中山大學管理學院
SUN YAT-SEN BUSINESS SCHOOL
SYSBS

国家自然科学基金委员会
NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA

LOGMS2018

The 8th International Conference on Logistics and Maritime Systems

Handbook

Business School, Sun Yat-sen University, China

09-12 December 2018

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01

Programme

PRELIMINARY PROGRAMME LOGMS 2018 - OUTLINE

Sunday December 9	
13:00 - 17:30	Registration
14:30 - 17:30	Tutorials (M311)
19:00 - 22:00	Welcome reception (Helipad roof, Crowne Plaza City Center) *Bus will departure at 18:00 from conference venue*

Monday December 10	
08:30 - 09:00	Registration
09:00 - 09:10	Opening (International Conference Hall)
09:10 - 10:00	Keynote Presentation 1 (International Conference Hall)
10:00 - 10:30	Take photo & Coffee break (M202)
10:30 - 12:00	Parallel sessions - 1 (M101 & M201)
12:00 - 13:30	Lunch (Sun Yat-sen Kaifeng Hotel)
13:30 - 15:00	Parallel sessions - 2 (M101 & M201)
15:00 - 15:30	Coffee break (M202)
15:30 - 17:00	Parallel sessions - 3 (M101 & M201)

Tuesday December 11	
09:00 - 10:30	Parallel sessions - 4 (M101 & M201)
10:30 - 11:00	Coffee break (M202)
11:00 - 12:30	Parallel sessions - 5 (M101 & M201)
12:30 - 14:00	Lunch (Sun Yat-sen Kaifeng Hotel)
14:00 - 16:30	Industrial Panel (International Conference Hall)
16:30 - 17:00	Coffee break (M202)
17:00 - 18:00	Keynote Presentation 2 & Closing (International Conference Hall)
19:00 - 22:00	Conference dinner (The Westin Pazhou) *Bus will departure at 18:00 from conference venue*

Wednesday December 12	
08:00 - 13:00	Nansha Port visit *Bus will departure at 8:00 from the North gate of the campus*
13:00 - 14:00	Lunch

Sunday December 9 (Tutorials on M311)	
13:00 - 17:30	Registration (Shansi Hall, Business School)
14:30 - 17:30	Tutorial (M311) **Optimal Solution of Vehicle Routing Problems** *Roberto Baldacci*
19:00 - 22:00	Welcome reception (Helipad roof, Crowne Plaza Guangzhou City Centre, No.339, Huanshi Road East, Yuexiu District, Guangzhou)

Monday December 10 (Symposium Day 1)	
08:30 - 09:00	Registration (Shansi Hall, Business School)
09:00 - 09:10	Opening (International Conference Hall) Chair: Fan Wang
09:10 - 10:00	Keynote Presentation 1 (International Conference Hall) Chair: Zhou Xu **The future for automation in shipping** *Michael Bell*
10:00 - 10:30	Coffee break
10:30 - 12:00	Session 1A (M101) Chair: Hongtao Hu Theme: Berth and crane scheduling **Yard Crane Scheduling in a New Automated Container Terminal Design** *Xiaoming Yang and Xinjia Jiang* **Berth Allocation and Quay Crane Assignment Problem Considering the Maintenance of Quay Crane** *Hongtao Hu and Wanyi Chen* **Synchronization of ship navigation and berthing operations in seaport container terminals with channel access** *Christian Bierwirth and Paul Corry* **A new model for the berth allocation problem with consideration of fairness and satisfaction** *Tingsong Wang and Zurui Wang*
10:30 - 12:00	Session 1B (M201) Chair: Mingzhu Yu Theme: Pricing, competition and game **Pricing competition for ocean container transportation with heterogeneous carriers and empty container repositioning** *Mingzhu Yu, Jiayin Qv and Zelong Yi* **Using Game Theory to improve Compliance Rates to Sulphur Regulations** *Thalis Zis* **Competition between container ports in EU, China and the USA in the period 2000-2016** *Elen Twrdy and Milan Batista*
12:00 - 13:30	Lunch (Sun Yat-sen Kaifeng Hotel)

Monday December 10 (Symposium Day 1)

13:30 - 15:00	Session 2A (M101) Chair: Roar Adland Theme: Optimization modeling
	Optimal vessel speed and weather effects *Roar Adland, Pierre Cariou and François-Charles Wolff*
	Modelling and optimizing placement of AGV transponders *Yuming Peng, Haobin Li and Yanchuni Guo*
	Simultaneous Optimization of Container Stacking and Crane Dispatching Policies for the Storage Yard in an Automated Container Terminal *Jeongmin Kim, Taekwang Kim, Kwang Ryel Ryu and Jaekwang Kim*
	Production and Transportation Integration for Commit-to-Delivery Mode with General Shipping Costs *Feng Li, Zhou Xu and Zhi-Long Chen*
13:30 - 15:00	Session 2B (M201) Chair: Yewen Gu Theme: Sustainability and environment
	Can Emission Trading Scheme really reduce CO2 in short term? Evidence from a maritime fleet composition and deployment problem *Yewen Gu, Stein W. Wallace and Xin Wang*
	Sustainability Efficiency Evaluation of Seaports in China: An Uncertain Data Envelopment Analysis Approach *Bao Jiang and Jian Li*
	Drone Scheduling to Monitor Vessels in Emission Control Areas *Jun Xia, Kai Wang and Shuaian Wang*
15:00 - 15:30	Coffee break
15:30 - 17:00	Session 3A (M101) Chair: Julio C. Goez Theme: Data science and IT-technologies
	Digital Twin for Next Generation Ports *Yuan Wang, Ek Peng Chew, Loo Hay Lee, Haobin Li and Chenhao Zhou*
	Effect of satellite data on weather routing problem *Li Ding, Harilaos N. Psaraftis and Thalis Zis*
	Autonomous transportation systems: state of the art and futures perspectives *Julio C. Goez, Mario Guajardo, Yewen Gu and Stein W. Wallace*
15:30 - 17:00	Session 3B (M201) Chair: Zhou Xu Theme: Scheduling in logistics and maritime systems
	Scheduling with autonomous vessels *Julio C. Goez, Yewen Gu, Mario Guajardo and Stein W. Wallace*
	Schedule design for liner services under Vessel Speed Reduction Incentive Programs *Dan Zhuge, Shuaian Wang and Lu Zhen*
	Managing Navigation Channel Traffic and Anchorage Area Utilization of a Container Port *Shuai Jia, Chung-Lun Li and Zhou Xu*
	Stochastic Bulk Ship Scheduling in Industrial Shipping *Lingxiao Wu and Shuaian Wang*

Tuesday December 11 (Symposium Day 2)

09:00 - 10:30	Session 4A (M101) Chair: Rommert Dekker Theme: Shipping operations
	Ship type decision considering empty container repositioning and foldable containers *Kai Wang and Shuaian Wang*
	The effects of the Ultra Large Container Ship on port choice and call size *Nemanja Milovanovic and Rommert Dekker*
	Liner Shipping Network Design in Indonesia "Sea-Toll" Agenda: Tanjung Perak Corridor *Muchammad Arya Zamal and Rommert Dekker*
	Geopolitical risk and capital structure decisions in the shipping industry *Suntichai Kotcharin and Sakkakom Maneenop*

Tuesday December 11 (Symposium Day 2)

09:00 - 10:30	Session 4B (M201) Chair: Kap Hwan Kim Theme: Port operations
	Job Sequencing of twin overhead shuttle cranes in a rail-based automated container terminal *Henokh Yernias Fibrianto, Permata Vallentino Eko Joatiko, Dong-Ouk Lee, Hoon Lee and Soondo Hong*
	A Handshake Policy Between Twin Over-head Shuttle Cranes in a Rail-based Container Terminal *Bosung Kim, Taehoon Lee, Myungsun Park, Hoon Lee and Soondo Hong*
	Optimal concession contract between the port authority and container terminals by a royalty fee scheme *Yanjie Zhou and Kap Hwan Kim*
	A LEGO based hardware-in-the-loop container terminal simulator *Zhuo Sun*
10:30 - 11:00	Coffee break (M202)
11:00 - 12:30	Session 5A (M101) Chair: Xiaofan Lai Theme: Optimization modeling
	Improved Benders decomposition algorithm for complex product supply chain network design under supply disruption risks *Hongtao Hu and Xinhe Bai*
	Robust Liner Schedule Design with Service Level Guarantee *Xiaofan Lai, Fan Wang, Jun Xia*
	Integrated Train Timetabling and Locomotive Assignment *Xiaoming Xu, Chung-Lun Li and Zhou Xu*
	Ship size optimization in maritime markets with uncertainty *Hongtao Hu*
11:00 - 12:30	Session 5B (M201) Chair: Michael Bell Theme: Performance analysis in logistics system
	Sensitivity analysis of collaborative hinterland transport *Alberto Giudici, Tao Lu, Clemens Thielen and Rob Zuidwijk*
	Spanning tree analysis of the world maritime network *Michael Bell, Kam-Fung Cheung, Jingjing Pan, Supun Perera and Shengda Zhu*
	Degree of Outsourcing of the Logistics Operations *Pedro Antonio Galvis González*
12:30 - 14:00	Lunch (Sun Yat-sen Kaifeng Hotel)
14:00 - 16:30	Industrial Panel (International Conference Hall) Chair: Fan Wang
	Thinking of Maritime Development in the Guangdong-Hong Kong-Macao Greater Bay Area *Xiaoming Song*
	A Study on Horizontal Transportation Systems in Fully Automated Container Terminals *Xunjie Luo*
	Building the "Golden Waterway" of Xijiang River in the Guangdong-Hong Kong-Macao Greater Bay Area *Botao Liu*
16:30 - 17:00	Coffee break (M202)
17:00 - 18:00	**Keynote Presentation 2 (International Conference Hall)** Chair: Fan Wang
	Competition between Container Terminals through Hinterland Transport Optimization *Rommert Dekker*
19:00 - 22:00	Conference dinner (The Westin Pazhou, No. 681, Fengpu Middle Road, Haizhu District, Guangzhou)

Wednesday December 12 (Port visit)

08:00 - 13:00	Nansha Port visit (The North Gate, Sun Yat-sen University)
13:00 - 14:00	Lunch (Business School)

02

Foreword by the Chair of the Local Organizing Committee

Foreword by Professor

Fan Wang

Chair of the Organizing Committee, LOGMS 2018
Dean & Professor of Operations and Information Management,
Business School Sun Yat-sen University

The objective of LOGMS is to provide a global forum for participants from universities and related industries to exchange ideas on the latest technical, operations and economic developments in container and bulk logistics and their related maritime systems. Logistical developments continue to drive the growth of international trade, leading to more complex global supply networks typically involving maritime, inland waterway, road and rail transportation systems. With participants from all over the world, the dialogue will be truly international. The balance of academic and industry participation will provide a fertile environment for the exchange of views and experience. Through LOGMS 2018, we hope to make a positive contribution to the development of maritime logistics.

LOGMS 2018 will be held in Business School Sun Yat-sen University in Guangzhou which is the capital of Guangdong Province and a thriving global commercial center. Its location on the center of Greater Bay Area has made Guangzhou a strategic port for centuries. We hope that you can enjoy your trip in Guangzhou!

03

LOGMS Scientific Advisory Committee

Michael Bell	*University of Sydney*
Rommert Dekker	*Erasmus University*
Erhan Kozan	*Queensland University of Technology*
Herbert Kopfer	*University of Bremen*
Lee Chung-Yee	*Hong Kong University of Science and Technology*
Kap Hwan Kim	*Pusan National University*
Stein W. Wallace	*Norwegian School of Economics*
Tang Loon Ching	*National University of Singapore*

04

LOGMS 2018 – Local Organizing Committee

Fan Wang (Chair)	*Sun Yat-sen University*
Zhou Xu	*Hong Kong Polytechnic University*
Yi Tao	*Guangdong University of Technology*
Shaorui Zhou	*Sun Yat-sen University*
Xiaofan Lai	*Sun Yat-sen University*
Li Jiang	*Sun Yat-sen University*
Minghua Xiong	*Sun Yat-sen University*
Xiaopo Zhuo	*Sun Yat-sen University*

05

Keynote Sessions

Keynote Presentation 1:
The Future for Automation in Shipping

Prof. Michael Bell

Michael Bell is the Foundation Professor of Ports and Maritime Logistics in the Institute of Transport and Logistics. Prior to his commencement at the University of Sydney in August 2012, he was Professor of Transport Operations and Director of the Port Operations Research and Technology Centre (PORTeC) at Imperial College London. Having graduated in 1975 from Cambridge University with a BA in Economics, he obtained a MSc in Transportation (1976) and a PhD on Freight Distribution (1981), both from Leeds University. Between 1979 and 1982 he worked as a Research Associate at University College London, before moving to the Institut für Verkehrswesen at the Technical University of Karlsruhe as an Alexander von Humboldt post-doctoral Research Fellow. He returned to the UK in 1984 to a New Blood lectureship at the University of Newcastle. In 1992 he became the Deputy Director of the Transport Operations Research Group (TORG), becoming its Director in 1996, when he was also promoted to a Personal Chair. In January 2002, he moved to Imperial College London. His research and teaching interests are catholic, spanning ports and maritime logistics, transport network modelling, traffic engineering, and intelligent transport systems. He is the author of many papers, a number of books (including Transportation Network Analysis, published in 2007) and was an Associate Editor of Transportation Research B for 17 years. In 2005 he founded the Port Operations Research and Technology Centre (PORTeC), a virtual centre spanning both Civil Engineering and the Business School dedicated to research and consultancy in the field of ports and maritime logistics.

Keynote Presentation 2:
Competition between Container Terminals through Hinterland Transport Optimisation

Prof. Rommert Dekker

Rommert Dekker is a professor of operations research, quantitative logistics, and IT at the Erasmus School of Economics (ESE). Professor Dekker currently leads an industry-sponsored research programme on service logistics. He has received numerous accolades for his research including ERIM's impact award which honours ERIM researchers who have successfully impacted management practice and the OR Society's Goodeeve medal for best applied paper. Professor Dekker began his career working at Shell Research. During his seven years at the company he published over 100 papers on topics including reverse logistics, service logistics, inventory control, maintenance optimisation, container logistics and transport optimisation. He was also co-founder of the well-known network for reverse logistics REVLOG.

06

Industrial Panels

Industrial Panel 1:

Thinking of Maritime Development in the Guangdong-Hong Kong-Macao Greater Bay Area

Xiaoming Song

Xiaoming Song is a Senior Economist and he is now the Secretary of the Party Committee and Deputy General Manager of Guangzhou Port Company Limited. He has made great contributions to several strategic projects such as “Guangzhou builds Asia Logistics Center”, “Guangzhou builds International Shipping Center” and “Development of Nansha New District in Guangzhou”. He was awarded “the 10th Anniversary Outstanding Staff of Guangzhou Port Group” and “the Outstanding Senior Managers of Guangzhou Port Group”.

Industrial Panel 2:

A Study on Horizontal Transportation Systems in Fully Automated Container Terminals

Xunjie Luo

One of key problems for designing of both handling system and a master layout of an automated container terminal (ACT) is to choose and optimize horizontal transportation system. Based on current condition of the handling system of ACTs in the world, this article presents a comparative study between AGV system and (A)SHC system by a both qualitative and quantitative analysis covering on factors such as technical specifications, productivity, capacity, energy consumption, investment and costs, technological advancement, etc. The results are useful references on how to optimize the horizontal transportation system of an ACT project.

Dr. Xuejie Luo is now the deputy director of the Yangshan Deepwater Port four-stage construction headquarters (Shanghai International Shipping Center). He is also the visiting professor of Wuhan University of Technology, Dalian Maritime University and Shanghai Maritime University.

He once studied at University of Antwerp, Business School of New Hampshire University, Business School of Pennsylvania State University and Lloyd's Maritime College. Until now, he has published 40 academic papers and several monographs such as “Operational Management of Container Terminal” and Optimal Control and Management of Container Terminal. He has hosted many major national port construction projects and won the Science and Technology Progress Award many times.

He once served as senior management personnel of many famous companies, such as Shanghai International Port (Group) Co., Ltd., Qingdao Port (Group) Co., Ltd., P&O Ports and APM Terminals.

Industrial Panel 3:

Building the “Golden Waterway” of Xijiang River in the Guangdong-Hong Kong-Macao Greater Bay Area

Botao Liu

General Manager, Strategic Development Department, Zhuhai Port Holding Group Co., Ltd.

Tutorials

Tutorial: Optimal Solution of Vehicle Routing Problems

By Roberto Baldacci

The solution of a vehicle routing problem calls for the determination of a set of routes, each performed by a single vehicle which starts and ends at its own depot, such that all the requirements of the customers are fulfilled, and the global transportation cost is minimized. The routes must satisfy several operational constraints which depend on the nature of the transported goods, on the quality of the service level, and on the characteristics of the customers and of the vehicles. One of the most common operational constraint addressed in the scientific literature is that the vehicle fleet is capacitated, and the total load transported by a vehicle cannot exceed its capacity. The tutorial provides a review of the past and most recent developments that had a major impact in the current state-of-the-art exact algorithms for vehicle routing problems, with a focus on the basic Capacitated Vehicle Routing Problem (CVRP) and the Vehicle Routing Problem with Time Windows (VRPTW).

It covers the following topics:

△ Introduction to the Vehicle Routing Problem family;

△ Mathematical formulations and comparison of different formulations;

△ Valid inequalities for tightening the lower bounds, including non-robust or master cuts;

△ Column generation techniques;

△ Route relaxations and the corresponding algorithms;

△ Exact methods, such as branch-and-cut, route enumeration and branch-price-and-cut;

Overview of the computational results obtained by the different methods. The tutorial also discusses how these approaches can be used to tackle problems arising in practical vehicle routing applications. Finally, we highlight current and future challenges.

About Roberto Baldacci

Roberto Baldacci is an Associate Professor of Operations Research at the Department of Electrical, Electronic, and Information Engineering “Guglielmo Marconi”, University of Bologna, Italy. He received the M.Sc. degree in Computer Science with top honours from the University of Bologna, Italy, in 1994 and the Ph.D. degree in Operations Research from the University of London, Imperial College, in 1999. From October 1999 to February 2001 he was Postdoctoral Research Associate at the Centre for Quantitative Finance, Imperial College, London. In 2001 he was nominated Researcher at the Department of Sciences and Methods of Engineering, Faculty of Engineering (Reggio Emilia), University of Modena and Reggio Emilia. From November 2005 to October 2012 he was a full-time Researcher at the Department of Electronics, Computer Science and Systems (DEIS), University of Bologna.

His major research and consulting interests are in the areas of transportation planning, logistics and distribution, and the solution of vehicle routing and scheduling problems over street networks. His research activities are in the theory and in the applications of mathematical programming. He has worked in the design of heuristic and exact methods for solving combinatorial problems as routing and location problems.

He is on the editorial board of Operations Research, and he has published papers in Mathematical Programming, Operations Research, Computers and Operations Research, European Journal of Operational Research, Computational Management Science, 4OR, Journal of Operational Research Society, Journal of Heuristics, Transportation Science, Networks, Annals of Operations Research, Discrete Applied Mathematics and INFORMS Journal on Computing.

Abstracts

10:30 - 12:00	Session 1A (M101) Chair: Hongtao Hu Theme: Berth and crane scheduling
	Yard Crane Scheduling in a New Automated Container Terminal Design Xiaoming Yang and Xinjia Jiang
	Berth Allocation and Quay Crane Assignment Problem Considering the Maintenance of Quay Crane Hongtao Hu and Wanyi Chen
	Synchronization of ship navigation and berthing operations in seaport container terminals with channel access Christian Bierwirth and Paul Corry
	A new model for the berth allocation problem with consideration of fairness and satisfaction Tingsong Wang and Zurui Wang

Yard Crane Scheduling in a New Automated Container Terminal Design

Xiaoming Yang[1] and Xinjia Jiang[2,]*

1 Shanghai Maritime University

2 Nanjing University of Aeronautics and Astronautics

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In traditional automated container terminals, storage blocks are laid perpendicular to the apron, while each block is usually equipped with two yard cranes (YCs). The YCs frequently move along the block for pick-ups or drop-offs at the seaside/land-side end. To reduce the wasted time for such YCs movements, a new design has been proposed to install a rail-mounted ground trolley along each block for container delivery. The Ground Trolley based Automated Container Terminal (GT-ACT) is proven to be very effective in operation, because it reduces gantry moves and YC relays. However, the sharing of GT increases the interactions of the two YCs in the same block. At the operational level, the container handling efficiency highly depends on the YC scheduling decisions. The objective and restrictions of YC scheduling considering GT are formally discussed in this study.

Berth Allocation and Quay Crane Assignment Problem Considering the Maintenance of Quay Crane

Hongtao Hu, Wanyi Chen[*]

Shanghai Maritime University

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This paper focuses on the berth allocation and quay crane assignment problem under the maintenance of quay crane. In this study, it is known that the maintaining time of the quay crane is within a given range. Considering that the quay crane is not available to assign to vessels and vessels are not allowed to berth under it during its maintenance, this paper assume that there is a virtual vessel corresponding to the quay crane maintenance plan. Therefore, an accurate time and position of the quay crane to start maintenance can be obtained by introducing the concept of the virtual vessel. This problem is formulated as a mixed-integer programming (MIP) model which aims at minimizing the total port time of all actual vessels. And an improved Particle Swarm Optimization (PSO) algorithm is implemented to solve the proposed model with large-scale problem instances. Numerical experiments are applied to test the performance of the algorithm in both accuracy and effectiveness of convergence.

Synchronization of ship navigation and berthing operations in seaport container terminals with channel access

Christian Bierwirth [1,*], *Paul Corry* [2]

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A major problem in seaports with channel access is that the time needed by ships to transit the navigation channel can be hard to predict when there are potential conflicts leading to delays. In addition to the length of the channel there can exist further restrictions like depth constraints related to tidal cycles and natural narrowing where opposing ships cannot pass each other. Under such circumstances the intensity of shipping traffic will significantly impact the turnover times for ships at berths. As a result, berth capacity reserved for a ship arriving on time is lost if it cannot enter the channel. Similarly, a departing ship may experience considerable waiting time prior to departure if a narrow section of channel is being transited by an arriving ship.

To counteract such disruptions, the resident terminal operators could aim at synchronizing their vessel arrivals and departures. A straight synchronization approach is to consider the joint berth allocation problem of the concerned terminal operator under a common channel capacity restriction. The results, however, will become less accurate the more time the ships need to pass the navigation channel. Simply ignoring the physical structure and nautical rules of the navigation channel bears the risk that a generated solution is not implementable on the operational level.

In this paper we define two MILP models addressing the sketched situation in essential details. In the Channel Scheduling Problem (ChSP) the movement of a set of ships calling at a port is synchronized with respect to the structure of the navigation channel so as to minimize the total ship turnover time. In the Berth Allocation Problem with Channel Restrictions (BAP-CR), the underlying ChSP is further extended by incorporating the berthing decisions for the involved ships. Computational tests are conducted to analyze the influence of a varying channel structure and ship arrival process, indicating constellations where synchronization can impacts total ship turnover time at most.

A new model for the berth allocation problem with consideration of fairness and satisfaction

*Tingsong Wang, Zurui Wang**

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Traditional berth allocation problems (BAPs) usually minimize total cost of vessels that consists of operating cost and penalty cost of departure delay or speed-up. As the penalty cost of vessels are various, the formulation of traditional BAPs may result in that a late vessel is serviced before an early vessel if its penalty cost is higher than that of the early vessel, which is unfair to the early vessel and cause dissatisfaction. However, the unfairness and dissatisfaction of vessels is not taken into account in the existing studies. In addition, it is possible that a vessel reports a fake penalty cost in order to be prior serviced.

Therefore, we revisit the BAP and reformulate it by taking the fairness and satisfaction of vessels into account. We firstly use a traditional BAP (TBAP) model to get an initial optimal berth allocation plan, then, we propose a fair BAP (FBAP) model by minimizing the total turnaround time of all vessels with the constraints of minimizing the deviation between the desired and the real berthing and departure time of each vessel. The FBAP model yields another optimal berth allocation plan. Secondly, we compare the two plans of TBAP and FBAP models to classify the benefit of each vessel obtained in the two plans into positive or negative. Thirdly, for each vessel, we calculate its negative benefit to other vessels. And we design a transfer payment mechanism based on Vickrey-Clarke-Groves (VCG) auction theorem. The transfer payment mechanism based on VCG auction can let vessels provide their actual penalty cost and eliminate dissatisfaction of some vessels. Finally, we design an efficient heuristic solution algorithm to solve the proposed FBAP model.

10:30 - 12:00	Session 1B (M201) Chair: Mingzhu Yu Theme: Pricing, competition and game
	Pricing competition for ocean container transportation with heterogeneous carriers and empty container repositioning *Mingzhu Yu, Jiayin Qv and Zelong Yi*
	Using Game Theory to improve Compliance Rates to Sulphur Regulations *Thalis Zis*
	Competition between container ports in EU, China and the USA in the period 2000-2016 *Elen Twrdy and Milan Batista*

Pricing competition for ocean container transportation with heterogeneous carriers and empty container repositioning

Mingzhu Yu [1], *Jiayin Qv* [1], *Zelong Yi* [2,*]

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In this paper, we study the pricing competition in an ocean transportation system involving two heterogeneous ocean carriers who provide ocean container transportation services between two ports. The empty container repositioning issue and hoteling demand model are emphasized. We model this problem as a pricing game and derive the pricing and profit equilibrium of the two ocean carriers under both homogeneous and heterogeneous conditions. We fully characterize the impacts of empty container imbalance degree and various parameters. The computational studies reveal that the prices, demands and profits of the ocean carriers are affected by the empty container repositioning cost. It is shown that reasonable empty container repositioning can increase the demands and profits of ocean carriers.

Using Game Theory to improve Compliance Rates to Sulphur Regulations

*Thalis Zis**

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According to the regulation ships sailing in regulated waters must use fuel that does not surpass the maximum specified limit in sulfur content, or alternatively be equipped with devices that result in an equivalent reduction of sulfur emissions. The question that arises is whether the current penalties are enough to dissuade intentional non-compliance of ship operators. Numerical examples presented in this paper illustrate that the current legislative framework is weak and would eventually lead to violations of the regulation. The purpose of this paper is to develop a game theoretic modelling framework that improves the effectiveness of sulfur regulations enforcement. Game theory concepts in port operations and management have been increasingly used by researchers.

The existing legislative framework poses several challenges, stemming (mainly) from a highly non-homogeneous and spatially differentiated system, with cases where the penalty fines are as low as the benefit that the violator enjoyed from not complying. This paper presents the status quo of enforcement in different countries, where the regulation applies, and develops a game theoretic approach for a uniform violation fine system. A mixed strategy game with two players is proposed, representing the ship operator (who can choose to comply or not comply to the regulation), and an enforcement agency (that can opt to inspect or not inspect the ship) respectively. The game is assumed to be a mixed strategy of complete information. In that sense, the ship operator is aware of the potential monetary fine if caught not complying, but is also aware of the cost per inspection that the port endures. At the same time, the port (inspecting body) knows the fuel benefits that each ship will enjoy if the player chooses to not comply. This is actually a realistic assumption as it is a straightforward calculation based on the fuel price differential, and high level data on the ship's technical specifications. In the context of this paper the enforcement agency is assumed to be the port. The equilibrium results in an improved penalty system (for both violators and enforcing agencies). Such a system can ensure a level playing field for ship operators that currently have invested heavily in abatement options to comply with the sulphur regulations, by promoting good practices among ship operators, while at the same time improve compliance rates and maximize societal environmental benefits.

A discussion on the implications of the global sulphur cap of 2020 is concluding the paper, and recommendations for transferability of this framework to other regulations are provided. Next steps will also consider the societal benefits of this framework. The society would want to ensure a pure strategy of compliance from the ship operator. This can lead to a hierarchical game where at the lower level the ship operator and the inspecting body randomize their actions, but at a higher level there is the society that seeks to minimize the emissions that are generated from this game.

Competition between container ports in EU, China and the USA in the period 2000-2016

Elen Twrdy [1,], Milan Batista [2,*]*

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2 University of Ljubljana
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Historically, Europe is one of the most influential economies in the World, and its maritime traffic is one of the key indicators of its stability and development. From 1980, among seaborne containers, throughput began to play an important role. Container throughput presented a new challenge for European ports and they started with specialization in this field. In 2000, 40 % of all containers were shifted in European ports. In the new century, China obtained high economic growth. The container throughput in their ports started to grow and in six years, they more than doubled the number of TEU's. With this fact, the situation on the container port market has changed.

In the article, we provide an analysis of containers throughput for the three most influential world economies: China, the European Union, and the USA in the period from 2000 to 2016, which, according to the World Bank data, have about 50 % of total world container traffic. In the analyzed period, the world containers throughput has increased from 224,7 to 701,4 billion TEU per year. The study includes performance indices: annual growth rate, market share, market concentration indices and shift-share analysis. It is shown that containers throughput in European ports increased 2,2 times but in the same period throughput in Chinese ports increased 4,8 times and China becomes the most important player in containers traffic, with 60% market share (Figure 1). We also compared containers throughput and GDP where we found a strong positive correlation (Figure 2).

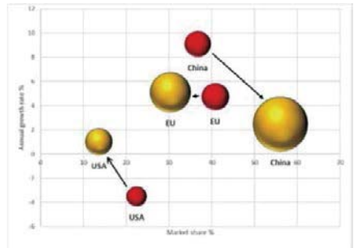

Figure 1: Market share in 2000 (red) and 2016 (gold)

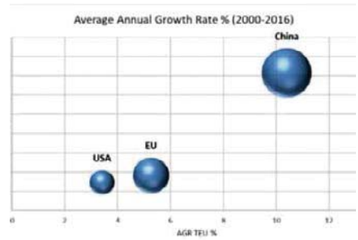

Figure 2: Average Annual Growth Rate (2000-2016)

Besides that, we conducted a cooperation-competition analysis using the Lotka-Volterra, competition model to identify relations between them. The result of the simulation shows that in the discussed period China and USA developed a win-win situation, while EU is a predator to both - China and the USA.

Table: Relationships between China, EU and the USA

	China	EU	USA	Rest of world
China		prey	win	win
EU	predator		predator	lose
USA	win	prey		prey
Rest of world	win	lose	predator	

13:30 - 15:00	Session 2A (M101) Chair: Roar Adland Theme: Optimization modeling
	Optimal vessel speed and weather effects *Roar Adland, Pierre Cariou and François-Charles Wolff*
	Modelling and optimizing placement of AGV transponders *Yuming Peng, Haobin Li and Yanchuni Guo*
	Simultaneous Optimization of Container Stacking and Crane Dispatching Policies for the Storage Yard in an Automated Container Terminal *Jeongmin Kim, Taekwang Kim, Kwang Ryel Ryu and Jaekwang Kim*
	Production and Transportation Integration for Commit-to-Delivery Mode with General Shipping Costs *Feng Li, Zhou Xu and Zhi-Long Chen*

Optimal vessel speed and weather effects

Roar Adland [1,], Pierre Cariou [2], François-Charles Wolff [3]*

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Most academic research on the speed optimization of vessels deals with various versions of the so-called “cubic law” which states that the fuel consumption is proportional to the sailing speed to the power of three. The cubic law is based on an assumption of idealized conditions - effectively a brand new hull, flat water and no weather effects. Even under such ideal conditions, recent empirical research suggests that the elasticity of fuel consumption with regards to weather is not constant across the range of possible sailing speeds and, in particular, that the elasticity is decreasing with speed. More importantly, the effect on the fuel consumption of external sailing conditions related to waves, wind, sea currents and hull fouling is known to be substantial and generally should not be ignored. Yet, the standard way of dealing with such weather effects is typically to add a 10 – 15% constant weather margin, both in the maritime industry and in academic models of consumption and emissions, if any such adjustments are made at all. The reason weather effects are dealt with in such a simplistic manner is that its impact is difficult, if not impossible, to assess theoretically because of the complex and dynamic interaction between the various weather covariates. For instance, a vessel will be simultaneously subject to interacting waves, swells, wind and sea currents, potentially from different and varying directions and with different strengths over time.

We propose a framework to reduce the dimensionality of the problem – both through the use of principal component analysis and the grouping of weather in categories related to the Beaufort scale – such that it is possible to assess and illustrate the impact of weather effects on the fuel consumption of a vessel (and its elasticity w.r.t both weather an speed). Our empirical data consist of vessel performance data for a large fleet of sister vessels in the Aframax and Suezmax crude oil tanker markets.

Our results suggest that the true elasticity of a vessel’s fuel consumption, when subject to various severity of weather, is far from the theoretical flat water conditions and that the elasticity itself remains speed-dependent. Overall, our results suggest that the benefit from speed optimization (with regards to both profits and emissions) in the real seaway is substantially smaller than has hitherto been assumed in the literature. This has potentially profound effects on everything from maritime environmental policy and the financial benefit of weather routing.

Modelling and optimizing placement of AGV transponders

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In recent years, automated guided vehicles (AGV) have been widely utilized in automated container terminals for material transfer. AGV can navigate in a facility via communicating with transponders buried beneath the surface of the ground. However, little research has been done on the placement configurations of the transponders which have significance in optimization of facility layout, bringing in flexibility and not hindering productivity. In this scope, this study provides a simulation model to evaluate the effectiveness of different transponder placement configurations and helps company decide the optimal transponder layout.

Simultaneous Optimization of Container Stacking and Crane Dispatching Policies for the Storage Yard in an Automated Container Terminal

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Many automated container terminals use a stacking policy to determine stacking positions of containers that come into a block as well as those relocated within the block. The policy uses a multi-criteria scoring function to make a selection from among various candidate choices, where the scoring function calculates the score of each candidate choice by a weighted summation of the evaluations on multiple criteria. As the score so calculated depends on the weights of these criteria, and thus a different weight vector leads to a different best candidate, a weight vector can be viewed as a policy. While the weights of the criteria are manually determined in real containers terminals, they had better be determined by an optimization search with simulations. In this paper, we advocate the use of such policies not only for container stacking but also for crane scheduling via appropriate dispatching. The crane dispatching policy recommends a job to be done next by the crane that has just finished its previously assigned job. The job to be recommended is selected from among the candidate jobs that include not only those generated for stacking and retrieval requests but also those for rehandling or remarshaling needs. We develop and use a new set of evaluation criteria to be used in the scoring function of the crane dispatching policy. Since the choices of container stacking and crane dispatching are interdependent of each other, we propose to use a cooperative co-evolutionary algorithm to optimize the container stacking policy and crane dispatching policy simultaneously. Although this search done offline is somewhat computationally demanding, the policies thus obtained are very quick and powerful in usage compared to an online search previously proposed to schedule the cranes.

Production and Transportation Integration for Commit-to-Delivery Mode with General Shipping Costs

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We study an integrated production and transportation problem for a make-to-order manufacturing company that operates under the commit-to-delivery mode and uses third party logistics service providers to deliver products to customers on or before certain committed delivery dates. Such third-party logistics service providers often provide various shipping modes with quantity discounts and different guaranteed shipping times. As a result, the company's shipping costs need to be represented by general shipping cost functions that are typically non-decreasing, subadditive, and piecewise linear with shipping quantities, and non-increasing with guaranteed shipping times. To the best of our knowledge, this paper is the first attempt at solving such an integrated production and transportation problem for the commit-to-delivery mode with general shipping costs. We prove that with general shipping costs, the problem is strongly NP-hard when the planning horizon consists of an arbitrary number of days. For the two-day problem, we show that it is ordinarily NP-hard, but is unlikely to have a fully polynomial time approximation scheme (FPTAS) unless NP=P. Interestingly, we find that when the unit inventory holding cost is relatively small, which is often true in practice, there exists an FPTAS for the two-day problem, the development of which hinges on a newly discovered property for minimizing the sum of two general piecewise linear functions. For the multi-day problem, we develop a heuristic algorithm based on column generation, which novelly utilizes a dynamic program for a variant of the problem with a single customer. Results from computational experiments demonstrate that the heuristic algorithm can find near optimal solutions with optimality gaps less than 0.5% in a short running time.

13:30 - 15:00	Session 2B (M201) Chair: Yewen Gu Theme: Sustainability and environment
	Can Emission Trading Scheme really reduce CO2 in short term? Evidence from a maritime fleet composition and deployment problem *Yewen Gu, Stein W. Wallace and Xin Wang*
	Sustainability Efficiency Evaluation of Seaports in China: An Uncertain Data Envelopment Analysis Approach *Bao Jiang and Jian Li*
	Drone Scheduling to Monitor Vessels in Emission Control Areas *Jun Xia, Kai Wang and Shuaian Wang*

Can Emission Trading Scheme really reduce CO_2 in short term? Evidence from a maritime fleet composition and deployment problem

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Global warming has become one of the most popular topics on this planet in the past decades, since it is the challenge that needs the efforts from the whole mankind. Maritime transportation, which carries more than 90% of the global trade, plays a critical role in the contribution of GHGs emission. Unfortunately, the emission from the global fleet still falls outside the scheme of GHGs emission reduction established by the Kyoto Protocol. Alternative solutions are therefore strongly desired. Several market-based measures are proposed and submitted to IMO for discussion and evaluation. In this paper, we choose to focus on one of these measures, namely Emissions Trading Scheme (ETS). An optimization model integrating the classical fleet composition and deployment problem with the application of ETS (global or regional) is proposed. The impacts of ETS on the fleet operation and the corresponding CO2 emission at this stage are studied. The results of the computational study suggest that in general a global application of ETS has better performance in CO2 reduction than a regional ETS. Nevertheless, in some settings, neither a global nor a regional ETS will lead to a lower CO2 emission, comparing to the business-as-usual scenario. In some extreme but possible cases, a regional ETS may even bring higher emission due to operational reasons.

Sustainability Efficiency Evaluation of Seaports in China: An Uncertain Data Envelopment Analysis Approach

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Sustainability is regarded as achieving economic, environmental, and social dimensions simultaneously that support an organization for long-term competitiveness.Port sustainability has attracted increasing attention ,because it is related to the issues of climate change issue and public health and safety. Port are facing increasing pressure to address their sustainability problems. Therefore, it is urgent to measure the sustainability of ports. However, some variables (for instance, air pollutants and the neighboring relationship with surrounding communities) cannot be measured precisely by collecting quantitative data. This led us to use uncertain variables and uncertain data envelopment analysis (DEA) model to measure the sustainability efficiency of 23 seaports in China, and to capture the radius of stability of each input. The results show that most Chinese seaports are deemed to be inefficient in terms of their sustainability. Our findings indicate that although the seaports are economically beneficial, their environmental and social dimensions need considerable improvement. On the basis of the results, we point out the managerial implications and put forward measures toward enhancing the efficiency of seaports with respect to these two dimensions.

Drone Scheduling to Monitor Vessels in Emission Control Areas

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The use of drones to monitor the emissions of vessels has recently attracted wide attention because of its great potentials for enforcing regulations in emission control areas (ECAs). Motivated by this potential application, we study how drones can be scheduled to monitor the sailing vessels in ECAs, which is defined as a drone scheduling problem (DSP) in this paper. The objective of the DSP is to design a group of flight tours for drones, including the inspection sequence and timings for the vessels, such that as many vessels as possible can be inspected during a given time period while prioritizing highly weighted vessels for inspection. We show that the DSP can be regarded as a generalized team orienteering problem, which is known to be NP-hard, and deriving solutions for this problem can be more difficult because additional complicated features, such as time-dependent locations, multiple trips for a drone, and multiple stations (or depots), are addressed simultaneously. To overcome these difficulties, we model the dynamics of each sailing vessel using a real-time location function in a deterministic fashion. This approach allows us to approximately represent the problem on a time-expanded network, based on which a network flow-based formulation can be formally developed. To solve this proposed formulation, we further develop a Lagrangian relaxation-based method that can obtain near-optimal decisions for large instances of the problem. Numerical experiments based on practically generated instances with 300 time points and up to 100 vessels are conducted to validate the effectiveness and efficiency of the proposed method. Results show that our method derives tight upper bounds on optimal solutions, and can quickly return good feasible solutions for the tested instances.

15:30 - 17:00	Session 3A (M101) Chair: Julio C. Goez Theme: Data science and IT-technologies
	Digital Twin for Next Generation Ports *Yuan Wang, Ek Peng Chew, Loo Hay Lee, Haobin Li and Chenhao Zhou*
	Effect of satellite data on weather routing problem *Li Ding, Harilaos N. Psaraftis and Thalis Zis*
	Autonomous transportation systems: state of the art and futures perspectives *Julio C. Goez, Mario Guajardo, Yewen Gu and Stein W. Wallace*

Digital Twin for Next Generation Ports

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Singapore's strategic location in the heart of Southeast Asia and at the nexus of major shipping routes has made it an important logistics and passenger hub, connected to almost everywhere in the world. Being the world's top trans-shipment hub, Singapore is connected to 600 ports, handling about one-seventh of the world's container trans-shipment throughput or about 31 million TEUs of containers in 2015 with daily sailings to every major port of call in the world, according to the Review of Maritime Transport 2015. Being the world's top transshipment hub, Singapore is handling about one-seventh of the world's container transshipment throughput or 34 million TEUs of containers in 2014. All these data and figure shows the significant impact of Singapore as the connection point in the worldwide transportation. However there are also the challenges and opportunities that Port of Singapore is facing: 1). Land Scarcity. In Singapore, the land space is limited as a whole. How to better utilize the space allocated for accommodating containers and other relevant maritime operations/activities is a very important question to retain Singapore as a competitive and global port hub; 2). Labor Shortage. Shortage of labor is another challenge for Singapore, this calls for innovative solution, such as adopting of the advanced automation technology to reduce the reliance of labor; 3). Sea Space Congestion. The Straits of Malacca and Singapore are critical and strategic waterways in the global trading system. According to estimates from the United Nations Conference on Trade and Development (UNCTAD), almost half of the world's total annual seaborne trade tonnage and 70% of Asia's oil imports pass through the straits; 4). Mega Port. With the adoption of the automation technologies in a mega port, without proper coordination, the port productivity will be significantly affected due to congestion and deadlock conflict.

To address all these challenges, the presented new Centre of Excellence in Modelling & Simulation for Next Generation Ports (C4NGP) aims to build a global leading research centre in modelling, simulation and optimization of next generation ports and maritime systems. In this talk, we will introduce the new centre and its contributions to build toward a digital twin for maritime system. The proposed port digital twin is a discrete event simulation software that captures the equipment and cargo movements as well as the operational logics for a port terminal together with related sea and land traffic, so as to form a digital replica of the physical system. With the ability to simulate the port as a complete system with combination of layout, equipment and technologies, it enables the objective comparison of various options during the port designing and transformation process.

Effect of satellite data on weather routing problem

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Weather routing is an optimization problem to determine an optimal track for an ocean voyage based on forecasts of weather conditions and ship motions. To optimize the shipping route, minimum time, minimum fuel consumption and safety are set as targets. The problem can be separated into three parts: (1) Forecasting of sea state (2) Ship hydrodynamics (3) Routing optimization algorithm

In most cases, weather forecast comes from satellites, consist of wave, current and wind data. This paper aims to analyze how much the forecast data can affect the results of routing, both in accuracy and integrity of the data.

The simulation is conducted using both a business software SeaPlanner and our own model. The model is based on the algorithm of iterative dynamic programming (IDP) and hydrodynamic performance model, which can estimate ship response under certain weather condition, and combined with the engine simulation model.

Autonomous transportation systems: state of the art and futures perspectives

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Growing technology on autonomous transportation systems is currently motivating a number of research initiatives. We conduct a survey on the literature about autonomous transportation systems, with special emphasis on the optimization and logistics challenges they pose. While our main interest lies on autonomous systems in maritime transportation, we contrast its development with respect to autonomous systems in road transportation. To a large extent, we observe that the debate has focused in design and safety issues. As the technology behind remote-controlled and autonomous ships is maturing, it is already relevant to study how this may affect logistics in future. We conclude with perspectives on how the research agenda may evolve in future.

15:30 - 17:00	Session 3B (M201) Chair: Zhou Xu Theme: Scheduling in logistics and maritime systems
	Scheduling with autonomous vessels *Julio C. Goez, Yewen Gu, Mario Guajardo and Stein W. Wallace*
	Schedule design for liner services under Vessel Speed Reduction Incentive Programs *Dan Zhuge, Shuaian Wang and Lu Zhen*
	Managing Navigation Channel Traffic and Anchorage Area Utilization of a Container Port *Shuai Jia, Chung-Lun Li and Zhou Xu*
	Stochastic Bulk Ship Scheduling in Industrial Shipping *Lingxiao Wu and Shuaian Wang*

Scheduling with autonomous vessels

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With traditional manned vessels, liner shipping cargo services and public passenger transport services commonly use fixed schedules on the basis of anticipated demand. There is little flexibility with respect to starting/ending points and timing, mostly caused by crew-related constraints. Passengers and cargo shippers must, therefore, adapt to schedules. With autonomous vessels, we foresee possible changes in this paradigm by making schedules adapt more closely to passengers' and shippers' preferences. By means of operations research tools, we study how scheduling with autonomous vessels could be performed and how to assess its advantages/disadvantages with respect to traditional scheduling.

Schedule design for liner services under Vessel Speed Reduction Incentive Programs

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Gas and particulate emissions, including SOx, NOx, CO2 and PM, from ship transportation are becoming increasing prominent in recent years. In order to mitigate ship emissions near coastal areas, Port of Los Angeles (LA) adopts a voluntary Vessel Speed Reduction Incentive Program (VSRIP), which designs an upper speed limit for ocean-going vessels to slow their speeds as they approach or depart LA and offers financial incentives to the eligible shipping companies. This paper studies a schedule design problem of a liner shipping company under VSRIPs. A mixed-integer non-linear mathematical model on minimizing total costs, consisting of fuel cost and operating and capital cost minus dockage refunds, is proposed considering how to balance three determinants, i.e., the compliance of VSRIPs, the speed limit (the maximum physical speed of ships and the upper speed limit in VSRIPs), and the limited number of ships. An enumeration algorithm and a piecewise-linear approximation algorithm are developed based on some properties of the non-linear model. The efficiency of the proposed algorithms are validated by conducting numerical experiments.

Managing Navigation Channel Traffic and Anchorage Area Utilization of a Container Port

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Navigation channels are fairways where vessels receive official pilotage services when traveling in and out of the terminal basin of a container port. The vessel traffic in navigation channels is regulated by vessel traffic service (VTS) operators. For tidal ports such as the Port of Shanghai where the availability of the navigation channel is limited due to tidal effect, the management of vessel traffic by VTS operators plays a crucial role in congestion mitigation. In these tidal ports, terminal operators determine the berthing and unberthing times of calling vessels based on their knowledge about the availability of the berths and navigation channels. After receiving the berth plans proposed by terminal operators, the VTS operator of the port needs to schedule the vessels for traveling through the navigation channels such that the time windows for the vessels to utilize the channels coordinate with the vessels' planned berthing and unberthing times at the terminals. Because of the limited number of traffic lanes and a safety clearance requirement in navigation channels, the number of vessels that can sail in the channels is limited. When the channels run out of capacity, the anchorage area in the terminal basin can serve as a buffer. However, poor planning of navigation channel and anchorage area utilization often leads to congestion, which lowers terminal operation's efficiency and incurs more vessel emissions. If the VTS operator fails to arrange a schedule for some vessels to utilize the navigation channel, the berth plans will be rejected by the VTS operator, and the terminal operators will have to revise their plans.

In this paper, we optimize the navigation channel traffic and anchorage area utilization at a container port. Different from most existing works that study terminal resource allocation problems from the standpoint of terminal operators, our work focuses on the management of vessel traffic from the standpoint of VTS operators. We provide a mixed-integer linear program (MILP) for the problem, and show that the problem is strongly NP-hard. We show that after relaxing the capacity constraint of the staging anchorages, this problem can be decomposed into two asymmetric assignment problems, which then can be solved in pseudo-polynomial time. Based on this result, we develop a Lagrangian relaxation algorithm for solving this problem. For evaluating the effectiveness and efficiency of the Lagrangian relaxation algorithm, we generate extensive test instances based on the physical layout and operational data of the Yangshang Deep-water Port of Shanghai, and compare the computational performance of our algorithm with the performances of a standard solver and a rule-based heuristic that mimics the current practice of VTS operators. Computational results show that our algorithm is superior over the benchmark methods for solving practical-sized instances, and is able to achieve satisfactory performance within reasonable computation time. We also compare our solution method with methods that schedule vessel traffic by ignoring anchorage area utilization. The comparison reveals the important managerial insight that integrating the management of the anchorage area utilization into the decision for channel traffic control can significantly improve the vessel service at container ports.

Stochastic Bulk Ship Scheduling in Industrial Shipping

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This paper studies a ship scheduling problem for an industrial organization that controls a fleet of bulk carriers under stochastic environments. The considered problem is an integration of three interconnected sub-problems from different planning levels: the strategic fleet sizing and mix problem, the tactical voyage planning problem, and the operational stochastic backhaul cargo canvassing problem. To obtain the optimal solution for the problem, this paper provides a two-step algorithmic scheme. In the first step, the stochastic backhaul cargo canvassing problem is solved by a dynamic programming (DP) algorithm, leading to optimal canvassing strategies for all feasible voyages of all ships. In the second step, a mixed-integer programming (MIP) model that jointly solves the fleet sizing and mix problem and the voyage planning problem is formulated using the results from the first step. To efficiently solve the proposed MIP model, this paper develops a tailored Benders decomposition method. Finally, extensive numerical experiments are conducted to demonstrate the applicability and efficiency of the proposed models and solution methods.

09:00 - 10:30	Session 4A (M101) Chair: Rommert Dekker Theme: Shipping operations
	Ship type decision considering empty container repositioning and foldable containers *Kai Wang and Shuaian Wang*
	The effects of the Ultra Large Container Ship on port choice and call size *Nemanja Milovanovic and Rommert Dekker*
	Liner Shipping Network Design in Indonesia "Sea-Toll" Agenda: Tanjung Perak Corridor *Muchammad Arya Zamal and Rommert Dekker*
	Geopolitical risk and capital structure decisions in the shipping industry *Suntichai Kotcharin and Sakkakom Maneenop*

Ship type decision considering empty container repositioning and foldable containers

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This paper makes an explorative study on the ship type decision considering the empty container repositioning and the foldable containers. Different from traditional research works on the ship fleet deployment, our study incorporates both the laden container transportation and the empty container repositioning into ship type decision in order to achieve the global optimum for a shipping service route over a whole planning horizon. Meanwhile, as researchers have shown the economic and logistical viability of foldable containers, the problem also considers the usage of foldable containers, which aims to find under what conditions, the shipping liner needs to use the foldable containers in its liner shipping services.

In this study, we find that given the ship type with a certain capacity, the problem transfers to a nonstandard minimum cost flow. Henceforth, we build a network flow model for the problem by constructing a network. When considering standard containers and foldable containers, a trouble arises in the network construction that is some parallel arcs share the same capacity restriction. To overcome this trouble, we design a revised network simplex algorithm that changes the standard pivot operation. The algorithm is applicable to any minimum cost flow problem with sharing capacity restrictions. Based on the algorithm, we develop a solution approach by using reduced costs for excluding some ship type, which can find the optimal ship type in the end. By using the solution approach, we conducted extensive numerical experiments to find some managerial implications on the ship fleet deployment and the foldable container usage. For example, we find the foldable container usage is highly dependent on the long-term leasing cost, but it is not sensitive to the folding and unfolding cost.

The effects of the Ultra Large Container Ship on port choice and call size

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Container liner shipping companies are currently undergoing heavy competition due to market overcapacity. This has pushed many companies to pursue economies of scales by ordering ever bigger container ships. In 2009, the biggest container ship could accommodate up to 14,000 TEU. Today, ships are being ordered by MSC and CMA CGM to be completed in 2019 and 2020, which are estimated to carry at most 23,800 TEU: an increase of nearly 10,000 TEU in 10 years time.

This increase in container ship size does not only bring about potential economies of scale for liner shipping companies, it also puts pressure on ports. In order for ports to be able to accommodate larger container ships, sizable investments in infrastructure need to be made. On top of that, it is envisaged that hub-and-spoke networks become more dominant. Thus, ports located in the same region need to compete for hub status, or specialize in other areas, for example in facilitating transshipments.

In this study, we investigate primarily how container ship growth affects port choice and port call size. This is done by assuming that the liner shipper faces the Liner Shipping Network Design Problem, and considering a range of different scenarios to determine optimal network configurations. The main novelty of this approach (compared to existing literature in economies of scale in shipping) is the use of operations research and the inclusion of hinterland locations in the network optimization model.

Liner Shipping Network Design in Indonesia “Sea-Toll” Agenda: Tanjung Perak Corridor

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The Sea – Toll Agenda is one of the most ambitious initiatives of the Indonesian government to reduce the economic disparity between eastern and western regions in Indonesia. This program provides integrated logistics network for maritime sector in the form of subsidized liner shipping operation. However, after four years of implementation, this network is still underperforming, which concerns some operation issues, such as a high Round-Trip-Voyage (averagely 30 days per voyage). In addition, the budget for Sea – Toll operation is increasing around 45% each year because the government attempts to target more ports for this program. This paper intends to offer a proposed network for the Sea – Toll Agenda to improve its performance in terms of vessel operation and total shipping cost.

The methodological approach is built based on the LSND (Liner Shipping Network Design) model to unravel the complex problem of establishing network into three decision levels, i.e., strategic, tactical, and operational. The k-means clustering algorithm accommodated our idea to group the set of port involved in the Sea – Toll Agenda into several clusters based on their distance. Then, a TSP (Travelling Salesman Problem) method is performed to yield the most efficient path to connect all ports and generate the Clustering Network. Some network options (Port Aggregation & Butterfly Hub) and scenarios (additional and backflow cargo) are developed from the Clustering Network to obtain the best-proposed network by comparing them with the current Sea – Toll Network in terms of operation planning and shipping cost performance.

Our paper finds that the k-means clustering algorithm and the TSP model can generate a Clustering Network that has a lowest total distance (10,776 nm). However, the Butterfly Hub option offers the lowest total cost among others. This option can reduce about 50% of the total cost and save around 60% of the subsidy compared with the current Sea – Toll Network. Moreover, the proposed network can provide a better regularity (14 days round-trip-voyage) using half of the number of vessels operating on the Sea – Toll option.

The finding, obtained from the additional and backflow cargo scenarios, suggests that the government should consider to revoke the policy of goods limitation in Sea – Toll Agenda. Both scenarios are capable of improving the network by providing more subsidy saving (10% lower than proposed network) and a competitive unit cost per TEU (770 USD/TEU) compared to the cost from initial Sea – Toll Network (1,830 USD/TEU). A sensitivity analysis shows these results are quite robust to changes in the model parameters.

Geopolitical risk and capital structure decisions in the shipping industry

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Geopolitical risk (GPR), for which Caldara and Iacoviello (2018) developed the calculation method, is defined as the risk associated with wars, terrorist acts, and tensions between states that affect the normal and peaceful course of international relations. With the unique nature of the shipping industry which consists of cyclical and capital-intensive companies, we question whether GPR influences firms when making leverage decisions based on their expectations about the future economic and political environment. The major objectives of this research are to investigate (1) how global shipping companies choose capital structure in response to GPR, and (2) whether geopolitical risk types have differing effects on a firm’s capital structure decisions. Therefore, we examine capital structure decisions of global shipping companies by employing panel data methodology. This study consists of 131 active and inactive globally-listed shipping firms for the period between 1987 and 2017.

Our main results show that shipping firms lower their financial leverage in response to higher geopolitical risks. Further, geopolitical threats, which capture the sentiment of possible geopolitical action, negatively and significantly affect capital structure decisions. Conversely, geopolitical acts, which are comprised of actual adverse events, have a negative but not significant influence on such decisions. Moreover, the GPR index calculated by narrow definition has a negative and significant impact on a firm’s decisions whereas GPR in a broader definition has a negative but insignificant effect.

This research contributes to the existing literature at least in twofold. First, to the best of our knowledge, this paper is the first work to connect geopolitical risk with capital structure decision, thus filling the gap in shipping finance research. Second, the research uses the global shipping industry as the setting and investigates which geopolitical risk types influence on the firm’s leverage behavior.

09:00 - 10:30	Session 4B (M201) Chair: Kap Hwan Kim Theme: Port operations
	Job Sequencing of twin overhead shuttle cranes in a rail-based automated container terminal *Henokh Yernias Fibrianto, Permata Vallentino Eko Joatiko, Dong-Ouk Lee, Hoon Lee and Soondo Hong*
	A Handshake Policy Between Twin Over-head Shuttle Cranes in a Rail-based Container Terminal *Bosung Kim, Taehoon Lee, Myungsun Park, Hoon Lee and Soondo Hong*
	Optimal concession contract between the port authority and container terminals by a royalty fee scheme *Yanjie Zhou and Kap Hwan Kim*
	A LEGO based hardware-in-the-loop container terminal simulator *Zhuo Sun*

Job Sequencing of twin overhead shuttle cranes in a rail-based automated container terminal

Henokh Yernias Fibrianto [1], Permata Vallentino Eko Joatiko [1], Dong-Ouk Lee [2], Hoon Lee [2], Soondo Hong [1,]*

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This study introduces the twin overhead shuttle cranes (OS) job sequencing model considering collaboration to reduce the makespan of storage/retrieval jobs. The storage area in an overhead rail-based automated container terminal consists of multiple bays, where each bay has a set of container slots and handover points with the other vehicles. The two OSs can collaborate with each other to handle storage/retrieval jobs. The collaboration between OSs is accommodated by a handshake area, an area where an OS can temporarily store a container before the container being transferred by another OS to its final destination. Collaboration promotes a balanced workload between OSs and possibly reduce makespan by eliminating most of the interferences between the two OSs. Two factors are crucial to reduce makespan by collaboration, the sequence of jobs and the location of the handshake area. In this study, we aim to optimally sequence OS jobs considering the collaboration using a mathematical model. We develop a twin OSs job sequencing model and test the performances by the proposed model under various handshake area configurations. We compare the makespan by the proposed model and by the first-come-first-serve (FCFS) sequencing strategy. The results show that the proposed job sequencing model achieve lower makespan than that of FCFS with the maximum relative gap between FCFS and proposed model is as high as 23.85%.

A Handshake Policy Between Twin Over-head Shuttle Cranes in a Rail-based Container Terminal

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A handshake operation between twin Over-head shuttle cranes (OSs) plays an essential role in a rail-based container terminal operation. Also, the handshake operation can reduce a waiting time of flatcars which transfer containers to quay cranes. The handshake operation preliminarily relocates the containers to a handshake area, and transfer containers to its destination after temporarily store in the handshake area. We propose a handshake policy model that selects handshake locations to optimize the workload balance between twin OSs. The mixed integer programming (MIP) model improves the balanced workload while satisfying the given container flow capacity. Simulation experiments show that the proposed model reduces 32.3%~38.8% of the waiting time of flatcars.

Optimal concession contract between the port authority and container terminals by a royalty fee scheme

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The goals of a port authority are to provide efficient and reliable services that meet the needs of port users and promote the development of trade through the port. To meet the long-term goals of a port authority, the port authority needs to boost container volumes by providing an optimal concession contract for container terminal operators. Traditional two-part tariff scheme consists two part: fixed fee and unit fee. No matter how much the container volume of a container terminal operator is, the container terminal operator needs to pay a fixed unit fee for per container. For stimulating container terminals to obtain higher container volumes, the port authority may provide some benefit in the rental fee to container terminals for a large handling amount of containers. The royalty fee scheme is a concession contract provided by a port authority which gives an opportunity for container terminals to obtain the financial benefits for the growth of traffic volumes. According to the royalty fee scheme, if the container volumes of a container terminals over a predefined threshold, the container terminal can get a discount on the unit fee per container. This study analyzes the optimal royalty fee offered by a port authority to competing terminal operators. To investigate the behaviors of the container terminals, a leader-and-followers game is defined. Like traditional leader-and-followers games, the game consists of two stages. Firstly, the port authority (the leader) determine a royalty fee scheme. Then, the container terminals (followers) complete with each other to maximize his/her profit by determining the container volume. The relationship of the price and the volume for container is modeled as an inverse demand market function. Each container terminals aims at maximizing their own profit. In this study, two different objectives for the port authority including maximizing the traffic volume and maximizing revenues are analyzed. Three contract schemes including fixed fee, unit fee and two part tariff are compared with the royalty fee scheme. The mistakes of previous studies are modified and compared with the method proposed in this study too. To help readers understand the proposed royalty fee scheme, numerical examples are provided to illustrate the proposed model of leader-and-followers game.

A LEGO based hardware-in-the-loop container terminal simulator

*Zhuo Sun**

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Container terminals are getting bigger and busier. Managing their operations becomes a challenge. Software simulators are widely used but they bear difficulties in use and development. In this study, we introduce the LEGO hardware as the counterpart of the software simulator to provide a touchable and modularized interface. Users can easily customize different parts of the simulator in the prototyping phase. Experiments show that it can facilitate teaching, training and research processes.

11:00 - 12:30	Session 5A (M101) Chair: Xiaofan Lai Theme: Optimization modeling
	Improved Benders decomposition algorithm for complex product supply chain network design under supply disruption risks *Hongtao Hu and Xinhe Bai*
	Robust Liner Schedule Design with Service Level Guarantee *Xiaofan Lai, Fan Wang, Jun Xia*
	Integrated Train Timetabling and Locomotive Assignment *Xiaoming Xu, Chung-Lun Li and Zhou Xu*
	Ship size optimization in maritime markets with uncertainty *Hongtao Hu*

Improved Benders decomposition algorithm for complex product supply chain network design under supply disruption risks

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This study investigates a complex product supply chain network design problem under supply disruption risks with multi-echelon, parallel modules, and multi-period. In this study, we make the decision of supplier selection, strategic partnership building, and the number of produced and transported products. To minimize the total cost including alliance cost, production cost, inventory cost, transportation cost, and penalty cost for unsatisfied demand, a two-stage stochastic programming is used to formulate this problem as a mixed-integer programming (MIP) model. Based on customer orders, candidate enterprises are selected to fulfill these orders, and inventories of raw materials and finished products are allocated to the selected enterprises during the planning horizon. And an improved Benders decomposition algorithm is designed to solve this MIP model with large-scale problem instances. Numerical experiments demonstrate improved performance of this algorithm in both accuracy and efficiency of convergence.

Robust Liner Schedule Design with Service Level Guarantee

Xiaofan Lai [1,], Fan Wang [1], Jun Xia [2]*

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This paper considers a robust schedule design problem in a liner service, which has taken the uncertain port time into account and can ensure a certain level of schedule reliability. Stochastic programming models are formulated and transformed into solvable deterministic models. Extensive experiments have shown the effectiveness and efficiency of the models and methods. The results can be applied to the practice so as to minimize the cost of carriers and also guarantee their service level.

Integrated Train Timetabling and Locomotive Assignment

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Train timetabling and locomotive assignment are often performed separately in a sequential manner. One obvious disadvantage of such hierarchical planning process is that it often results in poor coordination between the train schedule and the locomotive schedule. This research focuses on modeling and solving an integrated train timetabling and locomotive assignment problem with the following characteristics:

(i) The underlying railway network is a general network, with arcs and vertices representing track segments and stations, respectively.

(ii) All the track segments consist of one-way (i.e., mono-directional) tracks, and the capacity of each station is unlimited.

(iii) The route of each train is given, but the timetable of each train is to be determined.

(iv) The initial and final stations of each locomotive are given, but the route of each locomotive is to be determined.

(v) Each train needs only one locomotive, and the locomotive needs to be compatible with the train (e.g., with an operating power no smaller than the power requirement of the train).

(vi) After a locomotive has finished serving a train, it may light run to another station to serve another train.

(vii) A train may be canceled, and a penalty is incurred when there is a cancellation.

The problem considers a number of constraints, including train assignment constraints (i.e., each train is either assigned one compatible locomotive or canceled), time window constraints (i.e., each locomotive must begin its operation no earlier than a given start time and completes its operation no later than a given end time), headway constraints at stations, and track capacity constraints.

To solve this integrated train timetabling and locomotive assignment problem, we first construct a three-dimensional state-space-time network in which a state is used to indicate which train a locomotive is serving. We then formulate the problem as a minimum cost multi-commodity network flow problem with incompatible arcs and integer flow restrictions. We present a Lagrangian relaxation heuristic for solving this network flow problem. The Lagrangian relaxation heuristic uses a subgradient optimization procedure with a dynamic constraint-generation scheme. Under this scheme, we dynamically identify constraints that the relaxed solution violates, and we use a constraint pool to store these constraints.

We conduct a computational study to test the effectiveness of our Lagrangian relaxation heuristic and compare the performance of our heuristic with that of two benchmark solution methods, namely a priority heuristic which constructs schedules for locomotives one by one based on a pre-determined priority sequence of locomotives, and a sequential heuristic that solves the problem by following a traditional approach where train timetabling decision is made before the locomotive assignment decision. The computational results demonstrate that our Lagrangian relaxation heuristic can generate fairly effective solutions to all the test instances, and that it outperforms both benchmark solution methods. The computational results also show that making locomotive assignment decision after making train timetabling decision could result in more train cancellations.

Ship size optimization in maritime markets with uncertainty

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This paper considers the problem of optimizing the ship type of liner shipping between two container terminals. Fluctuations of demand and allowable due times of cargoes lead to challenges in making a robust ship type optimization in a maritime market with uncertainty. In the study, a stochastic dynamic programming method is proposed to calculate the expected total volume of the corresponding containerships within the planning horizon. Using the calculated volumes as input parameters, an integer programming model is then developed to determine the ship type to maximize the profits of the shipping companies. Numerical experiments are performed to validate the effectiveness of the proposed model and the efficiency of the proposed algorithm.

11:00 - 12:30	Session 5B (M201) Chair: Michael Bell Theme: Performance analysis in logistics system
	Sensitivity analysis of collaborative hinterland transport *Alberto Giudici, Tao Lu, Clemens Thielen and Rob Zuidwijk*
	Spanning tree analysis of the world maritime network *Michael Bell, Kam-Fung Cheung, Jingjing Pan, Supun Perera and Shengda Zhu*
	Degree of Outsourcing of the Logistics Operations *Pedro Antonio Galvis González*

Sensitivity analysis of collaborative hinterland transport

Alberto Giudici [1,], Tao Lu [2], Clemens Thielen [1], Rob Zuidwijk [1]*

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In this work, we consider the problem faced by hinterland container transport operators that join forces in a collaborative effort. In the hinterland transport means with different capacity and unit costs, like barges, trains, and trucks, operate to satisfy container transport demand from a port to the surrounding region, and vice versa. Companies are considered here to cooperate by pooling orders and sharing part of their transport capacity in a network. By doing so, better planning solutions can be found, thus, reducing the overall costs of transport. The resulting problem is that of how to share the generated cost savings in a way that is accepted by the different players and does not incentivize companies to leave the collaboration.

To address those issues, cooperative game theory has been applied in the literature by axiomatically proposing allocation methods and solution concepts. In contrast to this main point of view, recent results from the so-called Nash's Program have shown that the Shapley value has non-cooperative bargaining explanations, besides its well-known fairness properties. Supported with evidence from practice that the Shapley value can capture those bargaining dynamics, we consider the Shapley value as the outcome of the bargaining between the players and check whether it is stable for the considered cooperation. Thus, checking whether it belongs to the core of a non-convex, cooperative game based on a parametric minimum cost flow problem. While the minimum cost flow problem has been used to capture the essential traits of a transportation setting, parametrization of cost parameters allows us to perform a sensitivity analysis of the stability of the Shapley value. To the best of our knowledge, this is the first time the mathematical structure of this relation is studied. In this way, we can provide managerial insights into the effect of transport costs on cooperation stability. Differently, from other works which perform a sensitivity analysis numerically, we contribute to the literature by characterizing the mathematical structure of this problem, we then obtain closed-form solutions in stylized network setting and later perform solid numerical tests on more complex instances.

Our results show that high demand to capacity ratio for all players leads to stability of the Shapley value. Low levels of demand, instead, drive the Shapley value out of the core, thus, indicating instability of the cooperation. This result is similar to that found in other works on collaborative transport, thus allowing us to create first bridges between the results in this expanding field of research.

Spanning tree analysis of the world maritime network

Michael Bell [1,], Kam-Fung Cheung [1], Jingjing Pan [2], Supun Perera [1], Shengda Zhu [1]*

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In previous work, the authors pioneered the use of spanning trees to study the optimal structure of public transport networks. The spanning tree that minimises passenger-kilometers indicates where the public transport hubs should be located and which stations should be connected directly to each other. Spanning trees provide one and only one path between every pair of stations, with no loops. The number of links is one less than the number of stations. This paper applies the same technique to the world container shipping network to reveal the natural hubs and trade routes. However, finding the spanning tree with least container-kilometers poses two computational challenges. The first relates to the availability of demand data. Container flows between ports are not known so must be estimated. We use a gravity model to estimate container flows between ports based on port throughput data and the distances between ports. The second relates to the size of the network. Heuristics developed for finding a minimal passenger-kilometer spanning tree in a ferry system with 36 ferry stations already took an appreciable amount of computer time, so solving a problem with over 600 ports is not tractable. We present a family of new heuristics that 'grow' spanning trees using the fitness based attachment principal found in the complex network literature. The fitness of a port in this context depends on its size in terms of container throughput, its connectivity to other ports, and the size and distance of the ports to which it is connected. We test the growth heuristics against tried and tested heuristics for the ferry system with 36 ferry stations to gain insights into their performance. We then apply the best growth heuristics to the world container shipping network and comment on the topology of the resulting spanning trees.

Degree of Outsourcing of the Logistics Operations

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The present work exposes what is the degree of subcontracting or outsourcing of logistics operations and the analysis of factors, advantages and disadvantages of the process as soon as the competitiveness factors of the companies are explored, the characteristics of the outsourcing process of the company are also analyzed. business sector of the city of Neiva that have outsourced logistics services.

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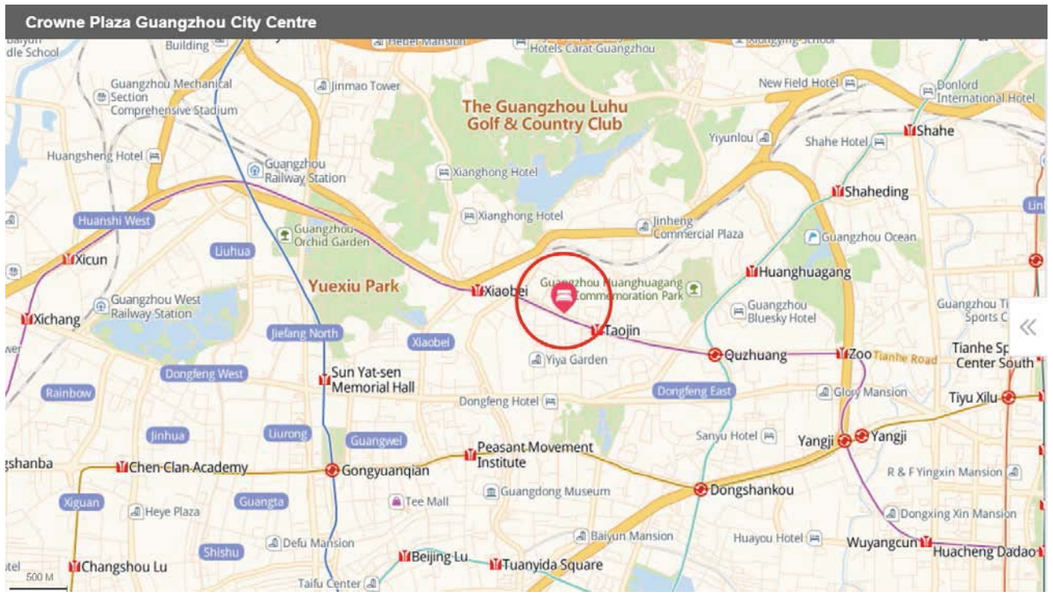
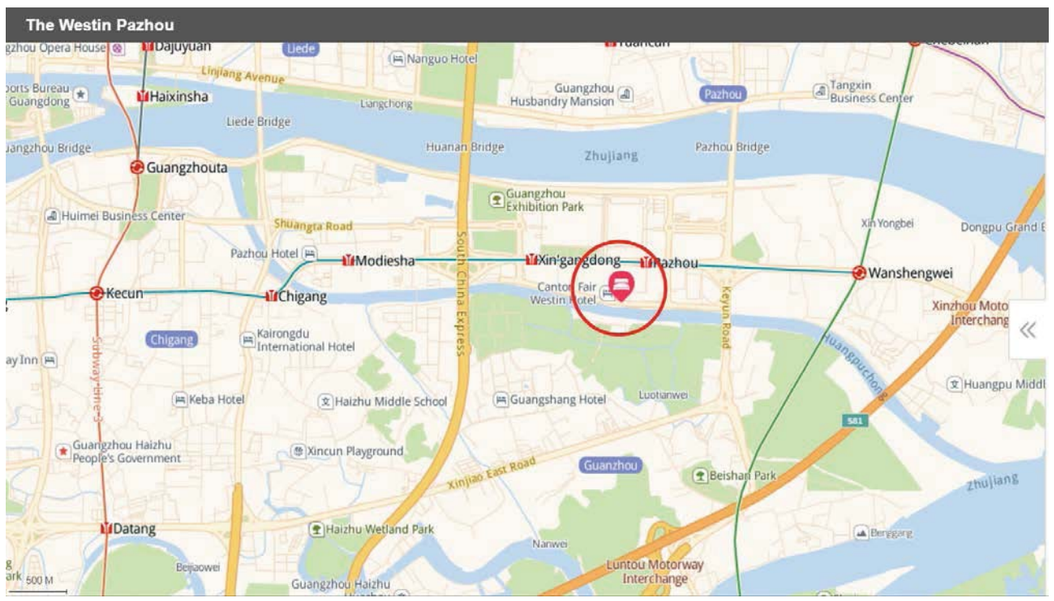
Location Map

1、Reception (Dec. 9): Crowne Plaza Guangzhou City Centre （广州市越秀区环市东路 339 号广州中心皇冠假日酒店）
No.339, Huanshi East Road, Yuexiu District, Guangzhou 510098



2、Conference Dinner (Dec. 11): The Westin Pazhou（广州市海珠区风浦中路 681 号，广交会展馆 C 区，威斯汀酒店）
No.681, Fengpu Middle Road (Area C, The Canton Fair Complex), Haizhu District, Guangzhou



3、Conference venue: MBA Building, Business School Sun Yat-sen University
Lunch: Sun Yat-sen Kaifeng Hotel