation chain of individual ships. The third module is to analyze the route choice of ships between an OD pair, which would be influenced by many factors including port operation management policies, ship drafts and pilots' experiences. This analytical approach not only paints a complete picture of the spatial distribution of ship traffic, but also provides the temporal dynamic ship traffic information. Therefore, the spatial-temporal dynamics of ship traffic at port waters can be completely analyzed using the developed approach. The real big AIS data in Singapore port waters are used to assess the developed ship traffic spatial-temporal analysis approach, which consist of about 182 million records with more than 30 GB for the detailed vessel trajectories of ships with an average time resolution of 20 seconds.

8. Optimal Timing of Cordon Toll Pricing in A Monocentric City, by Researcher Mr. Wang Yadong (Track Leader: Professor Meng Qiang)

Seminar Abstract:

This paper proposes an analytical model to address the timing issue of cordon toll pricing in a monocentric city. The proposed model allows an explicit consideration of the interactions among three types of agents in the urban system: (i) the local authority who aims to jointly determine the optimal time for introducing cordon toll pricing scheme, cordon toll location and toll level to maximize social welfare of the urban system; (ii) property developers who seek to determine the intensity of their capital investment in the land market to maximize their own net profit generated from the housing supply; and (iii) households who choose residential locations that maximize their own utility within a budget constraint. The effects of the cordon toll pricing scheme on household's residential location choice and housing market structure in terms of housing price and space are explicitly considered. A comparison of the toll pricing schemes with a fixed and a mobile cordon location over time and the no toll case is carried out. The proposed model is also illustrated in several Chinese cities. Insightful findings are reported on the interactions among cordon toll pricing scheme, urban population size, household income level, toll collection cost, and urban development

CMS Research Seminars

9. Mathematically Calculating the Transit Time of Cargo Through A Liner Shipping Network with Various Transshipment Policies, by Researcher Dr. Du Yuquan (Track Leader: Professor Meng Qiang)

Seminar Abstract:

This paper derives the mathematical expressions for the transit time of cargo through a liner shipping network. Main efforts are devoted to deriving the calculation expressions of the connection time of cargo during transshipment. For the forward and many-to-one transshipment policies, we conduct a minor correction towards the expressions by Álvarez (2012) to improve the completeness. Meanwhile, we propose an alternative but more straightforward calculation method for connection time which bypasses the complicated inductive argument in Álvarez (2012). Then we introduce two new transshipment policies: backward transshipment and one-to-many transshipment, mathematically calculate the connection time, and analytically evaluate their effects on transit time control.

10. Simulation and Control of Hydroelastic Floating Beam Structure, by Researcher Dr. Yang Jiasheng (Track Leader: Professor Fwa Tien Fang)

Seminar Abstract:

Nowadays, with size increasing of marine structures like ULCS and floating structures, their structure become inherently more flexible. The structural deformation induced by uneven loading or sea conditions would cause accelerated fatigue damage and serviceability issues. In this presentation, we initially investigate an active control problem to stabilize the hydroelastic vibration of a floating beam structure, which could usually be applied to simulate the hydroelasticity of ULCS and VLFS. In the numerical simulation, the floating structure sub-model is built based on Euler-Bernoulli beam theory and the wave fluid interaction sub-model is simply built based on potential theory. The numerical model is first calibrated using model test data. Then, a PID control method is used to stabilize the vibration of the system. Numerical results illustrate that active control is potentially effective to improve the hydroelastic performance of marine structures.

11. Discrete Choice Models (2)- Model Formulation and Survey Design, by Researcher Ms. Zhang Yiru (Track Leader: Professor Meng Qiang)

Seminar Abstract:

The viability of the Northern Sea Route (NSR) can be understood from navigation and commercial perspectives. Based on existing studies, researchers expected the NSR to become an attractive alternative to existing shipping routes. However, the real ship traffic at NSR demonstrates a different picture. In our project, the impact of opening of the NSR on the port of Singapore would be analyzed by quantifying the shift in shipping market share from traditional shipping routes to transarctic routes. The changes in shipping market share can be estimated by using discrete choice models. We believe that it is important to understand shipping companies' perspectives in order to have accurate model calibration. In this seminar, we will briefly go through the utility function and model that will be used and introduce how we construct our survey based on models.

CMS Research Seminars

12. Proposal of Novel Protocols for Monitoring and 2d/3d Analysis of Road Pavement Defeats and of Performance Indices, by Invited Visitor Mr. Giuseppe Sollazzo (Track Leader: Professor Fwa Tien Fang)

Seminar Abstract:

Road infrastructures are generally very old and part of wide networks. They continuously need proper maintenance to assure acceptable driving condition and thus safety to users. Then, maintenance is one of the most critical and strategic tasks in road management and development. However, highway and pavement engineers should act like "physicians": in order to optimize maintenance and thus funds, restoring pavement efficiency and ride quality, they need to know with good accuracy which are the various diseases affecting the pavement. Therefore, surveying techniques become very important in road and pavement management systems. According to this, in recent years various efforts have been made to improve survey methods for making them automated, more objective, reliable, and accurate. In this seminar, first, an innovative survey device for high-performance monitoring of road conditions is presented. This device, called "HiPRoSS" and developed at University of Messina, adopts laser lightning and both line and 3D cameras for collecting high-resolution pavement data. Then, to provide a significant application of 3D data, a novel hybrid algorithm for automated crack detection using 1mm 3D pavement data is presented. Finally, possible research plans to define innovative and more exhaustive pavement quality indices are discussed.

13. An Energy-Efficient Data Transfer Strategy with Link Rate Control for Cloud, by Researcher Dr. Li Wenhao (Track Leader: Professor Meng Qiang)

Seminar Abstract:

Data transfer is an indispensable step that is widely involved in the maintenance and processing of Cloud data. Due to rapid growth in Cloud data, methods of reducing the huge energy consumption of data transfer in the Cloud have become a challenge. In this paper, we propose a novel energy-efficient data transfer strategy called LRCDT (Link Rate Controlled Data Transfer). By scheduling bandwidth in a link rate controlled fashion, LRCDT intends to reduce the energy consumption specifically for data transfer that does not require the maximum transfer speed, which is referred to as 'lazy' data transfer, so to achieve the energy-efficient data transfer goal in the overall term. The result in our simulation indicates that LRCDT is able to reduce energy consumption by up to 63% when compared to existing data transfer strategies.

14. Bi-Level Approach to Multi-Objective Optimization of Maintenance Scheduling for Pavements, by Researcher Mr. André V. Moreira (Track Leader: Professor Fwa Tien Fang)

Seminar Abstract:

Pavements heavily influence the management costs in highway networks. Operating pavements represents a challenging task involving complex decisions on application of maintenance actions to keep them at a reasonable level of performance. The major difficulty in applying computational tools to support decision-making lies in a large number of pavement sections due to a high length of road networks.

This paper addresses maintenance scheduling for pavements by decomposing this task into two levels. In each level, multi-objective optimization is employed to optimize maintenance schedules. The major motivation is to obtain a computationally treatable model for large road networks. The lower level is defined by a collection of pavement sections composing the road network. In this level, the performance and maintenance models are addressed. These

models account for uncertainties in the future performance and effects of maintenance by defining model parameters as random variables. The upper level refers to combining maintenance schedules for individual sections to determine the optimal maintenance plan at the network level.

15. Determinants of Certificate of Entitlement Premium for Cars under Vehicle Quota System in Singapore, by Researcher Ms. Lu Zhaoyang (Track Leader: Professor Meng Qiang)

Seminar Abstract:

Confronted with the general dilemmas besieged by limited land resource and traffic congestion, land transport authority of Singapore has successfully implemented the Vehicle Quota System (VQS) to control the vehicle population. The VQS requires each new vehicle buyer to bid for a license, called Certificate of Entitle (COE), for the registration of her/his new vehicles. This study will examine the quantifiable and unquantifiable determinants of the COE premium for cars in Singapore firstly, based on a revealed reference (RP) survey and some related literature reviews. Through the collected real data, the impacts of these determinants are further analyzed by formulating an autoregressive model with exogenous variables, which is verified to well fit the trend of the COE premium. Thus, the autoregressive model can be used by the authority or bidders to understand the feasibility of VQS and to estimate COE premium changing trend more reasonably.

16. Experiment Design based on Simulator of Dalian Maritime University (DMU), by Researcher Ms. Xie Yajuan (Track Leader: Professor Meng Qiang)

Seminar Abstract:

Currently navigational simulations are based on the rules extracted from papers and don't consider human behavior factors. In order to extract the captain behaviors in navigational activities, an experiment design is developed based on the simulator of DMU. First, the statistic is analyzed for each legs in Singapore Straits based on historical AIS data; Secondly, a simulation is done to check the accident types for each legs using the platform of FSAS (Formal Safety Assessment System) which is developed by Liye and Wenhao before. Finally, an experiment design is developed based on the statistics and simulation results using ArcGIS tool.

