LOGMS 2017

NHH Norwegian School of Economics

August 23 - 26, 2017

Welcome to LOGMS 2017

We are pleased to invite you to attend and participate in the 7th International Conference on Logistics and Maritime Systems. The aim of this conference is to provide a forum for participants from universities and related industries to exchange ideas on the latest technical, operational, economic and sustainability developments in container and bulk logistics and their related maritime systems.

We are happy to host you all here at Norges Handelshyskole (NHH - the Norwegian School of Economics). NHH comprises over 2,700 full time students and a total staff of over 330, and the school co-operates closely with the foundations AFF and SNF. Together, NHH and its associated foundations constitute a major academic and organisational entity with more than 470 employees, and they are the leading centre of competence for economics and business administration in Norway. Its facilities provides a prestigious and spacious environment for conferences.

Bergen has given a warm welcome to its visitors for more than 900 years. Bryggen has become a symbol of our cultural heritage and has gained a place on UNESCO's World Heritage List. The old Hanseatic wharf is architecturally unique and is perhaps one of the most familiar image in all of Norway. Today, Bergen is an international city packed with history and tradition, a big city with small-town charm and atmosphere.

Contents

Programme at a Glance

PRELIMINARY PROGRAMME LOGMS 2017 - PARALLEL SESSIONS

Thursday August 24th, 10:45 - 12:15 hr

	T1A - NORS - Operations research 1 (Aud.14) Chair: J. Góez	T1B - Environment & Sustainability 1 (Aud.22) Chair: H. Jia	T1C - Facility location & Network design (Aud.23) Chair: K. Fagerholt	T1D - Empty container management (Aud.24) Chair: Y. Boucher
T1	S.D. Flåm, "Block-Coordinate Methods and Stochastic Programming"	X. Zhang and J.S.L. Lam, "Balancing the Economic and Environmental Performance of Seaborne Cold Chain: A Value-based Approach"	S. Backe and D. Haugland, "Strategic optimization of offshore wind installations"	M. Yu, J.C. Fransoo and C.-Y. Lee, "The Detention Decisions for Empty Containers in the Hinterland Transportation System"
	J.-J. Ruckmann, "On proper efficiency in multiobjective semi-infinite optimization"	N.K. Tran, J.S.L. Lam, H. Jia and R. Ådland, "Emissions in container liner shipping – A case study of a global shipping network"	K. Pan, D. Yang and S. Wang, "A Network Design Problem for COSCO under the One Belt One Road Initiative of China"	N. Dellaert, M. Steadieseifi and T. Van Woensel, "A metaheuristic for the multimodal network flow problem with product quality preservation and empty repositioning"
	H. Fujikawa, "Supply chain optimization by matrix expression"	A. Özmen, "Sustainability Measurement in Turkey Maritime Industry"	B. Medboen, M.B. Holm, P. Schütz and K. Fagerholt, "Feeder network design with transshipments at sea"	B. Legros, Y. Bouchery and J. Fransoo, "The role of consignees in empty container management"
	Y. Kisialiou and I. Gribkovskaia, "Heuristic based approach for generation of cost-effective and robust supply vessel schedules"	C. Aksu and I.M. Basaran, "Sustainable Logistics Villages: A Study on Logistics Villages Developed by Turkish State Railways with Respect to the Criteria for Sustainable Logistics Using TOPSIS Method"	F. Wang, M. Xiong, X. Zhuo, X. Xia, "Impact of Leadership and Government Subsidy on Port Construction and Operations"	F. Schulte, N.S. Bernat and S. Voss, "A Network-based Approach to Reduce Maintenance Costs and Pollution in Empty Container Management"

Thursday August 24th, 13:30 - 15:00 hr

	T2A - NORS - Operations research 2 (Aud.14) Chair: S.L. Nonås	T2B - Data analysis (Aud.22) Chair: V.M. Durski Silva	T2C - Scheduling (Aud.23) Chair: F. Spieksma	T2D - Liner shipping (Aud.24) Chair: R. Dekker
T2	E. Gustavsen, A.F. Tollefsen and B. Eggereide, "Military operations assessment through the use of opinion surveys"	J. Wang, B.-Y. Lai and P.-C. Lin, "Application of Spatial Econometrics on Logistics Performance Index"	W. Passchyn and F. Spieksma, "Scheduling a series of locks along a waterway"	J. Xia and Z. Xu, "A Column-Row-Generation Approach to Liner Shipping Network Design"
	M. Guttelvik and S. Glærum, "Norwegian Long Term Defence Planning"	J. H. Kim and S. Hong, "A storage relocation policy for a progressive zone picking system and its simulation analysis"	T. Zis, M. Golias and H. Psaraftis, "Implications of Berth scheduling with cold ironing provision for different penetration rates"	T. Vallestad, A. Weggersen, M. Christiansen, K. Fagerholt, J.R. Hansen and J. Rakke, "A Single Trade Routing Problem in Roll-on Roll-off Liner Shipping"
	J. Skålnes, K. Fagerholt, G. Pantuso and X. Wang, "Controlling the Cash Flow Risk in Maritime Fleet Renewal"	B. Frank and S.J. Schvaneveldt, "International Differences in the Customer Value of Autonomous Driving Systems"	R.D. Koster, A. Rijal and M. Bijvank, "Integrated Cross-Dock Scheduling and Assignment"	P. Cariou, A. Cheaitou and R. Larbi, "A traveling salesman problem model for liner shipping cost and CO2 minimization"
	S. Chandra, K. Fagerholt and M. Christiansen, "Analyzing the environmental impact of multi-modal coastal shipping for automobile distribution in India"	G. Campos Pires, V.M. Durski Silva and C.W. Nogueira Fernandes, "Measuring container terminals efficiency using the Data Envelopment Analysis Method"	A. Pérez Rivera and M. Mes, "Integrated scheduling in synchromodal transport"	J. Mulder, W.v. Jaarsveld and R. Dekker, "Simultaneous optimization of speed and buffer times in liner shipping"

Thursday August 24th, 15:30 - 17:00 hr

	T3A - NORS - Operations research 3 (Aud.14) Chair: B. Arnfinnsson	T3B - Stochastic problems 1 (Aud.22) Chair: F. Meisel	T3C - Electric vehicles & Routing (Aud.23) Chair: B. Frank	T3D - Collaborative logistics (Aud.24) Chair: M. Guajardo
T3	B. Arnfinnsson, "Scenario based military logistics modelling – methodological and practical challenges"	F. Meisel, "Robust traffic management for the Kiel Canal"	B. Frank and D. Xu, "The Role of Environmental Considerations in Consumer Decisions to Adopt Electric	S. Kotcharin, "Understanding of port collaboration: A case study of Thailand's port"
	S.E. Martinussen, D.H. Bentsen, M. Halsør, H. Ajer and U.-P. Hoppe, "Gaming of Possible Future Norwegian Land Forces"	B. Vermeulen, T. Tan, S. Eruguz-Çolak and G.-J.V. Houtum, "Online, adaptive condition-based maintenance planning for multi-component systems under a given operating schedule. A novel method for and application in the maritime sector."	C. Lee, "An Exact Algorithm for Electric Vehicle Routing Problem with Recharging"	V. Santén, M. Andreasson, I. Cedulf, C. Finnsgård and M. Svanberg, "Short sea shipping - a competitive alternative for land-based container transportation?"
	R.B. Lopes, C.W. Nogueira Fernandes and V.M. Durski Silva, "Logistics process mapping and simulation in a container terminal"	S.S. Pettersen, E. Sandvik, K. Fagerholt and B. E. Asbjørnslett, "Stochastic programming for fleet renewal in the offshore oil and gas industry"	M.F. Fauske and C. Mannino, "Generalized periodic vehicle routing and maritime surveillance"	A. Giudici, T. Lu, C. Thielen and R. Zuidwijk, "The value of collaboration in hinterland container transport"
	V. Prochazka, S.W. Wallace and R. Ådland, "Value of prediction in bulk shipping"	M.A. Strøm, C.F. Rehn, B.E. Asbjørnslett, S.O. Erikstad and S. Pettersen, "Scenario-analysis for assessment of operational strategies for evaluation of changeability in complex markets: case from offshore shipping"	R. Yaman, T.S. Tezer and G. Yaman, "An exact approach for a vehicle routing problem with pickup and delivery time windows and some sample solutions"	V. Carlan, C. Sys and T. Vanelslander, "Innovation in road freight transport: quantifying the environmental performance of operational cost reducing practices"

Friday August 25th, 8:30 - 9:35 hr

	F1A - NORS - Operations research 4 (Aud.21) Chair: M. Guajardo	F1B - Stochastic problems 2 (Aud.22) Chair: D. Pacino	F1C - Revenue management (Aud.23) Chair: S. Wang	:1D - NeLT - Next Logistics Technologies (Aud.24) Chair: K.H. Kim
F1	F. Wang, X. Zhuo, X. Xia, "Price Alliance and Service Competition Among Ports Group: Co-opetition Mechanism and Incentives Analysis"	S. Lee, Y. Park, S. Kim and I. Moon, "Robust Tractable Approximation of a Multistage Stochastic Program for Empty Container Repositioning Considering Foldable	K. Wang, S. Wang, L. Zhen, X. Qu and H. Hu, "Models of route planning for cruise shipping"	M.R. Kim and S. Lee, "Development of a K-DST for improving competitiveness of railway freight transport"
	B. Dong, K. Fagerholt, M. Christiansen and S. Chandra, "Maritime Inventory Routing in Roll-on – Roll-off Shipping"	N. Absi, D. Feillet, E. Sanlaville and X. Schepler, "The Stochastic Berth Allocation Problem"	B.v. Riessen, R. Dekker, R. Negenborn and J. Mulder, "Fare Class Sizes in Intermodal Container Networks- A Revenue Management Approach"	M. Kang and S. Yi, "Study on Genetic Algorithm for Vehicle Routing Problem using Drone"
	S.M. Mirhedayatian, M. Guajardo, S.W. Wallace and T.G. Crainic, "A time-driven two-echelon location-routing problem with synchronization and sequential delivery and pickup"	J. Christensen, A. Erera and D. Pacino, "The Stochastic Cargo Mix Problem"	D. Sturm and K. Fischer, "Considering the Special Characteristics of Cruise Line Revenue Management in Mixed-Integer Linear Programming Models for Cabin	V.N. Riaventin, K.H. Kim and C.S. Ko, "Scheduling appointments for trucks at container terminals"

Saturday August 26th, 11:30 - 13:00 hr

	S1A - Supply chains (Aud.21) Chair: V. Vrysagotis	;1B - Vessel speed & Energy consumption (Aud.22 Chair: R. Ådland	S1C - Disruptions & Resilience (Aud.23) Chair: M. Vidovic	S1D - Ports & Containers 1 (Aud.24) Chair: D. Pacino
S1	Y. Wang, L.H. Lee and E.P. Chew, "A balanced KPI tree to measure supply chain performance"	E. Lindstad, H. Jia and R. Ådland, "Speed Optimization for Crude Oil tankers as a function of Cargo Inventory Cost, Demurrage, Freight Market and Real Sea Conditions"	M. Vidovic, N. Bjelic and D. Popovic, "Disruption recovery and rescheduling problems in containers drayage"	X.J. Jiang, "Intelligent Cross-sectional Yard Crane Deployment in a Transhipment Container Hub"
	Y. Wang, R.Y. Shou, L.H. Lee and E.P. Chew, "A data driven supply chain facility location problem with stochastic demand and uncertainties"	H. Jia, V. Prakash, R. Ådland and T. Smith, "On the relationship between vessel speed, port time and demurrage"	P. Achurra-Gonzalez, S. Hu, K. Zavitsas, D.J. Graham, F. Su and P. Angeloudis, "Modelling the impact of infrastructure developments on the resilience of intermodal container transport networks: One-Belt-One-Road Case study"	T.K. Kim, S.P. Moon and K.R. Ryu, "Empirical Evaluation of an Automated Container Terminal with Truck Overpass Structures on the Storage Yard of Parallel Layout"
	B. Castelein, H. Geerlings and R.v. Duin, "Barriers to innovation diffusion in the reefer chain"	F.-C. Wolff, R. Ådland, P. Cariou and H. Jia, "Real energy efficiency in the seaway"	N. Liu, H. Chen and J.S.L. Lam, "Evaluating resilience of port-hinterland road-inland water shipping container transportation network"	K. Shintani, A. Imai and U. Malchow, "A container fleet sizing problem with combinable containers in liner shipping"
	V. Vrysagotis and T. Bratis, "A performance measures quantitative analysis for a three stage logistics system"	C. Li and X. Qi, "On the Fuel Consumption Function for a Vessel under Changing Sailing Conditions"	D.K. Li, J.S.L. Lam and X. Cao, "Natural catastrophe risk index of seaports"	D. Pacino and R. Roberti, "Block Stowage and Crane Intensity in Stowage Planning"

Saturday August 26th, 14:00 - 15:30 hr

	S2A - Simulation (Aud.21) Chair: H. Schuett	S2B - Environment & Sustainability 2 (Aud.22) Chair: Suk Lee	S2C - Risk management & Real options (Aud.23) Chair: C. Fulga	S2D - Ports & Containers 2 (Aud.24) Chair: E. Twrdy
S2	H. Li, C. Zhou, H. Chi, L.H. Lee, E.P. Chew, X.F. Yin and X. Fu, "A Modularized Discrete-Event Modeling Approach for High-Fidelity Mega Container Port Simulation"	Y. Gu, "Scrubber: a potentially overestimated compliance method for the Emission Control Areas; The importance of involving operational behavior changes in the evaluation"	C. Fulga, "Modeling and managing risk using portfolio optimization techniques for maritime systems"	E. Twrdy and M. Batista, "Competition between containers ports in Mediterranean"
	C. Zhou, A. Stephen, H. Li, E.P. Chew and L.H. Lee, "Index based Heuristic Approach for ULD Sorting Operation in Third Party Logistics"	T. Zis and Ha. Psaraftis, "Measures to mitigate and reverse the negative impacts of the low sulphur requirements on short sea shipping in Europe"	T. Bi-Huei, "The Event Study of Oil Price Shocks on Stock Returns of Transportation Industry in Taiwan"	M. Ng and W.K. Talley, "Chassis Management at U.S Container Ports"
	G. Tasoglu and G. Yildiz, "Solving dynamic multi-continuous berth allocation and quay crane scheduling problems simultaneously by using simulation optimization"	T. Freese, M. Gille, A. Hursthouse and J. Struthers, "Studying Determinants of Compliance with Maritime Environmental Legislation in the North and Baltic Sea Area: A Model developed from Exploratory Qualitative Data"	J. Leonhardsen, C.F. Rehn, B.E. Asbjørnslett and S.O. Erikstad, "Valuation of Rapid Reconfiguration: A Case from Bulbous Bows in Container Shipping"	V. Roso, S. Franzén, L. Streling, C. Finnsgård, V. Santén and M. Svanberg, "Value stream mapping of container flows in the Port of Gothenburg"
	C.T. Bjorbaek, O. Berg and H. Schuett, "Simulation based lectures for students in logistics"	M.R. Kim, Y.J. Kwon and S. Lee, "A comparison between EOQ and S-EOQ by logistics strategies under Emissions Trading System"	C. Christensen, C.F. Rehn, R.O. Ådland, B.E. Asbjørnslett, S.O. Erikstad and S.-E. Fleten, "Agility and investment lags in fleet expansion – a case from bulk shipping"	N. Milovanovic, "Port competition in Northwestern Europe: a case study"

Plenaries

Future Trends in Logistics: A Biased View on Urban Mobility and Its Interconnection with Transport Networks

Professor Stefan Voss
University of Hamburg
Opening and EURO Plenary
Thursday August 24, 9:00 – 10:15
Auditorium D
Chair: Stein W. Wallace

Logistics is currently undergoing major changes that have not been foreseen even a decade ago. While topics such as green logistics, reverse logistics, closed-loop supply chains and many other "buzzwords" have gained importance quite some time ago, we now see major challenges due to the upcoming ideas of autonomous vehicles, drones, 3D-printing and same day delivery, just to mention a few. Together with the internet of things (IoT), Logistik 4.0, big data and cloud computing we see a large momentum behind the digital transformation in various areas and disciplines largely influencing the future of sustainable logistics, taking into account economic, ecological, and social dimensions. We may concede that "the technology" is there, it "just" needs to be applied in a meaningful way in order to gain business as well as societal value.

While advances are observed in technology, this might also bring new problems. Besides managerial and cultural challenges for facilitating the digital transformation, everything is bound to be optimized so that vulnerability issues and the influence of disturbances get more and more important. A well-known example from production planning is the consideration of load dependent lead times. And on the societal side humans need to be trained to solve and resolve problems which are considered to be even more complex as more data is coming in and system-wide implications are more demanding etc. In this spirit, digital transformation is of utmost importance in the business world with major impacts on any of its sectors and especially logistics and supply chain management. As an example one may consider ports and logistics within maritime shipping to exemplify those developments. That is, as actors in world-wide supply chains, seaports are particularly affected by technological change. Past developments show how digital innovation can shape the modernization of ports.

In this presentation we review the outcomes of past developments and their impact on logistics operations with a view on urban mobility and its interconnection with transport networks. While a comprehensive treatment of the topic is beyond our goals, we provide a biased view focusing on one or more example(s) chosen especially from the following sets of challenges:

- Digital transformation in seaports:

  We identify issues regarding the timeline of different stages of digital transformation in seaports and discuss important aspects and challenges for their future.

- Digital transformation in electricity networks:

  One of the problems to exemplify modeling of self-adequacy of interconnected micro-grids and smart grids relates to the maximum partitioning of a graph with supply and demand where the objective is to find a set of vulnerable disjoint connected subgraphs observing certain supply and demand options.

- Digital transformation in public transport:

  Information exchange in public transport has reached new levels based on wireless sensor networks, GPS-technology, RFID and alike. The use in, for instance, passenger information systems should enable any type of user to take informed decisions in regular use, in case of disturbances or even in demand-responsive transport. We identify issues regarding the timeline of different stages of digital transformation in public transport and clarify important aspects and challenges for their future.

Industry plenary session: Western Bulk, Odfjell, Maersk Digital

Friday August 25, 10:00 – 11:30
Auditorium D
Chair: Roar Ådland

We have put together a nice mix of forward-leaning shipping companies for an industry plenary session at the upcoming conference on Logistics and Maritime Systems (LOGMS) at NHH in August - representing leading drybulk, chemical tankers and liner shipping operators.

This organization of this plenary is as follows:

- It will take place between 10:00 and 11:30 on Friday 25th August at the Norwegian School of Economics
- Western Bulk and Odfjell will have 20 minute presentations, and Maersk Digital will have a 30 minutes presentation.
- At the we will have an additional 20 minutes for a Q&A session/brief panel discussion.
- The presentations will be within the broader topic of digitalization in shipping and related logistics networks (including big data and applications).

Optimization in Roll-on Roll-off shipping

Professor Kjetil Fagerholt
Norwegian University of Science and Technology
Saturday August 26, 10:00 – 11:00
Auditorium D
Chair: Kap Hwan Kim

Roll-on Roll-off (RoRo) shipping is a specialized shipping segment where the vessels are designed to carry wheeled cargo, such as cars, high and heavy vehicles (e.g. trucks, agricultural and construction vehicles), and other types of breakbulk cargo (e.g. turbines, train coaches, boats) that can be placed on trolleys for loading and unloading. RoRo vessels have built-in ramps that allow the cargo to be efficiently rolled on and off the vessels, and come in four main types varying in their ability and flexibility to handle the different types of cargo: 1) pure car carriers (PCCs), 2) pure car and truck carriers (PCTCs), 3) large car and truck carriers (LCTCs), and 4) general RoRo vessels. The first vessel types are designed to carry cars but have also a few hoistable decks that allow also for taller cargoes. The latter types are optimized for carrying more high and heavy and breakbulk cargoes, but can also carry cars. The largest RoRo vessels have a capacity of around 8,000 so-called car equivalent units (CEUs), which is a measure based on a Toyota Corona 1967 model.

This presentation gives an introduction to the RoRo shipping segment and, based on a research collaboration with one of the major RoRo shipping companies in the world, discusses some important planning problems where optimization can provide valuable decision support. At the operational planning level, we present the stowage planning problem for a RoRo vessel visiting a given set of loading and unloading ports along its voyage. If we look at the stowage on one deck on board the vessel at a time, this is as a special version of a 2-dimensional packing problem where we want to utilize the vessels capacity so that we can carry as much cargo as possible. However, the problem has a number of additional considerations. One wants for example to place vehicles that belong to the same shipment close to each other to ease the loading and unloading. Another important consideration is that one wants to minimize shifting, which means temporarily moving some vehicles to make an entry/exit route for the vehicles that are to be loaded/unloaded at the given port.

We also present the fleet deployment problem arising in RoRo shipping. This tactical planning problem consists of assigning available vessels in the fleet to voyages along given geographical trades. The results from fleet deployment, in addition to which ship will perform which voyages, are sailing routes for the ships in the fleet, i.e. each vessel is assigned a sequence of voyages to perform, possibly with ballast (empty) sailing between the last port call of one voyage and the first on the next. Since the selection of vessel speeds heavily influences on the fuel consumption and costs, we also include sailing speed on each voyage as a decision variable.

This presentation provides an overview of mathematical optimization models and solution methods for both problems along with some computational results and discussion.

Integrating Resource and Revenue Management into Service Network Design

Professor Teodor Gabriel Crainic
Université du Québec à Montréal
NORS Plenary and Closing
Saturday August 26, 16:00 – 17:00
Auditorium D
Chair: Stein W. Wallace

Consolidation-based systems and carriers, e.g., railroads, less-than-truckload motor carriers, intermodal maritime and land transportation, and postal services, provide a significant part of the transportation of goods. They offer timely and economical services by moving the shipments of many different shippers within the same vehicle or convoy. They are also key elements of the new organizational and business models proposed for transportation and logistics such as City Logistics and the Physical Internet. Selecting how to provide consolidation-based services, in terms of routes, schedules, capacities, etc., is called the service network design problem. Recent developments in this area target the explicit integration of resource, e.g., vehicle or crews, and revenue management into the formulation, increasing the accuracy of the methodology as well as the modelling and algorithmic challenges. We discuss the issues, identify the challenges, present recent developments, and conclude with research perspectives and challenges.

Parallel Sessions

Thursday August 24

T1: 10:45 – 12:15

T1A - NORS - Operations research 1 (Aud.14)
Chair: Julio C. Góez

Block-Coordinate Methods and Stochastic Programming

Sjur Didrik Flåm

Thu. 24 Aug.
10:45-12:15
Aud.14

Considered here are extremal convolutions aimed at allocative efficiency or market equilibrium. At each stage two randomly selected agents/blocks implement a direct exchange. The latter depends on differences in their (resource) valuations or dual variables. This approach - and the attending convergence analysis - fits the frames of stochastic programming. Motivation stems from modern order markets.

On proper efficiency in multiobjective semi-infinite optimization

Jan-J. Ruckmann and Francisco Guerra Vazquez

Thu. 24 Aug.
10:45-12:15
Aud.14

We consider multiobjective semi-infinite optimization problems which are defined by finitely many objective functions and infinitely many inequality constraints in a finite-dimensional space. We discuss constraint qualifications as well as necessary and sufficient conditions for locally weakly efficient solutions. Furthermore, we generalize two concepts of properly efficient solutions to the semi-infinite setting and present corresponding optimality conditions.

Thu. 24 Aug.
10:45-12:15
Aud.14

Supply chain optimization by matrix expression

Hiroaki Fujikawa

Supply chain contains long and various processes such as procurement, production, sales, deliver and after service. Moreover supply chain involves a lot of companies who join this chain and deliver target items to their consumers. Planned production quantity of certain products may be revised due to some reasons. Such as the changes of consumers trend, quality assurance, overflow in warehouse capacity, miss operation in production lines etc. Supply chain situations are measured by yield of lines, lot size inconsistency, expiry dates of product and transport inefficiency. Also unit cost of production, procurement, storage and transportation may influence performance of supply chain operation. One of the important and uncovered issues is the specification of performance or cost index which must be improved for covering limited resources or unexpected affairs in certain process of supply chain. Usually managers must consider and take actions at their own field. This means that managers tend to work within the scope of their responsibility. But what is the best and appropriate operation to reach the totally optimal supply chain is not known. Hence we propose a matrix expression method of supply chain in order to visualize whole supply chain mechanism. Total cost of supply chain can be described by the sum of the product of quantity, efficiency and unit cost rate in every processes and in every items. Limitation of resources or some accidents happened in each process may make managers confused. At that time, managers have to find how to cover with the limited resources in their fields. Incurred various costs shall be measured by operational condition at each site. For example, when manufactured goods shall be stored, then the manager have to choose an appropriate warehouse. Stored quantity and equipment efficiency are fixed, then decision function must be cost matrix which shall be found by calculating inverse matrix of formulated equations. Thus E2E supply chain processes shall be formulated by the product of unit cost matrix, efficient indicator matrix and quantity matrix. When a certain matrix should be limited or fixed, then solution matrix must be found by calculating the inversed matrix. It is demonstrated that matrix expression of supply chain can provide optimal operational conditions. Also it is demonstrated that the proposed matrix expression has solved effectively by using Excel solver.

Thu. 24 Aug.
10:45-12:15
Aud.14

Heuristic based approach for generation of cost-effective and robust supply vessel schedules

Yauheni Kisialiou and Irina Gribkovskaia

In this work, we address the problem of supply vessel planning that arises in the upstream offshore oil and gas logistics. Supply vessels deliver all the necessary materials and equipment to offshore installations from an onshore supply base. Delivery takes place according to a weekly sailing plan (delivery schedule). Charter cost of supply vessels is the largest cost contributor in the upstream offshore supply. Therefore, planning of supply vessels should be done so that their number is minimized and in

the same time providing reliable flow of supplies from the base not allowing for the downtime at installations. Execution of weekly sailing plan is affected by weather conditions, especially in the wintertime. Harsh weather conditions increase vessels sailing and service time at installations and thus disrupt the schedule that leads to additional costs and reduced service level. We present a developed heuristic-based approach incorporating post-optimization simulation procedure enabling to create cost-effective and robust vessel schedules valid for a certain season, which enhances the possibility of generating schedules for the real large-size problem instances with the preferred trade-offs between robustness and vessel costs.

T1B - Environment & Sustainability 1 (Aud.22)
Chair: Haiying Jia

Balancing the Economic and Environmental Performance of Seaborne Cold Chain: A Value-based Approach

Thu. 24 Aug.
10:45-12:15
Aud.22

Xiunian Zhang and Jasmine Siu Lee Lam

Sailing speed has long been a decisive factor in shipping operations and has a crucial impact on the inherently thin margin of shipping companies. Although bunker prices plumbed last year, speed optimization problem remains hot due to the increasing environmental awareness, a trend that adds the emission consideration to the previous economic optimization problem. In spite of the accumulating studies on speed models for maritime energy efficiency, none has addressed this problem in the context of reefer shipping. Reefer shipping is a fastest-growing sector in the current industrial stagnancy. In seaborne cold chains, the speed optimization problem becomes particularly intricate because of the high value and time sensitive characteristics of reefer cargoes and the intrinsic high energy consumption associated with cold chains. Shippers are more sensitive to reefer ships sailing speed since the value of reefer cargoes depreciates exponentially when time eclipses. Meanwhile, the energy required to power reefers is proportional to the entire transport time, which directly depends on the sailing speed. This study will bridge the gap in literature with the aim to optimize the sailing speed of reefer container vessels while taking into consideration the greenhouse gas emission. A value-based speed model will be proposed to investigate the environmental impact of the reefers, and solutions will be provided to balance the economic and environmental performance of seaborne cold chains. Numerical examples will be presented to illustrate the model and sensitivity analysis will be conducted to shed light on managerial implications. The originality of this paper is fourfold. Firstly, it will construct the first speed model for energy-efficient reefer shipping. Moreover, it is the first study in the literature to approach the emission issue from the perspective of Value Based Management (VBM), which is a suitable tool to integrate the emission consideration and the operational concern. Another

uniqueness of the proposed model lies in its the polynomial fuel consumption function derived from regression analysis, which will present the energy consumption of both propulsion and auxiliary engines more precisely. Lastly, an auto-conduction second-order cone programming (SOCP)-transformation approach will be employed to solve the speed model. This work will widen the path for other maritime scholars and provide industry practitioners a practical decision tool.

Thu. 24 Aug.
10:45-12:15
Aud.22

Emissions in container liner shipping A case study of a global shipping network

Nguyen Khoi Tran, Jasmine Siu Lee Lam, Haiying Jia and Roar Ådland

Atmospheric emissions from shipping have various adverse effects on climate change, global warming, environment and human health. Therefore, the focus on emission accounting has been growing. Many attempts have been done to estimate greenhouse gas emissions from shipping, but estimates vary widely between the proposed models. This can be explained by many uncertainties in the activity and fuel data, emission factors, operational conditions and ship specifications. Our research focusses on CO2 emissions in container shipping, one of the most important shipping sectors. We propose a bottom-up performance-based model to quantify emission inventory of a fleet operating on a container shipping network, exploiting liner carriers service information regarding shipping routes and port schedules. The model also takes account operational characteristics of the fleet, such as observed vessel speed and draught reported by the Automated Identification System (AIS). Furthermore, a comparison between actual and planned schedules can be done to evaluate the reliability of shipping services. The model is applied on a global network of a leading liner operator. Our research not only computes emission amount at the global level, but also at different ports and on different routes. In such context, the environmental effects of a global shipping operation can be observed in detail. The computational results also enable us to establish formulae to estimate total emissions and unit emission per TEU-mile based on a route length, operational speed and deployed ship size.

Acknowledgement This research is supported by the Singapore Maritime Institute under the project SMI-2015-MA-16.

Sustainability Measurement in Turkey Maritime Industry

Thu. 24 Aug. 10:45-12:15 Aud.22

Aslı Özmen

The sectoral weight of maritime trade in world economic development is increasing every year. Maritime transport, fleet management, shipbuilding, ship dismantling, shipping markets, and ports all of which are considered to be elements of maritime trade are becoming separate sectors and have an important role in the development of countries. For example, 80% of the cargo carried in world trade and 70% of world trade value is transported by sea. Sustainability an important concept discussed in fast-developing sectors is defined as meeting the needs of present generations while ensuring that the needs of future generations can be met without risk. When we look at the literature, it can be observed that studies on maritime trade and sustainability are limited. This research uses multi-criteria based methods to evaluate sustainability performance in the Turkish maritime industry over time. The paper is structured as follows: (1) environmental, social, and economic indicators are determined; (2) indicators are weighted; (3) time ranking is obtained using multi-criteria decision-making methods for the years between 2013 and 2016. Using Turkey development report goals, results are analyzed to determine if the Turkey maritime industry sustainable development aims will be accomplished for 2018 or not. Findings show that multi-criteria decision methods are useful and simple decision tools for the measurement of sustainability. Additionally, these allow the economic, social, and environmental evaluation of sustainability practices of the Turkish maritime industry.

Sustainable Logistics Villages: A Study on Logistics Villages Developed by Turkish State Railways with Respect to the Criteria for Sustainable Logistics Using TOPSIS Method

Thu. 24 Aug. 10:45-12:15 Aud.22

Cansu Aksu and Ibrahim Mujdat Basaran

Sustainable supply chain management and logistics activities have become topics of significant interest among researchers and operators in recent years. In order to be able to ensure the sustainability of supply chain management, it is necessary to manage the economic, social and environmental influence of products and services over the course of their lifecycle. A sustainable supply chain involves manufacturers, suppliers, distributors, logistics service providers, businesses and other stakeholders. The purpose behind the sustainability of the supply chain, on the other hand, is to create long-term economic, social and environmental value for the stakeholders involved in the process in which products and services are made accessible and to preserve and further develop such values. Sustainability is defined in terms of its economic, social and environmental aspects. Logistic villages combine logistics based activities which in return creates an important competitive advantage with respect to costs, speed, efficiency, improvement and sustainability. The planning and determination of the location, capacity and other specifications of logistic villages, centers and bases in Turkey, definition of procedures and principles for the establishment

of such units and relevant authorizations, coordination and supervision of institutions assigned to build infrastructure and to allocate land necessary are among the responsibilities of the General Directorate of Railway Transport Regulation under the Ministry of Transport, Maritime Affairs and Communications. In this study, seven logistics centers in Turkey were explored using TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution) with respect to sustainability criteria. One of the main purposes of this study is to define sustainability criteria which encompass environmental, social, and economic aspects. These criteria are compiled from the previous studies available in the literature, having consulted to the opinion of logistics village users and logistics service providers. Relevant weights of these criteria were defined using AHP method and operational logistics villages in Turkey, namely, Samsun (Gelemen), Uak, Denizli (Kaklk), zmit (Kseky), Eskiehir (Hasanbey), stanbul (Halkal) and Balkesir (Gkky) were compared using TOPSIS. This study contributes to the study, titled "Determination of the Criteria for Sustainable Logistics Measures".

T1C - Facility location & Network design (Aud.23)
Chair: Kjetil Fagerholt

Thu. 24 Aug.
10:45-12:15
Aud.23

Strategic optimization of offshore wind installations

Stian Backe and Dag Haugland

This work considers logistical planning of offshore wind farms installations. An optimization model is developed to determine cost effective port and vessel strategy for offshore installation operations. By applying principals of mixed integer linear programming (MILP), a mathematical model is constructed to minimize total costs of constructing a given amount of wind turbines. Different vessel strategies, ports, time horizon and weather restrictions are considered in the model. Several test cases are presented for a deterministic optimization model implemented in AMPL using the CPLEX solver. The test cases show promising results in aiding strategic decisions.

A Network Design Problem for COSCO under the One Belt One Road Initiative of China

Kai Pan, Dong Yang and Shuaian Wang

Thu. 24 Aug. 10:45-12:15 Aud.23

China issued a concrete development plan entitled One Belt One Road in 2015. As a part of this initiative, eleven Chinese cities have successively launched railway container services to directly deliver goods to European cities. In the same year, COSCO successfully signed a concession agreement with the Piraeus Port Authority, which aims to transform this port into an important hub of Europe. This significant attempt is further supported by the investment from Chinese Government on the construction of a railway connecting Budapest and Piraeus via Skopje and Belgrade, which is expected to be completed on 2018. Under this background, it is of significance for the Chinese linear shipping company like COSCO to re-optimize its service network. Therefore, this paper aims to discuss the reconstruction of shipping service network between Asia and Europe for COSCO with real data, considering the New Eurasian Land Bridge, Budapest-Piraeus railway and the capacity expansion of Piraeus port. Accordingly, a bi-level optimization model is established to maximize the total profit of the linear shipping company and meanwhile minimize the total cost of the shippers. Several interesting findings are observed from the calculating results. Management and policy suggestions are proposed based on the findings.

Feeder network design with transshipments at sea

Benjamin Medboen, Magnus B. Holm, Peter Schütz and Kjetil Fagerholt

Thu. 24 Aug. 10:45-12:15 Aud.23

We present a study for designing a feeder network with transshipments between two vessels at sea. The model is based on a new conceptual maritime transportation system for shipping containers between the west coast of Norway and continental Europe. The purpose of the study is to provide insight regarding size and number of feeder vessels for the proposed concept. The model is formulated using a path flow approach and possible routes are generated a priori using a label-setting algorithm. The objective is to minimize the total cost of the transportation system, i.e. the sum of time charter and operational costs. We present numerical results for two different model formulations that restrict the number of synchronized transshipments at sea at 1 and 2, respectively. The results provide useful information for a decision maker at a conceptual stage when discussing potential fleet size and utilization of vessels.

Thu. 24 Aug.
10:45-12:15
Aud.23

Impact of Leadership and Government Subsidy on Port Construction and Operations

Fan Wang, Minghua Xiong, Xiaopo Zhuo and Xiaofan Xia

Traditionally, ports are constructed and operated by government. However, private sectors have increasingly participated in ports construction and operations since 1980s, particularly in the developing counties. For example, many governments, such as Philippines, Malaysia and Thailand, are on the way of privatizing their major shipping ports (Tongzon, 2006). Why private sectors participated in port construction and operations? The possible driving forces are private sectors have more capitals and technologies, and operate ports effectively. In practices, private sectors generally participate in port construction and operations via signing a build-operate-transfer (BOT) contract with government. That is, a private sector builds a port by own expense, then in return the private sector can operate the port and charge for the port service in a pre-negotiated concession period. After the concession period, the ownership, operating and charging of the port is transferred to the government.

According to industrial report, government subsidy becomes a key factor in the port construction and operations BOT contract. In addition, during the BOT contract negotiating process, the relative power between the government and the private sector is important, which influences the leadership of the BOT contract. That is, who becomes the leader to determine the key items, such as port capacity, services charge and concession period in the BOT contract?

We consider a government and a private sector to construct and operate a new port via BOT contract. A two-stage bi-objective model is established to illustrate the BOT scheme. Firstly, we analyze two extreme cases as the benchmarks: the private sector (the government) dominates the decision-making process. Then we consider two practical cases: the government determines the concession period before (after) the private sector determines the port capacity and service charge. Moreover, we adopt a Nash bargaining model to investigate the effects of the parties' relative power.

T1D - Empty container management (Aud.24)
Chair: Yann Bouchery

The Detention Decisions for Empty Containers in the Hinterland Transportation System

Thu. 24 Aug. 10:45-12:15 Aud.24

Mingzhu Yu, Jan C. Fransoo and Chung-Yee Lee

In this paper, we study a hinterland empty container transportation system which consists of a sea container terminal and an inland container terminal. There are a consignee who is in charge of the hinterland container transportation and an ocean carrier who has an empty container depot at the sea container terminal. We utilize a two stage game model to describe the ocean carrier's decision about the container's free detention time and the hinterland consignee's decision about the time when the empty container in the inland terminal is sent to the sea terminal. Optimal delivery policies of the empty container and the ocean carrier's optimal free detention time are derived when the empty container needed time by the shipper follows different distributions. It is shown that the decentralized system does not guarantee system coordination all the time. The ocean carrier has incentive to integrate the hinterland transportation operation in the port area which is not very busy or not efficient in local transportation.

A metaheuristic for the multimodal network flow problem with product quality preservation and empty repositioning

Thu. 24 Aug. 10:45-12:15 Aud.24

Nico Dellaert, Maryam Steadieseifi and Tom Van Woensel

Perishable supply chains are international businesses and the horticultural industry of the Netherlands is an example. Every day, around 400,000 types of cut flowers and plants (FloraHolland, 2015) are transported from around the world to the auction houses in the Netherlands, to get auctioned, sold, and further transported throughout Europe and beyond. Kenya, Ethiopia, Israel, Belgium, Germany are among the top producers of these products, and United Kingdom, Netherlands, Germany, France, Italy, Poland, and Russia are among the top European markets. The challenge of finding the optimal transportation fleet plan is added to other operational issues such as resource management. An optimal transportation of perishable products needs synchronized flow with minimum waiting and handling. In the horticultural supply chain, this is highly dependent on the availability of Reusable Transport Items (RTIs). An RTI is an empty loading unit which can have different sizes ranging from a small box to a large 45-feet container. In the horticultural chain, for instance, flowers and bouquets are loaded in small RTIs (e.g. boxes and buckets), and plants in medium RTIs (e.g. cages and trolleys) to be transported. Their number is limited, and their shortage results in quality decay of the products

awaiting them, and therefore, in less profit. Returning or repositioning these units is costly and does not bring any direct profit. As a result, solutions integrating the forward flow of loaded RTIs with the backward flow of empty ones are needed to minimize the system-wide costs. A cheap, diverse, flexible, and environmentally friendly transportation, ensuring freshness of the products while offering a competitive price, requires consolidation and switching from air and road to other modes of transport.

In this paper, we study the long-haul transportation of perishable products, modeled here as a Mixed-Integer Program (MIP), where we add new sets of constraints to the classic Fixed charge Capacitated Multi commodity Network Flow Problem (FCMNFP). These constraints include a product quality measure based on temperature and travel time, and enforces a maximum limit on the products after which the products are spoiled. Moreover, we integrate the forward flow of loaded RTIs with the backward flow of empty ones via a set of novel constraints. Based on a given demand, these constraints automatically assign and move the needed empty RTIs. This problem incorporates additional resource management constraints which add further complexity to the problem. The number of decision variables goes quickly beyond what can be solved to optimality with a state-of-the-art MIP solver. Therefore, in this paper, we build upon the literature and propose an ALNS algorithm with new operators, improved scoring mechanism, and extra strategies, to solve this problem. We then provide detailed computational analysis on its properties, compare its results with a state-of-the-art MIP solver, and provide practical insights.

Thu. 24 Aug.
10:45-12:15
Aud.24

The role of consignees in empty container management

Benjamin Legros, Yann Bouchery and Jan C. Fransoo

Nowadays, the majority of consumer goods is transported into a maritime container during at least one stage of the journey. Besides the many advantages of containerization, the management of empty containers is a key issue responsible for costly repositioning operations. This article investigates the potential for consignees to manage an inventory of empty containers at their location so as to enable direct reuse of these containers by shippers located in the surroundings. Our model aims at minimizing inventory holding and repositioning costs. These costs are not always linear and often depend on the age of the container in the system. The problem is modeled as a Markov decision process and we use the value iteration method to identify the optimal inventory policy as a threshold policy in the age of the oldest container in stock. We identify closed-form formulas for this optimal threshold. We analyze the impact of this proactive management of empty containers by the consignees on the level of direct container reuse. We show that this practice is very promising to enable a high level of direct reuse, but we also highlight that the consignees have little interest in implementing such a solution in the current settings of container supply chains. We consequently propose remedies illustrated via a series of insights.

A Network-based Approach to Reduce Maintenance Costs and Pollution in Empty Container Management

Frederik Schulte, Norberto Sáinz Bernat and Stefan Voss

Thu. 24 Aug.
10:45-12:15
Aud.24

International trade imbalances have made empty container management a substantial economic and ecological problem within shipping networks. While import-dominated ports accumulate large amounts of empty containers, export-dominated ports need them as transport resources, requiring a repositioning transportation of empty containers. Acknowledging the importance of the problem, a significant body of literature has been published on empty container repositioning models, and periodic review inventory management systems have emerged as a solution approach that allows to cope with the inherent stochasticity of empty container transportation [4]. Nevertheless, few studies address some crucial economic and ecological real-world conditions determining the success of empty container management such as pollution, maintenance, and repair [2]. Especially, network-based options to reduce maintenance and repair costs as well as pollution are hardly considered in the literature. While maintenance costs are modeled for network design [3], respective operational models remain to be developed. In this work, we present an operational approach based on stochastic review policies to model (1) costs for maintenance and repair and (2) pollution for different locations in a shipping network. First, we model container deterioration using fraction formulation constraints as known in production planning [1] and consider transportation and service costs for various possible maintenance locations in the network. Second, we incorporate emission data for all empty container replenishment options within a network. That means, all locations and the respective transportation modes are analyzed and emissions are calculated according to the European norm EN 16258. Emissions are valued by different emission prices and added to the cost-based objective function. We evaluate the proposed polices in a simulation model with metaheuristic parameter search based on extensive real-world data from a major global shipping company operating in Latin America. The results provide novel insights for academics and practitioners in order to reduce costs and the negative environmental impact of empty container movements in maritime shipping using distinct network-based polices in operational planning.

References

1. Pahl, J., Voss, S.: Integrating deterioration and lifetime constraints in production and supply chain planning: A survey. European Journal of Operational Research 238(3), 654-674 (2014)

2. Sinz Bernat, N., Schulte, F., Voss, S., Böse, J.: Empty container management at ports considering pollution, repair options, and street-turns. Mathematical Problems in Engineering 2016 (2016)

3. Shintani, K., Imai, A., Nishimura, E., Papadimitriou, S.: The container shipping network design problem with empty container repositioning. Transportation Research Part E: Logistics and Transportation Review 43(1), 39-59 (2007)

4. Song, D.P., Dong, J.X.: Empty container repositioning. In: Handbook of Ocean Container Transport Logistics, pp. 163-208. Springer (2015)

T2: 13:30 – 15:00

T2A - NORS - Operations research 2 (Aud.14)
Chair: Sigrid Lise Nonås

Thu. 24 Aug.
13:30-15:00
Aud.14

Military operations assessment through the use of opinion surveys

Elin Gustavsen, Andreas ForøTollefsen and Bård Eggereide

From 2005 and until its termination late September 2012, Norway led the Provincial Reconstruction Team (PRT) Maimanah in Afghanistan. While qualitative understandings of the operations effect on security and development have emerged, quantitative lessons have a more limited track-record. One reason for the few systematic empirical studies is data limitations and lack of access to conflict-ridden areas.

It is essential to conduct both qualitative and quantitative assessments of military operations in order to plan for, execute, and learn from such operations. Since many of todays international operations are population-centric operations, such as in Afghanistan, where the goal is to protect the population from insurgent violence and winning hearts and minds, it is crucial to include the local populations perceptions and attitudes in the assessments.

Through nine survey waves, an opinion survey (Faryab Survey) was conducted in the Faryab province in Afghanistan on behalf of the Norwegian Defence Research Establishment (FFI). The same survey was carried out twice a year, as well as for two years after the termination of the PRT, allowing for follow-up studies of local developments. This considerable data collection effort enables observations of the same area across time, from the execution of the operation, until after its end. Our study explores the Faryab Survey through the use of multiple statistical methods related to the trajectory of both security and development in the conflict-ridden region. By combining geocoded survey data on the location of respondents with georeferenced conflict data, we can study the impact of the PRT on changes in security and development at a truly local geographical level.

Norwegian Long Term Defence Planning

Mona Guttelvik and Sigurd Glærum

Thu. 24 Aug.
13:30-15:00
Aud.14

The Norwegian Defence Research Establishment (FFI) is the prime institution responsible for defence-related research in Norway. The Establishment is the chief adviser on defence-related science and technology to the Ministry of Defence and the Norwegian Armed Forces military organization.

The Analysis division at FFI carries out a broad spectrum of analyses of defence tasks, structure and budgets, as well as the coherence between these elements. This is a part of FFIs support to the Ministry of Defences long term defence planning. In FFIs method for long term defence planning we use scenario analysis and capability based planning to study future force structures. We will present our method for long term defence planning, its application and its impact on the development of the Norwegian armed forces.

Controlling the Cash Flow Risk in Maritime Fleet Renewal

Jørgen Skålnes, Kjetil Fagerholt, Giovanni Pantuso and Xin Wang

Thu. 24 Aug.
13:30-15:00
Aud.14

For many shipping companies the renewal of their fleet is a crucial strategic decision since it is a costly process and will affect the shipping capacity of the fleet for a long period of time. Because of the long lifetime of ships and high uncertainty in demand and freight rates, good fleet renewal plans are needed in order to adapt the fleet capacity to customer requirements and cope with market volatility. In such a context, the maritime fleet renewal problem (MFRP), a class of the maritime fleet size and mix problem, is receiving more attention in research and the maritime transportation industry.

This study considers a stochastic MFRP that takes into account uncertainties in the shipping market, and incorporates the consideration of cash flow risk which is a vital issue for most shipping companies in the maritime transportation industry. In this capital intensive industry the acquisition of a ship (new or second-hand) normally represents a large amount of capital cost and the related payment, either in a lump sum or through a series of installments, can cause a cash flow problem. This problem is especially relevant when there is a long lead time for acquiring a new ship and when the market condition is highly uncertain in the future.

We present a multi-period stochastic programming model for the MFRP with cash flow risk concerns, using scenarios to represent the uncertainties of the shipping market. Unlike in the literature, where the objective is usually maximizing the expected total profit/return or minimizing the expected total cost across scenarios, we explicitly model the cash flows including revenues from contractual and optional cargoes, payments for new-buildings and second-hand ships, and incomes from scrapping and selling old ships; and aim to recognize and control the cash flow risk during the planning period. In particular, we aim to find out how to improve the renewal plan in order to mitigate the risk and reduce the possibility of poor cash flow even in a bad market situation. We apply the model to the case of Wallenius Wilhelmsen Logistics (WWL), a LOmajor shipping company engaged in the

transportation of rolling equipment, and analyze the trade-offs between pursuing high expected total profits and obtaining a renewal plan that is, in a way, robust in terms of steady cash flows.

The preliminary results of this study have shown that it is possible to reduce the cash flow risk by means of such as postponing the decisions on ordering new ships, and, when the market is temporarily bad, laying up old ships instead of scrapping. We also demonstrate the relationship between increased risk control and its financial costs. These insights are able to provide guidance when making the fleet renewal decisions and are therefore of good value for shipping companies operating in a volatile market.

Thu. 24 Aug.
13:30-15:00
Aud.14

Analyzing the environmental impact of multi-modal coastal shipping for automobile distribution in India

Saurabh Chandra, Kjetil Fagerholt, Marielle Christiansen

Indian automotive manufacturers rely mainly on on-to-one distribution model from the factory to the dealers/customers. India being a large country having a long coastline and extensive railways network, companies should be able to develop more efficient ways of distribution in the country. In this regard we propose a mixed integer linear programming based mathematical model to test the viability of various efficient means of multi-modal logistics like coastal shipping, railways, and hub- and -spoke systems etc. in the context of outbound distribution of finished cars in India. The model results present economically viable system for multi-modal distribution. Comparisons are made related to the possible effect of mode change on environmental pollution.

T2B - Data analysis (Aud.22)
Chair: Vanina Macowski Durski Silva

Application of Spatial Econometrics on Logistics Performance Index

Jenhung Wang, Bo-Yen Lai and Pei-Chun Lin

Thu. 24 Aug.
13:30-15:00
Aud.22

The study deals with the spatial dependence problem in linear regression analysis. This spatial patterning spatial autocorrelation may be treated as useful information about unobserved influences, but it does challenge the application of methods of statistical inference that assume the mutual independence of observations. In addition to characteristics of individual countries, the infrastructure to support better logistics performance in one country are not independent of whether neighboring countries have sufficient infrastructure to support logistics or not. The aim of Chinas recently announced One Belt, One Road plan is to invest in the infrastructure and linkages associated with these Roads to help bolster its overseas trade. We are suggesting that there is feedback among proximate countries that influences their economic wealth and logistics performance. Are high levels of average income infrastructure requisites for logistics? What is the average value of LPI in the neighbors of the United States? Are these average values of neighboring observations correlated with each country's own score on LPI or GDP per capita?

Spatial association in the case of measures of logistics performance would join a measure of how close countries were to one another in terms of some spatial measurement with a measure of the similarity of LPI scores for each pair of countries examined. Based on Gleditsch & Ward (2001), specifying that countries are neighbors if they have a minimum distance of 200 or fewer kilometers between them. To combine information about the connected countries, we usually assume that all neighbors carry equal weight and that the weight of each is proportional to 1 over the total number of connectivity. The lag of LPI over space is the mean or average of LPI score across all connected countries. The main goal of getting a spatial lag is to derive an average value that exists in the neighboring region.

We have seen that the distribution of LPI displays spatial clustering in the sense that countries are more likely to have higher values on the LPI score if they are surrounded by countries that also have high levels of LPI. Although some of the clustering in LPI obviously could be due to spatial clustering in GDP per capita, which in turn is positively related to LPI, we have shown that the spatial clustering in the LPI data does not completely disappear when we condition on a country's level of GDP per capita. Given that the distribution of LPI still displays spatial clustering after conditioning on a country's GDP per capita, we should look for possible ways to incorporate this spatial dependence in our previous regression model.

Thu. 24 Aug.
13:30-15:00
Aud.22

A storage relocation policy for a progressive zone picking system and its simulation analysis

Jeong Hwan Kim and Soondo Hong

We investigate a storage policy which facilitates zone picking by reducing recirculation in a zone picking system connected with a circular conveyor. When picking at a zone is completed, an order tote transfers to the next picking zone via the conveyor. The waiting space in each zone is capacitated, and if the space is full, the tote passes over the designated zone and goes to the next picking location in the order. Any tote which has skipped a zone recirculates until the skipped zone is available. We develop a mixed integer model (MIP) to balance the workload among each zones and reduce the number of revisits. The model determines both the relocated products and the new storage locations of the products under the limited number of the storage relocations. A simulation study evaluates the storage policy using industry data compared with available industry policies. The results show that completion time drops by 6.4

Thu. 24 Aug.
13:30-15:00
Aud.22

International Differences in the Customer Value of Autonomous Driving Systems

Björn Frank and Shane J. Schvaneveldt

Autonomous driving technology enables cars to drive automatically without intervention by a human driver. This technology is expected to revolutionize the automotive industry and even has led pure IT/software companies such as Google and Apple to ponder whether to enter the automotive industry despite limited experience in traditional automotive design, manufacturing, and selling. The development and introduction of autonomous driving technology has been accompanied by promises of higher driver safety and of a more relaxing driver experience, but recent accidents have sparked security concerns. This study aims to understand the mechanisms driving the consumer adoption and rejection of autonomous driving systems as an optional add-on function to regular automobiles. It presents a multi-dimensional design of the customer value of autonomous driving systems and of necessary customer sacrifices. To test a number of novel hypotheses, data were collected from consumers in Japan, France, USA, and China for different scenarios representing possible future legal regulations of autonomous driving systems. Multivariate analysis is used to explicate country differences both in the customer value of autonomous driving systems and in consumer motivations to adopt autonomous driving systems. Based on multivariate analysis of the collected consumer data, the results are valuable for managers in the automotive and IT industries, for managers and public policy makers interested in autonomous transportation systems as a tool for improving logistics processes, and for public policy makers evaluating appropriate legal stipulations governing the use of autonomous driving systems.

Measuring container terminals efficiency using the Data Envelopment Analysis Method

Gabriel Campos Pires, Vanina Macowski Durski Silva and Christiane Wenck Nogueira Fernandes

Thu. 24 Aug.
13:30-15:00
Aud.22

In the cargo transportation industry, a port can be considered an important tool for the economic growth of the region, and it can be one of the main ways to increase a products ability to compete. These statements show that ports are complicated places due to being on the transition link of the road transport or waterway transport, which makes management and operations more difficult. Port planning can be quite complicated. This process does not solely involve answering specific questions but also needs to be approached in a way that considers other types of transportation, so that all types of cargo are able to be transferred in the most efficient way.

Ports lasted several generations. The first generation of ports worked mainly as a mode change point, with a lack of strategic planning in the operations. The ports of both the second and third generations began to work together with the industry, whereas the third generation came to work in an integrated manner as logistics platforms. Starting form the second generation of port terminals, reduction of costs became a large area of focus. Planners and managers aimed to decrease each individual ships operation time and, in turn, experience an increase in the ports productivity. The same generation began the practice of adding industrial activities within the port space. Jnior (2010) states that the ports of the third generation have stronger participation in management than past generations with the use of technological tools, being evaluated and monitored by information systems which contribute to efficiency. Lastly, the theme of the fourth generation of ports is global integration. The ports of this modern, globalized generation seek to complement each other instead of compete. In addition to the ports classification, it is possible to tell that the functions of them are: provide services to the ships, operate interfacing land-sea, and provide land service (movement of cargo to the warehouse, courtyard). For this, a good port system should be able to perform the function of coordinating each of the ports several activities. However, port management systems are extremely specialized and require advanced technology for adequate division of work. Currently, the ports efficiency depends on the capacity of its managers to coordinate the various aspects, inside and outside of the system.

In this context, this paper presents the study of the relative efficiency of certain container terminals using the data envelopment analysis (DEA) method. During the work it is given a contextualization of the Brazilian and global water transport along with the justifications for the preparation of this work. Following, it is presented an overview of national and international container terminal efficiency. In the next sections, the mathematical model based on linear programming used with the terminals chosen for the study is presented, along with the defined variables (inputs and outputs). Continuing, it shows the relative efficiency obtained in each terminal for analysis and after a benchmarking analysis a comparison between terminals is performed, proposing changes to optimize the port operations, thereby increasing the relative efficiency.

T2C - Scheduling (Aud.23)
Chair: Frits Spieksma

Thu. 24 Aug.
13:30-15:00
Aud.23

Scheduling a series of locks along a waterway

Ward Passchyn and Frits Spieksma

Consider the problem of operating a series of locks along a river or a canal. In such a situation, ships (the jobs in scheduling terminology) travel in one of two directions, while locks (the machines) control the water level of the waterway. A lock can transfer a set of ships simultaneously, but only when all ships in this set travel in the same direction; the time this operation takes is called the lockage time, and is given. Further, we are given (i) the first lock of each ship (its arrival lock), its arrival time, and the last lock a ship needs to pass, (ii) the speed of each ship, (iii) the position of the locks and their capacity, and (iv) the distances between adjacent locks. A solution specifies for each lock when it should start a lockage (and in which direction) and which ships are transferred during that lockage, such that each ship is able to traverse the waterway from its first lock till its last lock. We are interested in obtaining a solution that minimizes total waiting time of the ships, and denote this problem by SPBM (scheduling parallel batching machines).

The above problem models so-called staircase locks, which consists of multiple locks in immediate succession, i.e., where the travel distance between adjacent locks is equal to zero. Such a setting occurs, for example, at the Three Gorges Dam in China and at Caen Hill in the United Kingdom, consisting of respectively 5 and 16 successive locks. With nonzero travel distance, however, the described problem can be used to model an entire waterway where multiple locks are present over a longer distance. In fact, several waterways of major economic importance fall in this category. We mention, for example, the Rhine-Main-Danube canal which features 16 locks over a length of 171 kilometers, connecting the Danube basin and the Rhine basin. Also, the Panama Canal features 3 sets of locks over a length of 77 kilometers. Both waterways have tremendous economic value.

SPBM is, in its generality, a difficult problem to solve to optimality. We analyze the complexity of SPBM for various special cases. The following options are considered: uni-directional (meaning all ships travel in the same direction) versus bidirectional, and arbitrary speeds versus identical speeds. Our results are the following: we prove that SPBM is NP-hard even in the uni-directional case, even for two locks. Further, we show that SPBM is NP-hard in the bi-directional setting, even if all ships have the same speed. We discuss a class of solutions which satisfy particular properties: so-called synchronized solutions. Synchronized solutions can be compared to the green-wave concept used in car-traffic. We investigate in what special cases the existence of an optimum solution that is synchronized can be guaranteed. Finally, we prove that the uni-directional SPBM with equal speeds, and with a common lock can be solved in polynomial time.

Implications of Berth scheduling with cold ironing provision for different penetration rates

Thalis Zis, Mihalis Golias and Harilaos Psaraftis

Thu. 24 Aug.
13:30-15:00
Aud.23

Maritime transport is responsible for less than 3% of the global CO2 emissions, however shipping activities near coastlines and ports have been linked to fatalities attributed to respiratory health issues due to the generation of harmful pollutants such as sulphur oxides, nitrogen oxides, and particulate matter emissions. New regulations are introduced that seek to reduce near-port emissions through the promotion of low-sulphur initiatives, and the use of clean energy for yard operations. Vessels at berth are amongst the highest contributors in the generation of harmful pollutant emissions in the vicinity of a port. One option that aims to significantly reduce such emissions is via the provision of shorepower from the grid, in order to cover the energy demands of vessels while at berth. This technology which is otherwise known as alternative marine power (AMS) or cold ironing allows the elimination of emissions generation from the activity of auxiliary engines of vessels at berth. However, due to the very high capital costs that the port has to bear in order to be equipped with cold ironing facilities, only a limited number of ports currently is able of providing shorepower. At the same time, ships need to be retrofitted at significant capital costs, in order to receive shorepower and there are additional discrepancies in voltage formats in different regions that can further limit the ability of a vessel to receive power. Therefore, the use of cold ironing has been limited and it has seen significant use only in ports where it is mandatory by regulation, such as in California. Recent research has shown that cold ironing has the potential to significantly reduce port emissions, provided that a significant number of vessel calls are actually using the technology. This paper studies the berth scheduling problem with cold ironing capabilities at berth, considering a discrete number of berths and a dynamic arrival of vessels. The problem is formulated as a multi-objective problem where the terminal operator seeks to maximize the utilization of its cold ironing berths (e.g. minimize emissions generation from all vessels at berth), while minimizing waiting times for incoming vessels. The paper considers instances with different penetration rates of cold ironing-ready vessels, and performs a sensitivity analysis on the number of berths with AMS provision. The paper estimates the different cost per ton of abated pollutant for the terminal operator and the retrofitted vessels. The long term prospects of cold ironing as an emissions reduction option for the maritime transport sector are discussed, and additional research problems are proposed in the field.

Thu. 24 Aug.
13:30-15:00
Aud.23

Integrated Cross-Dock Scheduling and Assignment

Rene De Koster, Arpan Rijal and Marco Bijvank

Companies use cross-docks to simultaneously minimize transport and inventory holding cost. Two main operational decisions that have to be taken in a cross-dock are scheduling the trucks and assigning them to dock-doors. Literature and practice often consider these problems sequentially or, if both problems are considered, often only inbound or outbound trucks are included. However, first scheduling, or sequencing the trucks, followed by assignment may lead to large internal travel distances. In this paper, we integrate the scheduling and assignment problem at unit-load cross-docks for both inbound and outbound trucks. The objective of the problem is to minimize delay cost of outbound trucks, cost of temporary storage of unit loads and the cost of direct dock-to-dock travel. We do so while considering several cross-dock attributes prevalent in practice but often ignored in the literature, such as flexible dock-doors and predetermined truck processing time windows.

We develop a mathematical model and a metaheuristic based on Adaptive Large Neighborhood Search for real-sized instances. Extensive computational experiments demonstrate that the algorithm produces quality solutions compared to existent sequential approaches within reasonable computation time, particularly for large instances. When cost parameters in different components of the objective function are comparable, integrated solutions outperform sequential solutions by a significant margin. We use the metaheuristic to plan the cross-dock operations of a retailer and demonstrate that significant savings can be generated by adopting the metaheuristic as the planning tool. In addition, we use the metaheuristic to position and size the temporary storage areas. It appears that strategic positioning of these areas can reduce the internal travel distance substantially.

Thu. 24 Aug.
13:30-15:00
Aud.23

Integrated scheduling in synchromodal transport

Arturo Pérez Rivera and Martijn Mes

In todays world, environmental issues are pressing Logistic Service Providers (LSPs) to measure performance in more than just instantaneous rewards. LSPs are increasingly adopting network-wise and periodic measurements of performance in order to achieve their environmental and economic goals. These measurements have triggered new opportunities in the ways carriers can organize freight transport. One of such opportunities is integrated scheduling of pre-haulage and long-haul operations in synchromodal transport. In synchromodal transport, scheduling decisions are dynamic, anticipatory, and network oriented. For example, when there is flexibility in which terminal to bring a container for its long-haul, the impact on the long-haul needs to included when scheduling pre-haulage operations.

In this paper, we study the problem of transporting containers in a synchromodal hinterland network over a finite horizon. Usually, the transport is divided into three problems: (i) pre-haulage, (ii) long-haul, and (iii) end-haulage, and each problem is solved independently. However, separate solutions do not take advantage

of all opportunities in a synchromodal network, such as the choice of the intermodal terminal in the pre-haulage mentioned before. In a synchromodal network, there is no restriction on the mode of transport to use for any container; nor is there a restriction on changes of mode (i.e., transfers in intermodal terminals) that can be done to any container. The only restriction comes from the release and due-date of each container. Each day, new containers with different characteristics arrive. The LSP has probabilistic knowledge about the arrival of containers and their characteristics. To transport the containers, the LSP uses high-capacity modes in the long-haul (e.g., barges, trains) and trucks for the pre- and end-haulage operations. All high-capacity modes have known schedules and duration. Trucks can also be used to transport a container directly from its current location (i.e., origin or intermodal terminal) to its destination, as long as the container is deemed urgent. The goal of the LSP is to transport all containers while maximizing performance over the entire network and horizon. To achieve this goal, the LSP schedules the transport of each container considering all available information and anticipating on future demand. Although the plan of the LSP may involve multiple transfers between different transport modes, only the first trip is fixed.

To solve this stochastic optimization problem, we propose to integrate two existing anticipatory and heuristic approaches for scheduling different parts of the transport. The first, based on Adaptive Large Neighborhood Search, is used for scheduling pre- and end-haulage operations considering terminal assignment. The second, based on Approximate Dynamic Programming, is used for scheduling services and transfers in long-haul synchromodal networks where re-planning is allowed after each trip. We analyze the anticipatory mechanisms of each method individually and evaluate different forms of integrating them, under different problem settings. Finally, we provide a discussion about the benefits and weaknesses of our solution approach and present potential extensions for further research.

T2D - Liner shipping (Aud.24)
Chair: Rommert Dekker

Thu. 24 Aug.
13:30-15:00
Aud.24

A Column-Row-Generation Approach to Liner Shipping Network Design

Jun Xia and Zhou Xu

Liner Shipping Network Design (LSND) aims at creating a set of regular services (or rotations) for a designated fleet of oceangoing ships to transport containerized cargos. Containers can be transshipped from one ship to another at an intermediate port in order to improve a carriers transportation efficiency, as well as to extend its market coverage. The major objective of LSND is to maximize the carriers total profit, this being the total revenue from satisfied demands minus the total operating cost, which includes any transshipment costs. For this issue, many solution methods known to be effective for network design problems assuming zero transshipment cost cannot directly apply, because the calculation of transshipment cost has significantly complicated the problem and its mathematical formulation. To tackle this challenge, we propose for LSND a new mixed-integer linear programming (MILP) model where transshipment costs are well captured. Since, in this new model, both decision variables (columns) and constraints (rows) are proportional to the number of feasible rotations, there can be a large number of columns and rows, which makes the model very challenging to solve. In this work, we develop a new optimization method, referred to as a Column-Row-Generation (CRG) approach, to solve the LP relaxation of the new model, which provides an upper bound on the optimal solution for LSND. We embed this CRG approach into a branch-and-price framework to compute optimal or near-optimal solutions for LSND. Numerical experiments have been conducted to show the effectiveness and efficiency of our models and solution methods.

Thu. 24 Aug.
13:30-15:00
Aud.24

A Single Trade Routing Problem in Roll-on Roll-off Liner Shipping

Torbjørn Vallestad, Aaron Weggersen, Marielle Christiansen, Kjetil Fagerholt, Jone R. Hansen and Jørgen Rakke

Roll-on Roll-off (RoRo) shipping deals with seaborne transportation of vehicles and other types of rolling material between different regions of the world according to predefined plans. These special purpose vessels have multiple decks where the rolling cargo is placed, similar to a multistorey car park.

Major improvements to the efficiency of maritime transportation have been made during the last decades due to operations research. However, compared to other segments in maritime transportation, the Roll-on Roll-off (RoRo) shipping segment have received little attention. Lower freight rates provide a challenging reality for the shipping companies, due to a surplus of tonnage in the world's deep sea fleet. In

addition, increased near-sourcing reduces the need for deep sea shipping, affecting the freight rates. Motivated by these threats, we seek to improve the profitability of the RoRo segment, by minimizing the cost of a single trade on a tactical level.

This paper considers a single trade routing problem (STRP) in RoRo liner shipping. Here, a trade is defined by a set of ports along the trade route, e.g. from Asia to Europe. The shipping company is committed to fulfilling a number of contracts of affreightment (COA), a contract type where the shipping company agrees to carry a given quantity of products or cargoes between two ports, during a specified period of time. The contractual demand for each contract is usually distributed over several voyages along the trade route.

The objective of the STRP is to minimize the costs of fulfilling all contracts during the planning horizon (typically one month). Decisions to be made are the number of voyages along the trade, which vessel to serve each planned voyage, which ports to visit on each voyage, the route of each voyage, and the loading and unloading quantities of each contract at each port visit. Several factors complicate the problem. The company operates a heterogeneous fleet of vessels, with different storage capacities, bunker consumption functions, and speed options. Most contracts have service frequency restrictions, requiring that the total quantity transported must be divided among a minimum and a maximum number of services over the planning horizon. Most contracts also require that services are fairly evenly spread in time during the planning horizon. Finally, different product types are considered, such as ordinary vehicles, trucks, heavy construction equipment, and trains. Some products can only be placed on certain decks, which affect the space utilization of the vessel.

We present an arc-flow model of the problem. Preliminary testing showed that small instances of the problem are solvable with a commercial solver. Computational results will be presented.

A traveling salesman problem model for liner shipping cost and CO2 minimization

Pierre Cariou, Ali Cheaitou and Rim Larbi

Thu. 24 Aug.
13:30-15:00
Aud.24

According to the International Energy Agency, the contribution of international shipping to carbon footprint is as large as some major countries, ranking international maritime emissions in 6th place in the world between India and Germany. To curb emissions, containerized shipping lines have implemented some technical and operational changes accounting for the traditional trade-off between cost and CO2 emissions reduction. This paper considers this element in the context of the strategic and tactical aspects of liner services design. The objective is to determine the optimal sequence of ports to be visited as well as the number and operating speed of vessels to be deployed in a liner service when considering the joint objectives of cost and CO2 emissions minimization. We analyse the problem using a non-linear bi-objective optimization framework for which an approximation scheme for the sailing speed and a reformulation are required to solve the problem using a bi-objective integer linear program based on the travelling salesman problem. Using data from a service operating between Europe and Asia with seven ports of call,

we apply the proposed new scheme that can be solved using any commercial solver for real life instances. The results from the numerical and sensitivity analysis show that the cost and CO2 minimization objectives are easier to reconcile when bunker prices are high and tax on CO2 emissions is therefore more efficient at such a time.

Thu. 24 Aug.
13:30-15:00
Aud.24

Simultaneous optimization of speed and buffer times in liner shipping

Judith Mulder, Willem van Jaarsveld and Rommert Dekker

Transport companies often have a published timetable. To maintain timetable reliability despite delays, companies include buffer times during timetable development, and adjust the traveling speed during timetable execution. We develop an approach that can integrate decisions at different time scales (tactical and operational). We model execution of the timetable as a stochastic dynamic program (SDP). An SDP is a natural framework to model random events causing (additional) delay, propagation of delays, and real-time speed adjustments. However, SDPs alone cannot incorporate the buffer allocation, as buffer allocation requires to choose the same action in different states of the SDP. The objective is finding the buffer allocation that yields the SDP which has minimal long run average costs. We derive several analytical insights into the model. We prove that costs are joint convex in the buffer times, and develop theory in order to compute subgradients. Our optimal algorithm for buffer time allocation is based on these results. Our case study considers container vessels sailing a round tour consisting of 14 ports based on Maersk data. The algorithm finds the optimal timetable in less than 80 seconds for realistic problem instances. The optimal timetable yields cost reductions of about six to ten million USD per route per year in comparison to the current timetable.

T3: 15:30 – 17:00

T3A - NORS - Operations research 3 (Aud.14)
Chair: Brynjar Arnfinnsson

Scenario based military logistics modelling methodological and practical challenges

Thu. 24 Aug.
15:30-17:00
Aud.14

Brynjar Arnfinnsson

In the absence of major threats to national security after the end of the cold war, the focus of the Norwegian armed forces gradually shifted away from national defense towards international operations. As a consequence, the logistics and combat support elements required for major national joint operations have been neglected and underfinanced during these years. A recent shift back towards a focus on national defense has revitalized the question: How can and should we deploy and sustain our future armed forces in a national joint operation? Based on our work on this subject, we will discuss methodological and practical problems with logistics modeling and analysis as part of a scenario and capability based method.

Gaming of Possible Future Norwegian Land Forces

Thu. 24 Aug.
15:30-17:00
Aud.14

Svein Erlend Martinussen, Dan Helge Bentsen, Marius Halsør, Halvor Ajer and Ulf-Peter Hoppe

The Norwegian Defence Research Establishment has supported the Norwegian Army with methodology and analysis of future land forces in preparation for the ongoing study of the future land forces structure. In doing so, we have had to rethink the relation between planning gaming events and running serious games. Our emphasis now is on replicating the planning processes properly, and especially on monitoring the planning process of the enemy forces. To facilitate this we need a better understanding of enemy force structures and procedures. In this paper we go through some unclassified observations after having finished the work.

Thu. 24 Aug.
15:30-17:00
Aud.14

Logistics process mapping and simulation in a container terminal

Raiza Bender Lopes, Christiane Wenck Nogueira Fernandes and Vanina Macowski Durski Silva

The World Trade was boosted in the 1960s with the emergence of the container, however, it entailed a problem of empty container handling/allocation in the transport chain. The empty container terminal is part of the transport chain, where the container is made available to the exporter for subsequent storage of cargo, transportation and then it is returned by the importer after spawning. The present work refers to the simulation of a specialized empty container terminal (located in Itapo-SC, Brazil), inserted in a highly competitive market and with a great prospect of growth. It aims to present a simulation model to optimize some logistic operations occuring in the terminal in order to reduce time and to ensure na increasing level of service. The simulation model was implemented in Arena software and through the performance indicators analysis it was possible to identify some operational bottlenecks, as in the maintenance area, proposing a better operational design for this container terminal.

Thu. 24 Aug.
15:30-17:00
Aud.14

Value of prediction in bulk shipping

Vit Prochazka, Stein Wallace and Roar Ådland

Contrary to liner shipping, most vessels in bulk segment cruise the world ocean without a regular schedule. The spatial distribution of ship capacities changes at every time step as well as the demand for transportation service. This is caused by many factors, let us mention seasonality (harvest period) among others. As a consequence of these changes in supply and demand, high fluctuations of prices are observed across different regions of the world.

We study dry bulk spot trade with the focus on the most fundamental operational decisions of shipowners or operators which cargo to carry or where to reposition an empty ship. In order to make an optimal decision, its future consequences must be taken into account. However, capabilities of evaluating these consequences are limited, since they are derived from the uncertain future. We investigate the impact of theoretical knowledge of future prices and the length of the horizon for which prices are known.

We model the trade in the bulk shipping as a network flow problem with multi-period horizon. A flow of a unit of vessel capacity is associated with a revenue, cost and travel time specific for each route. We define two types of market participants - an ""average operator"" and a ""superior operator"" - and simulate their decisions and corresponding earnings. The average participant's decisions are derived from observations of vessels movements on the real market. Such participant thus reaches the world average earnings. The superior operator is assumed to have perfect information of future market prices for a horizon of X days and can make the optimal decision accordingly. By comparing results of these two participants, we follow several research goals:

- We evaluate the extent to which regional differences in spot freight rates can be exploited economically by relocating tonnage. If optimization based on knowledge of the spatial distribution of ships can be used to outperform the average operator then this would challenge the notion of a spatially efficient market.

- If X is large enough, the earnings of the superior agent represent an upper bound for all other different strategies that can be based on more realistic assumptions on the knowledge of the future.

- By varying X, we evaluate the impact of the length of the horizon, for which we "see" the future rates. Such results suggest operators or shipowners, how valuable it is to invest into better forecasting methods and tools that provide better knowledge of the freight market.

- By this approach, we are able to identify certain spots in space and time where the freight rates were the most miss-valued, for example if a sudden increase of demand, that market did not anticipate in a correct way, occurs. Analysis of that phenomena provides better insight into the shipping market.

For our study we use data for movements of the world Capesize (vessels with DWT $> 115,000$) fleet between years 2013-2016.

T3B - Stochastic problems 1 (Aud.22)
Chair: Frank Meisel

Robust traffic management for the Kiel Canal

Frank Meisel

Thu. 24 Aug.
15:30-17:00
Aud.22

The Kiel Canal is an artificial waterway that connects the Baltic Sea and the North Sea. It allows ships to save about 250 nautical miles compared with travelling around the Jutland Peninsula (Denmark). Unfortunately, the canal consists of several narrow transit segments where large ships cannot pass each other. Passing of ships of any size is possible in so-called sidings, which are widened segments of the canal. The purpose of the traffic management is to decide on the ships that have to wait in a siding in order to avoid conflicts in the transit segments. The decisions affect the transit times of ships and, thus, have an impact on the attractiveness for ship operators to send their vessels through the canal rather than going around Jutland. There has been prior research on this traffic management problem in a deterministic setting. In our presentation, we extend the setting by stochastic travel times of ships and stochastic exit times when ships leave the locks and enter the canal. Various priority rules are used to produce conflict-free ship schedules of low average transit times for the deterministic setting. We then test the robustness of these schedules by checking whether the waiting decisions remain feasible under a given set of scenarios for travel times and exit times. It is shown by experiment that robust solutions require just slightly larger average transit times.

Thu. 24 Aug.
15:30-17:00
Aud.22

Online, adaptive condition-based maintenance planning for multi-component systems under a given operating schedule. A novel method for and application in the maritime sector.

Ben Vermeulen, Tarkan Tan, Sena Eruguz - Çolak and Geert-Jan Van Houtum

We present research on maintenance of vessels in the maritime sector conducted as part of the MaSeLMa project in which several universities, consulting agencies, big original equipment manufacturers, and main asset owners take part. Despite the sophistication of multi-component maintenance scheduling literature, there is a substantial gap between academic models and maintenance scheduling in practice. The stylized academic models particularly fail to incorporate the particularities of the maritime sector. Scheduling maintenance of moving capital stock in the maritime sector is complicated by (i) operating schedules with operating mode-specific maintenance opportunities and costs, as well as downtime costs or availability requirements, (ii) technical and economic dependencies providing opportunities for clustering of maintenance activities, (iii) operating mode-specific yet unknown degradation/ failure behavior of components (having asset owners follow OEMs' hyperconservative MTBFs), as well as (iv) frequent overhauls in dry-dock required by the classification society.

The research goal of the work presented is to provide a general maintenance scheduler for a system with a realistic, non-trivial number of components that provides a solution within practical computation time. This is scheduler is to be used online to adjust the maintenance plan whenever component state information is acquired and used to update component degradation and/or failure models. To enhance both the accuracy of degradation and failure models as well as provide maintenance schedules with lower maintenance costs (and/ or increase availability), the maintenance scheduler is to take into account the (finite horizon) operating schedule. Moreover, the scheduler should cope with mentioned cost particularities due to operating mode specificities and economic dependencies.

We present our online, adaptive condition-based maintenance planning method, the underlying methodological considerations, and in depth studies of an application of our scheduler for a system of one of the OEMs in the research consortium. More specifically, we explain our two-step forward recursion method (akin to approximate dynamic programming) to determine the (near-)optimal impending maintenance activity given an operating schedule. Hereby, for the lookahead in the approximate dynamic programming, we use tabu search to find a (near-)optimal maintenance schedule for specific sample paths. The neighborhood generator of the tabu search algorithm hereby uses context information such as the points in time for low cost maintenance (e.g. particular operating modes in the schedule) and points of other maintenance activities. We also describe how we use component simulation to abstract away underlying differences in degradation and failure behavior and to accommodate updating of the degradation and failure models upon online, incidental arrival of component status information.

We present findings of applying our method to a multi-component system and compare the estimated cost and availabilities of our method and heuristic methods such as just-in-time, next low cost period, etc.

Stochastic programming for fleet renewal in the offshore oil and gas industry

Sigurd Solheim Pettersen, Endre Sandvik, Kjetil Fagerholt and Bjørn Egil Asbjørnslett

Thu. 24 Aug. 15:30-17:00 Aud.22

In this paper, we investigate the applicability of stochastic programming for generating insights into fleet renewal decisions in the offshore industry. Developments in the offshore oil and gas sector in recent years have shown the importance of accounting for uncertainty in the fleet planning process, as a number of costly vessel acquisitions have been made with little consideration of possible downside scenarios. This has lead to a situation in which very expensive special vessels are being laid up.

Stochastic programming has been used as a technique to solve fleet planning problems under uncertainty in the maritime industry for some time. However, none of the previous studies have been done for cases from the offshore oil and gas industry. We present a stochastic fleet renewal model for this particular industry. The case considers the renewal of a fleet of complex offshore vessels described through decision variables on the subsystem level, facilitating ship design insights. The fleet is tasked with non-transportation missions, such as offshore construction, inspection, maintenance and repair, and light well intervention operations. There will be uncertainty surrounding the rates that can be earned, as well as the demand and requirements for specific operations. The fleet renewal problem is modelled as a multi-stage stochastic program. Metrics such as the value of the stochastic solution is reported to demonstrate the added value of the approach. An early conclusion is that the use of fleet renewal models in the offshore industry could significantly enhance ship owner decision making under uncertainty.

Scenario-analysis for assessment of operational strategies for evaluation of changeability in complex markets: case from offshore shipping

Morten Andreas Strøm, Carl Fredrik Rehn, Bjørn Egil Asbjørnslett, Stein Ove Erikstad and Sigurd Solheim Pettersen

Thu. 24 Aug. 15:30-17:00 Aud.22

In this paper, we develop a method for conducting scenario-analysis to gain insight into the strategic operational domain of systems operating in heterogeneous markets, to better understand which changeability (real option) to exercise when. Changeability is an umbrella term for system properties, such as flexibility and adaptability, which represents the ability of a system to change its configuration of operation and is used to handle uncertainty. By incorporation of changeability, a system can adjust to meet the inevitable changes in operational context and even possibly stakeholder needs, thereby continue to deliver value to key stakeholders throughout its entire lifecycle. This active approach is less understood than the traditional approach of architecting passive systems. We argue that it is essential to design systems not only optimized for the most likely scenario, but which that can change its design

and operational strategy to mitigate the downside of uncertainty, and to exploit the possible upsides that lies in the future.

For heterogeneous markets, that is comprising contracts with different specifications and durations, it remains difficult to incorporate and value changeability, let alone even understand which changeability that can be used when and why. This paper attempts to connect the operational domain and design domain for systems operating in such complex environments. The developed method is applied on a case from offshore vessel design, were we demonstrate the importance of pairing the incorporated changeability with operational execution strategies to better utilize the change options. The knowledge from this paper can be important when engineering high-value, complex systems, with long-lifetime, facing a high degree of exogenous uncertainty.

T3C - Electric vehicles & Routing (Aud.23)
Chair: Björn Frank

Thu. 24 Aug.
15:30-17:00
Aud.23

The Role of Environmental Considerations in Consumer Decisions to Adopt Electric Vehicles

Björn Frank and Da Xu

In combination with renewable energy, zero-emission electric driving technology is regarded as a sustainable solution to environmental problems such as climate change. However, at the current stage of technology development, electric vehicles still suffer from problems such as high price, reliability problems, non-sustainable battery technology, and an incomplete transition to renewable energy sources, which causes consumers to shy away from purchasing electric vehicles. This study aims to explore the drivers behind consumer motivations to adopt electric vehicles. It extends the unified theory of acceptance and use of technology (UTAUT), which explains consumer motivations to adopt new technology products, in order to explain better the consumer adoption of sustainable new technology products. Specifically, it explores the pathways through which environmental attitudes and perceived environmental sustainability drive the adoption of environmentally sustainable products. In addition, it elucidates the moderating roles of environmental expertise, consumer personality, government environmental support, and exposure to technology information sources. To test these hypotheses, the authors perform structural equation modelling of reliable survey data collected from 300 consumers across multiple regions of China. The results of this research are relevant to managers in logistics-related occupations or in the automotive industry and to public policy makers seeking to accelerate the deployment of sustainable transportation systems.

An Exact Algorithm for Electric Vehicle Routing Problem with Recharging

Thu. 24 Aug.
15:30-17:00
Aud.23

Chungmok Lee

In this talk, we present a novel optimization algorithm for the electric vehicle routing problem with recharging. The electric vehicles are rapidly being adapted by the logistics companies because of cost-efficiency and environmental merits. One critical factor, however, that makes wide adaptation of electric vehicles difficult, is limited travel range of electric vehicles. An electric vehicle's battery should be recharged during the route if the travel distance of the route is longer than the vehicle's travel range. We propose an optimization algorithm for the problem, which utilizes an extended network that implicitly addresses the recharging retirement of the electric vehicles. We develop the branch-and-price approach on the extended network. Computational experiments on the well-known benchmark instances will be also presented.

Generalized periodic vehicle routing and maritime surveillance

Thu. 24 Aug.
15:30-17:00
Aud.23

Maria Fleischer Fauske and Carlo Mannino

Planning maritime surveillance activities in military operations is a huge task that is done manually today. As maritime surveillance resources are extremely expensive, the potential cost savings of using optimization models to do such planning are large. In this study, we developed a methodology for making maritime surveillance planning more efficient. The purpose of our tool is to find routes for the force elements involved in maritime surveillance operations where the goal is to keep a maritime picture sufficiently updated. Our problem may be viewed as a variant of the classical Periodic Vehicle Routing Problem, but it differs from this problem in some major aspects. To cope with the novel issues of our problem, we introduce a novel timeindexed formulation. To tackle instances of practical size, we applied delayed column generation and developed efficient heuristic techniques. We show how our approach can plan 24-hour realistic missions, routing ships, with or without satellite observations and aircraft observations.

Thu. 24 Aug.
15:30-17:00
Aud.23

An exact approach for a vehicle routing problem with pickup and delivery time windows and some sample solutions

Ramazan Yaman, Tuba Sinoplugil Tezer, Gulsen Yaman and Cansu Aksu

In this study, a static-deterministic vehicle routing problems with pickup and delivery time windows have been investigated. These problems include many pickup points and only one delivery point that called cargo agent or depot. Two phase exact solution algorithm is applied to solve these problems. In the first phase, recessive feasible routes have been obtained by depth first search, then they are solved by branch and bound approach. In the second phase, a restricted version which includes subsets of the column of set partitioning formulation was used by implemented column generation. Improved exact solution approach has been applied on some of the test problems from Lin (2008) and Solomons benchmark problems.

T3D - Collaborative logistics (Aud.24)
Chair: Mario Guajardo

Thu. 24 Aug.
15:30-17:00
Aud.24

Understanding of port collaboration: A case study of Thailands port

Suntichai Kotcharin

Researchers have paid more attention to supply chain management in seaport studies over the last few years. Consequently, a number of studies into seaport in the context of supply chain management have been increasingly published. The importance of port and terminal integration in the supply chain is recognised. Previous studies point that port competitiveness, value creation and customer satisfaction can be achieved through the establishing of the inter-organisational relationship. However, todays port industry is more complex and dynamic. Thus, the use of different theories in port research may help to enhance an understanding of the complex phenomena.

Some researchers focus on inter-organisational relationships of port management entities to understand why and how inter-organisation relationships have been built between firms. This reflects the modern role of port authorities. In addition, some studies suggest that cohesive internal integration is required to have better external integration. Moreover, internal sustainability practices and external sustainability collaboration lead to sustainability performance. Therefore, a body of knowledge of supply chain collaboration and performance exists. However, our knowledge of understanding of internal collaboration and inter-organisational relationships in port research is still little.

This purpose of this paper is to better understand the motivation for seaport collaboration and how the collaboration of activities and resources along business process can enhance ports competitive advantage. This paper employs two theoretical lenses to explore and understand the phenomenon. The resource based view

of the firm (RBV) is used to understand why and how port has formed a certain form of collaboration relationship. In addition, the relational view of the firm (RV) is complementary perspective employed to understand and explain how resources and collaborative practices are utilised to generate relational rents. The exploratory study is primarily used to develop the research framework. Prior research into to supply chain collaboration, port relationships, port competitiveness and relevant studies will be reviewed.

This study employed qualitative case study method. The research will propose causal relationships and justify the relationships by using a case study of the container port. A top management level will be interviewed. In addition, observations and the collection of documents will be used. Unit of analysis is at a port level. Content analysis and interpretation draws insights based upon those theoretical perspectives.

The expected findings would help to increase our understanding of the motivation for seaport collaboration and initiative practices. Additionally, the finding results would provide some new insights into exchanging, sharing and exploiting information and resources internally and externally. Also a significant contribution of this paper is adding into literature that supply chain collaboration can be a source of competitive advantage for ports.

Short sea shipping - a competitive alternative for land-based container transportation?

Vendela Santén, Martina Andreasson, Isabelle Cedulf, Christian Finnsgrd and Martin Svanberg

Thu. 24 Aug.
15:30-17:00
Aud.24

Road transport is the dominating mode for moving goods within Europe, while sea transport mostly is used for longer distances, i.e. from other parts of the world to Europe. The European Commission promote Short Sea Shipping (SSS) as a competitive alternative in order to make logistic chains in Europe more sustainable and efficient than road-based transport. However, despite the efforts and financial support during the last 15 years, the modal shift has not yet reached the levels of EUs goals (Douet and Cappuccilli, 2011).

In order to increase the use of SSS, such solutions must become a competitive alternative for commercial players. Unfortunately, SSS is often seen as an old-fashioned, non-competitive way of transporting goods (Medda and Trujillo, 2010). To show the potential of SSS, the ongoing project NKS II aims to develop attractive, safe and green waterborne transport solutions within the geographical area of Skagerack and Kattegatt. Within this project, a new SSS-concept is demonstrated, i.e. by performing a one day container barge shipment, between port of Uddevalla and port of Gothenburg by sea, a distance of approximately 55 nautical miles.

This paper analyses if short sea shipping of containers between Port of Uddevalla and Port of Gothenburg can be a competitive alternative to other modes of transport. The two alternatives used today (road and rail transport) are compared with the demonstrated transport solution by sea and evaluated with regards to economic, environmental and logistics aspects.

Data are collected; (1) by semi-structured interviews with involved actors (e.g. ship owner, port, road/rail transport provider and shippers), (2) by observation of logistics and transport activities during handling and transport and (3) from internal company documents. A quantitative evaluation compares environmental impact, transport costs and logistics efficiency of the different transport alternatives (road/rail/sea), which is complemented with a qualitative analysis of what prerequisites are of importance for making SSS a competitive alternative for involved actors.

The paper identifies aspects that needs to be considered for making SSS a competitive alternative in the specific situation of a container flow between port of Uddevalla and port of Gothenburg. Further, the paper provides a recommendation for how such a logistics solution can be designed and discusses possible transferability to other contexts. The results will help involved actors (ports, ship owners, goods owners, logistics providers and authorities) to understand common and individual challenges and pinpoint the importance of collaboration between them. Main references

Douet, M. and Cappuccilli, J.F. (2011) A review of Short Sea Shipping policy in the European Union. Journal of Transport Geography, vol. 19, no. 4, pp. 968-976.

Medda, F. and Trujillo, L. (2010) Short-sea shipping: an analysis of its determinants. Maritime Policy & Management, vol. 37, no. 3, pp. 285-303.

Ng, A.K.Y. 2009, Competitiveness of short sea shipping and the role of port: the case of North Europe, Maritime Policy & Management, vol. 36, no. 4, pp. 337-352.

Paixo, A.C. & Marlow, P.B. 2002, Strengths and weaknesses of short sea shipping, Marine Policy, vol. 26, no. 3, pp. 167-178

Thu. 24 Aug.
15:30-17:00
Aud.24

The value of collaboration in hinterland container transport

Alberto Giudici, Tao Lu, Clemens Thielen and Rob Zuidwijk

Collaboration in hinterland container transport has been addressed as a way to further improve efficiency. This study considers collaboration between multiple organizations that are involved in the planning and execution of synchromodal transport connected either by horizontal or vertical relationships. Those organizations can improve their efficiency in terms of reducing operating costs, while satisfying the demand requirements, by improving the utilization of their resources. At the same time, new seamless logistics solutions can be created by vertical integration of their assets.

One of the main issues in cooperation is the construction of fair allocation mechanism for sharing the benefit (Cruijssen et al. 2007). In this direction, several studies have addressed the issue of fairly sharing collaborative benefits by applying concepts from cooperative game theory (e.g., Krajewska et al, 2008). Taking a different perspective, we aim at dissecting the connection between optimal coordination of different stakeholders and their singular contribution to the whole collaboration. While seeking for optimization in planning stands for coordinating different players actions, the application of solution concepts from game theory embodies the tentative of fairly sharing the benefits of joint actions by looking at each players contribution to the underlying collaboration. The link between those two aspects is

analyzed here to provide decision support for network operators that find themselves in the process of joining a collaboration.

This research considers collaboration at the operational planning level where already accepted orders must be shipped from an origin to their final destination. An order represents a transport request for a number of containers that has to reach a final destination within a deadline. For each organization joining the collaboration, available transport services are given, as well as, their schedule and capacity over a short-term planning horizon. The assumption is that different stakeholders operating on a transport network will pool resources and orders to find an optimal joint transport plan, i.e., a minimum cost allocation of containers to services. By considering a whole network, our model captures both horizontal and vertical collaboration and is able of establishing the value of collaboration in the two different settings. By doing so, both vertical and horizontal synchronization of resources is analyzed, thus leading to insights on how synchromodal transport can be organized by multiple collaborating organizations. With respect to this specific topic, this research is novel as it inspects quantitatively the link between cooperation and operational planning taking into account the time dimension and the network structure.

Krajewska, Marta Anna, Herbert Kopfer, Gilbert Laporte, Stefan Ropke, and Georges Zaccour. "Horizontal cooperation among freight carriers: request allocation and profit sharing." Journal of the Operational Research Society 59, no. 11 (2008): 1483-1491.

Cruijssen, Frans, Martine Cools, and Wout Dullaert. "Horizontal cooperation in logistics: opportunities and impediments." Transportation Research Part E: Logistics and Transportation Review 43, no. 2 (2007): 129-142.

Innovation in road freight transport: quantifying the environmental performance of operational cost reducing practices

Valentin Carlan, Christa Sys and Thierry Vanelslander

Thu. 24 Aug.
15:30-17:00
Aud.24

Road freight transportation remains still the leader when it comes to ensuring the hinterland connection of most European ports. Companies in this sector are improving their services and use innovative solutions to remain competitive. Constrained by low profit margins, these companies have developed new technical solutions to bring economic benefits. Moreover, these innovative initiatives yield also positive environmental effects. The latter however are poorly recognized. This paper looks into the details of operative practices from a fleet management perspective. It investigates the characteristics of different types of trailers and analyses the cost effectiveness of these technical solutions in relation with the environmental emissions they save. Transport data from a road haulier serving the hinterland connection of a port in Western Europe is used to build up a case study. Results show that by using special types of trailers, which enable the combination of transport tasks in round-trips, the operational costs are reduced by 25% to 35%. Equally, the CO2 emissions are also lower by 34% to 38%. Moreover, the cost effectiveness analysis suggests that the multipurpose chassis are used with the best cost effectiveness ratio in comparison with mini eco-combi chassis, tilt chassis and re-use of empty containers.

Friday August 25

F1: 8:30 – 9:35

F1A - NORS - Operations research 4 (Aud.21)
Chair: Mario Guajardo

Fri. 25 Aug.
8:30-9:35
Aud.21

Price Alliance and Service Competition Among Ports Group: Co-opetition Mechanism and Incentives Analysis

Fan Wang, Xiaopo Zhuo and Xiaofan Xia

Port competition is an important concern and receives considerable attention in maritime system studies, typical works include Slack (1985), Cullinane et al. (2005), Yap and Lam (2006), and Ishii et al. (2013). Recently, an excessive port competition has becomes significant in Asian market, particularly in China. For example, an intensified competition happens in the port group of Pearl River Delta region in Southern China, which includes Hong Kong port, Shenzhen port and Guangzhou port. Similarly, port group of Bohai Bay and Yangtze River Delta are also suffering excessive port competition. According to industrial reports, port authorities have realized that excessive port competition leads to a waste of resources, and turn to seek for cooperation.

Furthermore, the alliance tendency of shipping lines has greatly improve the relative status and bargaining power of shipping lines in maritime supply chain. For example, the big 3 alliances (i.e. P3, CKYHE, and G6) have significantly strengthened the bargaining power of shipping lines. Therefore, the shipping lines ask for an improved port service but with a lower service fee, when they have an advantage of bargaining power. This tendency also drives the port authorities to have more incentives to cooperate to improve their bargaining power when negotiate with the shipping lines.

The critical problem is how to cooperate. Collective bargaining, where competing sellers form an alliance to jointly price goods or services to customers, has become a frequency used cooperation strategy (King, 2013). In practices, leader-based collective bargaining (LCB) alliance is widely adopted, where one of the alliance members (the leader) is given the authority to carry out the pricing activities on behalf of the other members (the followers). This motivates us to consider the LCB alliance in port operations. Based on the maritime practices, we ask the following research questions: Will a LCB alliance with service competition become beneficial to the competing ports? What is the co-opetition mechanism for ports with price alliance and service competition? Is it possible for ports to cooperate over incentives as profits distribution under LCB alliance?

To address these questions, we consider a shipping supply chain with two competing ports and one monopolistic shipping line. We first establish a basic model

under joint price and service competition as benchmark to evaluate port competition. Then we adopt a LCB alliance to the competing ports. That is, the two ports cooperate in pricing while compete in service operations.

Maritime Inventory Routing in Roll-on Roll-off Shipping

Bo Dong, Kjetil Fagerholt, Marielle Christiansen and Saurabh Chandra

Fri. 25 Aug.
8:30-9:35
Aud.21

Maritime transportation is the major mode of international transportation of automobiles and other types of rolling equipment. The importance of this mode of transportation, which is referred to as Roll-on-Roll-off (RoRo), is in particular obvious for the long distance transportation of automobiles, i.e. deep sea shipping.

In this paper we consider a combined fleet deployment and inventory management problem arising in RoRo shipping. In this problem, we assume that a RoRo liner shipping company is responsible of coordinating the transportation of goods with the inventories at the ports while deploying its fleet such that the demand for various automobiles is satisfied during the planning horizon. Inventory management considerations are taken into account at the both sides of transportation, and production and consumption rates are given and assumed constant.

The objective of the problem is to find the optimal deployment of a heterogeneous fleet of ships to a given set of pre-defined trade route voyages along with inventory management of products at production and consumption ports in their respective trade routes. In other words, we need to determine which ships should perform which voyages and in which sequence, the start time of each voyage, which voyages should be served by spot ships, and the quantity of each product to be loaded/discharged at an associated port during a voyage, in order to minimize the costs of transportation and chartering of spot ships. The above objective has to be achieved keeping into consideration that all voyages are serviced within their given time windows, the aggregate inventory limit of all products in a particular port should not exceed the maximum storage limit, and there is no backlogging of demand for any product in any of the ports.

We propose two distinct mathematical formulations for the problem: 1) a continuous time model, and 2) a discrete time model adapted from the case where the production and consumption rates may be varying. The continuous time formulation considers an ordering of the visits, and introduce an index indicating the visit number to a particular port. The discrete time formulation performs a discretization of the time to overcome the complicating factor of handling the multiple visits to each port. The network structure differs between the two formulations. In general, the second network is larger than the first one. We also introduce different extended formulations and valid inequalities to strengthen the original two formulations.

A computational study comparing performance of the various models according to their size, linear relaxations and running time is conducted based on realistic small-sized instances, using a commercial software.

Fri. 25 Aug.
8:30-9:35
Aud.21

A time-driven two-echelon location-routing problem with synchronization and sequential delivery and pickup

Seyed Mostafa Mirhedayatian, Mario Guajardo, Stein W. Wallace and Teodor Gabriel Crainic

Motivated by an actual problem of a national postal service company, we introduce and define a new two-echelon location-routing problem (2E-LRP). The activities in the two echelons are organized with two waves; first a delivery wave where products are sent from the primary facility to the customers through intermediate facilities. This is followed by a pickup wave, where the flow of products is reversed. Each echelon has its own type of vehicles, and we model the synchronization of transshipments at the intermediate facilities. The model only considers temporal constraints, assuming that capacities are never binding; the vehicles are always large enough given the constraints on time. The decisions in the problem is to determine the locations of intermediate facilities and the vehicle routes at each echelon. The resulting problem is a time-driven 2E-LRP with synchronization and sequential delivery and pickup waves. Most papers studying 2E-LRPs ignore synchronization of transshipments at intermediate facilities, while the synchronization is important to be addressed due to the storage limitation at intermediate facilities and time windows for visiting the customers. To the best of our knowledge, time windows and time synchronization have not been studied together in the literature on 2E-LRP and, in fact, a survey paper on two-echelon routing problems by Cuda et al. (2015) highlights these aspects as worthwhile to investigate. Due to the complexity of problem, only very small instances are solved optimally and large instances are not solved using commercial solvers. We propose three schemes that are used in combination with the model. The aim of schemes is to reduce the set of feasible solutions by removing routes that are unlikely to be part of high quality solutions. We provide the computational results for the schemes on different sets of instances.

F1B - Stochastic problems 2 (Aud.22)
Chair: Dario Pacino

Robust Tractable Approximation of a Multistage Stochastic Program for Empty Container Repositioning Considering Foldable Containers

Sangyoon Lee, Youngsoo Park, Sungwoo Kim and Ilkyeong Moon

Fri. 25 Aug.
8:30-9:35
Aud.22

According to the globalization and industry developments, containers have become the standard ocean transport unit for international shipment. Due to the stupendous imbalance of the intercontinental trade, there is a shortage of empty containers in export ports and a surplus of empty containers in import ports. Therefore, shipping companies have to execute non-value added transportation of empty containers from surplus ports to deficit ports with enormous transportation costs and consumption of the vessel capacity. Empty container repositioning has been one of the most critical problems in liner shipping. Foldable containers have been developed and commercialized to solve the problem of empty container repositioning. For example, Holland Container Innovations (HCI) has invented a 40ft foldable container that four foldable containers can build a pack and the volume of the pack is equal to that of the standard container. Using the foldable container, shipping companies can drastically reduce repositioning costs, which leads to competitive advantages in extremely competing liner industries. At the same time, as the uncertainties and risks increase due to the globalization and high degree of variability, the importance of the consideration of uncertainties in the decision making process come to the fore. Hence, the dynamic decision making under the stochastic nature of uncertainties is essential when it comes to providing robust repositioning schedules in response to the uncertainties.

This study presents a multistage stochastic programming formulation for empty container repositioning that takes into account foldable containers and the uncertainty of demand. Demand for empty containers is regarded as a random variable and decisions on repositioning empty containers are defined as recourse variables. As the recourse variables are dependent to the realization of the past demand, we can formulate recourse variables as functions of the demands which have been realized. It is well known that optimization over the space of measurable functions is computationally intractable. Therefore, a tractable approximation of the multistage stochastic programming model using recently proposed robust optimization technique is presented. The technique utilizes the truncated linear decision rule which restricts the functions of recourse variables to the class of affine functions. The truncated linear decision rule helps to develop a tractable robust optimization methodology to approximate the multistage stochastic program. The proposed approximation requires partial knowledge of the distributions such as mean, deviation measures, and supports. The approximate model is shown to be a second-order cone program, which can be solved efficiently using commercial solvers. The optimal solution of the approximate model is distributionally robust, i.e., feasible for

the family of distributions. Moreover, the optimal objective value can be used as an upper bound to the multistage stochastic program. Computational results show that the result of considering the uncertainties into the empty container repositioning problem outperforms the deterministic case where the expected values of uncertainties are used. The cost-saving effect of introducing foldable containers has been observed. This result implies that there are noticeable possibilities to reduce repositioning costs when foldable containers are commercialized.

Fri. 25 Aug.
8:30-9:35
Aud.22

The Stochastic Berth Allocation Problem

Nabil Absi, Dominique Feillet, Eric Sanlaville and Xavier Schepler

The BAP (Berth Allocation Problem) consists in allocating mooring times and berthing positions on a quay to incoming ships in a (usually container) port terminal, with the objective to minimize the total time they will spend at the port (turnaround time). The BAP, which is a NP-hard problem, has received significant attention in the literature in operational research, but only a few among hundreds of studies consider explicitly the uncertainty on the arrival times of ships. However, in 2007, a large survey revealed that over 40% of the container ships deployed on worldwide liner services arrive one or more days behind the initial schedule.

Therefore, we extend the discrete model of the berth allocation problem, well established in the literature, to the case of stochastic arrival times. The quay is partitioned into segments, referred to as berths, which can each accommodate one ship at a time. Random variables, following binomial distributions, are used for the arrival times. The service duration of a ship depends on the berth which it is assigned to, but is still deterministic as the loading or unloading duration variations are quite small, for a given crane type and a given position of the container in the yard. The objective is to minimize the expected total turnaround time, or equivalently, the expectation of the mean turnaround time.

The solution approach that we propose to tackle the uncertainty combines a proactive and a reactive phase. In the proactive phase (several days before the first ships arrivals), a first planning is computed, taking into account the stochastic hypotheses of the uncertainty model. We present a TABU search based algorithm inspired from the deterministic case. Each encountered solution is evaluated by computing exactly its expected objective value. During the reactive phase (when the ships actually arrive), the berth assignment to ships is fixed according to the proactive phase. There are two motivations for this choice : the confidence, justified by the tests, in the value of the decisions taken proactively, and the fact that few, if any, terminal managers would accept to postpone the berth assignment to the actual arrival of the ships. Still, the ships assigned to one berth are dynamically resequenced as they arrive. Several methods are tested for the sequencing, the best is a Dynamic Programming method that takes into account the stochastic information on the future arrivals of the ships.

Classical instances from the BAP literature, with 25 to 60 ships and 5 to 12 berths, are adapted to the stochastic setting, and tested. Thousand scenarios are generated for each instance. The tests show the interest of using a proactive/reactive

approach, compared to purely static approaches, using for instance the mean value of each arrival time, or purely on line approaches. Furthermore, taking into account the stochastic nature of the data provides better results for both phases, with large benefits for some scenarios. Lastly, the computation times are reasonable, with a few minutes for the proactive phase, and a few seconds for the reactive phase.

The Stochastic Cargo Mix Problem

Jonas Christensen, Alan Erera and Dario Pacino

Fri. 25 Aug.
8:30-9:35
Aud.22

Aside from a few years of financial crisis, the liner shipping industry has had a continuous growth. The growing demand has resulted in a fierce competition to deliver the best product with respect to efficiency, reliability, but most important cost. As a result, the shipping rates are historical low, making it paramount for the carriers to utilise their vessels as efficient as possible. In the recent years, carriers have been building bigger and bigger vessels to follow the trends in demand, but also to achieve economies of scale. With the increasing size of the vessels, a small decrease in utilisation results in a few hundred containers having to be dropped. Moreover, the unreliability wrt. demand forecast in the industry makes it harder to plan ahead.

The focus of our work is the analysis of vessels' cargo mix, in particular finding the cargo composition needed for a vessel to maximise its revenue on a given service. We include the unreliability of the industry by including stochasticity in the demand. As for the horizon, we consider a few ports and determines the best plan for these ports while considering cargo destined for future ports on the service. E.g. optimising the revenue obtained in a region while considering the interregional leg of a service.

Delgado (2013) showed that a cargo-mix analysis based on simple capacity constraints overestimates the revenue of the vessel. Therefore it is important to include a number of additional features and limits to correctly estimate the capacity and/or revenue. Additionally, we enforce that the stowage plan adheres to a block stowage strategy used within the industry. This corresponds to a logical partitioning of the vessel into blocks, and by enforcing the block strategy each block is only allowed to host containers that have the same discharge port. This way of stowing containers is aimed at improving operations at ports since it makes it possible to perform e.g. dual cycling (where load and discharge operations are no longer sequential).

In Christensen and Pacino (2017) a deterministic version of the cargo mix problem is described, and multiple matheuristics based on the same idea are compared. This work can be seen as a stochastic extension of the paradigm developed in Christensen and Pacino (2017), and thus contributes to the state-of-the-art by first extending the formal definition of the cargo mix problem from Christensen and Pacino (2017) to include stochastic cargo flows. Second, we include the stochasticity in the compact formulation of Christensen and Pacino (2017). Lastly, we show that the compact formulation can only solve the smallest of the instances, and therefore we propose a matheuristic to solve the problem.

We envision the application of this model will be valuable for the industry and makes it possible to test different demand scenarios and perform various 'what if' analysis. The model can, for example, be used to answer questions like What is the impact on the revenue if the cargo mix available at next port changes?.

F1C - Revenue management (Aud.23)
Chair: Shuaian Wang

Fri. 25 Aug.
8:30-9:35
Aud.23

Models of route planning for cruise shipping

Kai Wang, Shuaian Wang, Lu Zhen, Xiaobo Qu and Hongtao Hu

Cruise shipping uses a cruise ship or a cruise liner to provide cruise passengers with pleasure voyages. The voyages and the onboard activities bring rich experience and benefits for cruise passengers, as well as the shore excursion in ports along the way. For the cruise shipping, different from liner shipping, transportation is not the major purpose, as cruise ships normally pick and return the cruise passengers at the same port, and traverses a service route with some pre-determined ports of call. Over the past two decades, the cruise industry had a dramatic development. In 2014, there were 296 cruise ships for all the cruise lines in the world. With such a massive fleet, the cruise industry generated revenues of 37.1 billion US dollars, and the number of cruise passengers reached 22.04 million in 2014 globally.

The cruise shipping related studies belong to the area of tourism research as cruise ships provide cruise passengers with tourism service. Meanwhile, it is also sorted into the area of maritime research as the cruise services are akin to container liner services. However, the past research on cruise shipping is limited, the reason of which may include: (i) the worldwide cruise ship tourism just accounts for about 2% of the world tourism market revenue, thus the tourism related researchers have not paid much attention to the cruise shipping related studies; (ii) the maritime logistic related researchers mainly focus on the freight transportation.

Therefore, this study firstly conducts a review of cruise shipping and the cruise industry. The current industry trends are analyzed showing that this industry is still young and has great potential to boom. The past state-of-the-art research works in the cruise industry are reviewed, which are categorized into four research aspects, i.e., regional analysis, risk management, environmental concerns and cruise shipping. By analogizing from the research problems of the liner shipping and considering the characteristics of the cruise shipping, several research opportunities for the cruise shipping are proposed, which are cruise fleet management, cruise ship deployment, cruise itinerary design, and cruise service planning.

Secondly, a specific research problem is addressed for the cruise shipping, which is a decision problem on planning cruise services for a cruise ship to maximize the total profit during a planning horizon. The service is a sequence of ports that the cruise ship visits. In the decision problem, the constraint about the availability of

berths at each port is considered. In reality, if a cruise service is executed by the ship repeatedly for several times, the profit earned by the cruise service in each time decreases gradually. Based on the characteristic, we propose a nonlinear integer programming model with a concave objective function to maximize the profit. To solve the nonlinear model, two linearization methods are developed, one of which takes advantage of the concavity for a tailored linearization. The efficiency of the linearization methods is validated by conducting numerical experiments. Some properties of the problem are also investigated by using the dynamic programming and heuristics.

Fare Class Sizes in Intermodal Container Networks- A Revenue Management Approach

Bart van Riessen, Rommert Dekker, Rudy Negenborn and Judith Mulder

Fri. 25 Aug.
8:30-9:35
Aud.23

Introduction In recent years a large amount of literature has been published on the topic of synchromodal transportation. Most studies focus on creating efficient transportation plans, but aim to include practical elements into the existing models of intermodal transportation, see for an overview Pfoser et al. (2016). One side is to find the best possible solution to a transportation problem; however, without flexibility i.e. multiple options per order no possibility for optimisation exists. Therefore, the other side is to focus on the right amount of flexibility in the order pool. This combination is relevant for any application in which the transportation customer has much influence on the degrees of freedom for the transportation plan, e.g. inland container transportation, online retail, express parcel delivery and ride sharing applications. By addressing transportation planning and product offering simultaneously, our work aims to create a bridge between optimising transportation planning and optimising the service portfolio. In earlier work (Van Riessen, 2016) we presented the Cargo Fare Class Mix in a case study of a single corridor. With this study we aimed to find the optimal balance between a higher priced Express delivery (1 day, only a single option available for the transporter) and lower priced Standard delivery (2 days, multiple options available to the transporter). The optimal balance can be achieved by setting fixed daily limits for each fare class, up to which demand is accepted. All accepted demand must be transported by the intermodal operator. The driver for this research is not solely profit increase, but mainly to increase asset utilisation (more sustainable, more efficient use of assets and infrastructure and cost reduction).

Contribution In our talk we present ongoing work on the generalisation of the Cargo Fare Class Mix model for a network of multiple corridors. Not only will we explore the development theoretical methods for solution approaches, but we will also highlight developments and issues from practice, based on our experience with an intermodal network in Northwest Europe. In the traditional capacity allocation problem (e.g. Littlewood 1972/2005), only the inferior product is limited, to guarantee enough capacity for the higher priced product. We show that for the cargo case the CFCM model gives better results than such a traditional revenue management setting: The cost savings resulting from an efficient transportation plan are

the main reason that the Standard product is not inferior to the Express product when considering profit maximisation.

References

Littlewood, K. (2005). Special issue papers: Forecasting and control of passenger bookings. Journal of Revenue and Pricing Management, 4(2), 111-123. (Original work published 1972)

Pfoser, S., Treiblmaier, H., & Schauer, O. (2016). Critical Success Factors of Synchromodality: Results from a Case Study and Literature Review. Transportation Research Procedia, 14, 1463-1471.

Van Riessen, B., Negenborn, R. R., & Dekker, R. (2016-b). The cargo fare class mix problem - revenue management in synchromodal container transportation. Manuscript submitted.

Fri. 25 Aug.
8:30-9:35
Aud.23

Considering the Special Characteristics of Cruise Line Revenue Management in Mixed-Integer Linear Programming Models for Cabin Capacity Allocation

Daniel Sturm and Kathrin Fischer

The cruise industry represents a unique intersection between the hospitality industry and the global maritime industry and is growing steadily in terms of passenger numbers, as well as total revenue generated. Similar to adjacent branches, like the container liner shipping industry and the hotel business, cruise lines can therefore profit from the application of customized revenue management methods and systems. Nevertheless, the development of quantitative optimization models, as well as corresponding pricing and capacity allocation policies tailored to the special requirements of cruise lines, have only been sparsely studied in the existing literature. And even though revenue management in the cruise industry shares some similarities with other fields of application, like liner shipping, airlines, and hotels, cruise lines possess some specific characteristics which require the adaptation of existing approaches.

Cruise ships contain a large number of different cabin categories with distinctive amenities which are almost exclusively sold to leisure passengers, in contrast to the hotel or liner shipping industries where the customer base consists partially or entirely of business customers. Thus, not only is a distinctive customer market segmentation to be applied, but also should the individual customer choice behaviour patterns with respect to selection of cruise route, departure date and cabin category be considered in order to benefit from upgrade or displacement decisions by the customer. The specific product structure and pricing schemes used in the cruise industry need to be considered in the revenue management process, as well as an individual customers value, for example represented by expected on-board spending or the probability of the customer returning for another cruise based on the customers satisfaction. Lastly, the possibility of multiple capacity limitations per cruise, e.g. for cabins and lifeboat seats, goes hand in hand with the requirement to consider the interdependence of the components of a booking request, i.e. the inseparability of a passenger party placing a booking request.

We present an extended mixed-integer linear programming model formulation for the optimal cabin capacity allocation based on a given set of cruises and a deterministic demand forecast that considers some of the special characteristics of the revenue management problem in the cruise industry, especially the expected on-board expenses of each passenger party, the interdependence of the components of a booking request, as well as the typical product structure and pricing schemes prevalent in the cruise industry today. Based on datasets close to reality, we present the results of our numerical experiments and show the effects resulting from the usage of our extended model formulation compared to revenue management approaches not considering the special characteristics of the cruise industry. Finally, we give an outlook on our future work, which comprises the further extension of the presented model formulation, as well as the validation of the practical applicability of our numerical results using real-world data sets.

F1D - NeLT - Next Logistics Technologies (Aud.24)
Chair: Kap Hwan Kim

Development of a K-DST for improving competitiveness of railway freight transport

Fri. 25 Aug.
8:30-9:35
Aud.24

Mi Rye Kim and Suk Lee

As use of environmental resources is increasingly important after the United Nations Framework Convention on Climate Change (UNFCCC), the reduction of carbon emission become international interest. In case of Korea, government is aiming to improve the modal share rate of railway freight from 5.8% to 15%, reducing transport of road freight (Ton-km standard). However, in the view of improving the modal share rate of railway freight, it is need to solve the problems such as high transport cost and railway capacity. Although a lot of research had done with those problems, it is need an improvement of the facilities. Therefore, different from most existing studies, this study focused on the maximum use of existing facilities and tried to solve the problems shown above. More specifically, we studied the container freight cars for high capacity and double stack using the existing facilities and developed Korean style Double Stack Train (K-DST) for domestic logistics environment. As a result, this study suggested the low-floor freight car of pocket type applied 3-axle bogie. And when this low-floor freight car is introduced, the capacity would be improved by 50% compared with the conventional one. This technology will contribute in better improvement on price competitiveness of railway logistics and invigoration of railway logistics by reducing national logistics cost and carbon emission. In addition, it is expected that K-DST will be able to have an international competitiveness power as well as increase the possibility of application to Eurasian trans-railway.

Fri. 25 Aug.
8:30-9:35
Aud.24

Study on Genetic Algorithm for Vehicle Routing Problem using Drone

Moohong Kang and Sanghyuk Yi

Recently, interest in unmanned vehicles which is called as drones has been rising. They can be applied to diverse areas such as agriculture, inspections, photographing, mapping etc. In the field of logistics, numerous projects for implementing drones have been conducted to deliver cargoes to inaccessible areas like rural or island regions, for example Amazons Prime Air, DHLs ParcelCopter, etc. However, most of these researches have focused on technical studies to improve its applicability to parcel service. Thus, more researches on how to optimally utilize a drone in actual freight transportation are needed. This paper applies the vehicle routing problem (VRP) for the operation of drones. There has been almost nothing about a research on VRP for a drone. Therefore, we define the VRP using drones where the drones are deployed on a truck and the drone flights are executed within the required range from the target point considering its limitation like the battery consumption. We propose the genetic algorithm to minimize the movement of trucks considering the one of drones. The experiments are performed and analysed in various factors like the flight range and weight limitation of drones, etc.

Fri. 25 Aug.
8:30-9:35
Aud.24

Scheduling appointments for trucks at container terminals

Veterina Nosadila Riaventin, Kap Hwan Kim and Chang Seong Ko

In container terminals at hub ports, one trucking company deliver a large number of containers during a shift. The delivery operation may lead to congestion of trucks mostly due to concentrated arrivals of trucks at peak hours. In order to relieve the congestion, many container terminals use a truck appointment system in which trucking companies book the truck arrival times in advance. A new scenario of truck appointment system is presented. The new truck appointment system provides a negotiation channel between container terminals and trucking company when determining appointment times for trucks. This study proposes a new scheduling method for multiple appointments. In the problem of scheduling appointments, the objective function is to minimize the total cost that consists of appointment cost, demurrage cost, and operation cost. In the mathematical model, the first constraint indicates, at each time window, that there is a specific number of available trucks and thus the total operation time of trucks is restricted by a prespecified total available time; the second constraint indicates that the number of appointment may not exceed a specified number of available slots during each time window at each storage area; the third constraint says that the number of deliveries must satisfy the requirement for the task. A mathematical formulation is provided, in which its main structure is the transportation problem and some additional constraints are added. Two heuristic algorithms to solve the problem within a practical computational time are proposed: one based on stepping stone method; the other based on shortest path-augmenting method. The result of a numerical experiment conducted to evaluate the heuristic approaches showed that heuristic approaches

can solve the problem much faster than the optimizing approach which solves the formulation directly by using CPLEX. The heuristic algorithm based on stepping stone method with additional constraint (SSM) and the shortest-path augmenting algorithm with additional constraint (SAP) were found to be practicable and more efficient. Moreover, it was found that the heuristic approaches are also robust to various input data. The computational time remain stable even when the tightness of capacity constraint changes. The shortest path-augmenting algorithm with additional constraint (SAP) found to outperform the stepping stone method with additional constraint (SSM) in terms of the computational time.

Saturday August 26

S1: 11:30 – 13:00

S1A - Supply chains (Aud.21)
Chair: Vasileios Vrysagotis

Sat. 26 Aug.
11:30-13:00
Aud.21

A balanced KPI tree to measure supply chain performance

Yuan Wang, Loo Hay Lee and Ek Peng Chew

Performance of a supply chain determines its ability to fulfill customer demands and thus, its competitiveness and success. An overall performance measurement system needs to be in place to evaluate whether a company is performing up to its expectation or better than expected. This is to ensure that it can service its customers at a certain standard. The system can also signal it to take corrective actions when needed and show possible areas for improvements. As different functions in a supply chain are related, a company must ensure that performance measurement system used is comprehensive and reflects overall performance instead of only a few areas. For instance, a company should not go after an improvement in lead time while ignoring costs involved and depleted margins. It must be able to strike a balanced system to improve it overall performance.

A typical supply chain involves a few functional areas. These functional areas include demand planning, manufacturing, finance, sales & customer relationship, distribution & delivery, and innovation. Given the abundance of indicators to choose from, we will be looking to identify the key indicators for each functional area. As performance measurement involves resources, companies must focus only on the important areas. Measuring performance is an important activity of companies as those measurements act as a feedback on how they are performing. Without a clear observation of its performance, a company will be unable to identify areas for improvement or to know how they are performing, leading to a stagnant company with unclear directions for the future. The main aim of this study is to identify key indicators in the six functional areas to create a KPI tree diagram, and a balanced scorecard that can be translated to a structured evaluation programme. This programme can be used to measure end-to-end supply chain performance. The information gathered can be used to identify deficiencies in the supply chain, helping organisations realign their supply chain strategies. Such realignment can assist companies to improved their performances and identify their competitive advantages.

Through surveys followed by research and analysis, critical indicators in the six major business functions, namely demand planning, distribution and delivery, finance, sales and customer Relationships, manufacturing, and innovation have been identified. A tree diagram is created to link the indicators and their respective functions. The combinations of identified indicators allow companies to assess their supply chain performance.

A data driven supply chain facility location problem with stochastic demand and uncertainties

Yuan Wang, Ru Yan Shou, Loo Hay Lee and Ek Peng Chew

Sat. 26 Aug.
11:30-13:00
Aud.21

A Multi-National Corporation in today's world has given more and more research focus to constructing a detailed and robust Supply Chain Network(SCN), which is categorized into strategic, tactical and operational phases across a planning horizon (Bender et al., 2002). These phases are differentiated based on strategy detail levels. The focus of this study is on Facility Location Selection (FLS) problem during the strategic phase. FLS is interrelated with Supply Chain Management (SCM). It is because the strategic phase emphasizes on SCM long-term decisions which often require a tremendous amount of investment and it is difficult to change decisions once they were made (Badri, 1999). FLS is one of these long-term decisions.

A long-term decision is considered robust only when it can last under different types of global market influences for a long period of time. For example, a facility location is well chosen when it takes both quantitative factors like total cost or profit, product cycle time and qualitative factors like customer satisfaction, legal regulations into account (Badri, 1999). We observe that just transportation costs resulted from FLS already contribute up to 50% to 60% of a company's total distribution costs (Frank and P, 2002). And since products are not mainly transported directly from a company's production sites to its customers but through different types of facilities such as distribution centers (DCs), time spent due to production, transportation and storage is therefore another aspect needs to be considered in FLS. We also observe that a good facility location gives a decrease of 5% to 15% in logistics costs while maintaining or improving customer satisfaction (Ballou, 2001). As a result, placement of facilities at optimal locations and removal of redundant facilities ensure SCN performs well with lower costs, shorter cycle time and fulfills specific requirements (Sule, 2001, p. 3-4).

In this study, we focus on facilitating a decision making for an international company to choose the optimal facility location(s) taking consideration of different factors and conflicting objectives, such as transportation cost, storage cost, cycle time, taxations and regulations. Multi-objective multi-shipment level multi-commodity MIP models are developed for both deterministic settings and stochastic scenarios. All relative data including demands, shipment levels, and shipment costs are provided by company. Various heuristic algorithms are proposed to obtain a close-optimum solution within a reasonable amount of time for stochastic case. Sensitivity analysis is also conducted to analyze the results and identify the key factors in the facility decision makings.

Sat. 26 Aug.
11:30-13:00
Aud.21

Barriers to innovation diffusion in the reefer chain

Bob Castelein, Harry Geerlings and Ron van Duin

Reefer containers are a fast-growing segment in the container shipping market and in global supply chains. The intermodal compatibility, increased reliability (in terms of delivery and quality control), flexibility, and traceability that these containers and associated technology provide, make it an attractive mode of transportation for temperature-sensitive cargoes. Facilitated by these technical developments in the reefer market, the growing global demand for temperature-sensitive products, such as agri-food products, flowers, specialty chemicals and pharmaceutical products, drives the further expansion of reefer trades. As of now, the reefer market is the only segment that shows consistent year-on-year growth in a generally depressed container shipping market.

A distinctive feature of reefer containers is that they need a (near) constant supply of energy to control their internal temperature and airflow in order to optimally protect product quality. Addressing the increasing scale and scope of these energy-intensive reefer flows as well as improving the environmental performance of shipping, port, and hinterland operations present a complex organizational challenge. The complexity stems from the fact that many different stakeholders around the world are involved in these cold supply chains, and the high energy costs involved have a strong impact on their cost structure, incentives and behavior in terms of strategies, investments, business models, collaboration modes, and risk management.

Numerous technical and organizational innovations have been developed to address these energy use concerns. Throughout the chain, quality-driven logistics concepts can be applied by giving handling priority to reefer containers according to their real-time internal conditions, energy requirements, and time-sensitivity of their cargoes, ideally at a premium price for customers willing to pay. Sophisticated reefer software can be used to make the control system of a reefer more energy-efficient and reduce CO2 emissions while still preserving product quality (e.g. QUEST I and II). Similarly, at terminals, reefers energy consumption can be controlled to prevent costly peak use and reduce reefer racks overall energy consumption.

However, despite their potential, we observe that these innovations often do not diffuse in reefer chains. As of now, diverging interests and lack of cooperation and information sharing result in sub-optimal supply chain arrangements, excessive use of energy, and a high incidence of cargo loss. This analysis aims to explain this by identifying barriers to innovation diffusion in the reefer shipping market and present some preliminary suggestions for improvement.

Through exploratory interviews, it is found that shippers, particularly those with high-value cargoes, are reluctant towards accepting energy-saving innovations, as they perceive these to jeopardize the quality of their cargo. Secondly, the contractually determined constraints and incentives posed to stakeholders along the reefer chain vary considerably, as does these stakeholders discretion to adjust their processes. Thirdly, the implementation of quality-driven logistics is hindered by proprietary data concerns regarding reefers cargo and internal conditions. These qualitative observations of stakeholders revealed preferences are augmented with

stated preference research into the conditions under which stakeholders are willing to implement and accept energy-saving innovations in the reefer chain.

A performance measures quantitative analysis for a three stage logistics system

Vasileios Vrysagotis and Theodore Bratis

Sat. 26 Aug. 11:30-13:00 Aud.21

On our paper, we deal with a set of correlations between quantitative performance measures of the supply chain management such as fill rate, WIPretailer, WIPwholesaler ,WIPsystem , and operational variables of reorder point (s) and up- to- order inventory level (S) such as Sretailer,sretailer,Swholesaler,swholesaler for a three echelon serial supply network. In addition, we present a correlation analysis between fill rate, WIPretailer, WIPwholesaler ,WIPsystem and the total profit of the logistics system. The findings, a number of relations between the above mentioned variables offer managerial insights regarding the performance of a logistics system.

S1B - Vessel speed & Energy consumption (Aud.22)
Chair: Roar Ådland

Speed Optimization for Crude Oil tankers as a function of Cargo Inventory Cost, Demurrage, Freight Market and Real Sea Conditions

Elizabeth Lindstad, Haying Jia and Roar Ådland

Sat. 26 Aug. 11:30-13:00 Aud.22

Traditionally seagoing vessels has been designed and optimized to operate at their boundary speeds based on hydrodynamic considerations. For any given hull form, the boundary speed area can be defined as the speed range where the resistance coefficient goes from nearly a constant, to rise rapidly and increases fuel consumption significantly. For a typical Aframax tanker, the boundary speed is around 15 knots, with a gradual increase in the resistance coefficient from 12 knots upwards. With higher fuel prices and more public focus on maritime transports emission and its contribution to climate change and local pollution, reducing fuel consumption has become a priority for shipping lines.

The three main responses for reducing fuel consumption are slower speeds, larger vessels and more hydrodynamic hull forms, i.e. more slender vessels. While larger vessels and more hydrodynamic hull forms requires new-buildings, speed reductions and optimization is applicable for the entire fleet. The key insight is that the power required for propulsion is a function of the speed to the power of three for lower speeds, four for an incremental speed increase when operating at boundary speed, and which gradually increases against infinity for higher speeds. This implies that when a ship reduces its speed, the speed consumption per freight work unit is reduced. (Corbett et al., 2009; Seas at Risk and CE Delft, 2010; Psaraftis and Kontovas, 2010, Lindstad et al, 2011; Jonkeren et al 2012).

However, the reduction in speed from a booming shipping market in 2007 to a 2012 market with overcapacity in major shipping segments and peak fuel prices was less than 10 %, i.e. from 12 to 11 knots (Smith et al. 2014). One explanation is the cargo inventory cost, which implies that with lower speeds the voyage length increases, and hence the cost for the owners of the cargo. Moreover for crude oil transport, Lindstad and Eskeland (2015) findings indicates that the additional cargo inventory cost is of the same magnitude as the savings which can be made by reducing speed. Speed decisions is also influenced by the sea conditions and the freight market (Lindstad et al. 2013) and the potential demurrage income from arriving early when there is a backlog of vessels waiting to be served.

There is hence a need for a more holistic approach to optimize speed decisions for crude oil tankers. For these reasons the present study has focused on developing a model for Speed Optimization as a function of Cargo Inventory Cost, Demurrage, Freight Market and Real Sea Conditions.

Sat. 26 Aug.
11:30-13:00
Aud.22

On the relationship between vessel speed, port time and demurrage

Haiying Jia, Vishnu Prakash, Roar Ådland and Tristan Smith

Vessel sailing speed, being a key driver of fuel consumption, has been a long-time research topic in maritime economics. In recent years, high fuel prices, depressed freight markets, and increasing awareness of the environmental problems caused by emissions from vessels have brought a new focus to speed optimization. Economic theory suggests that vessels should slow down when the ratio of bunker prices to freight rates is relatively high, and vice versa. However, empirical studies of sailing speeds have largely failed to demonstrate that vessel speeds are optimized in such a manner. Common arguments to explain this apparent market failure is that a) charter clauses on speed or cancelling dates constrain the optimal adjustment of sailing speed and b) that owners have an incentive to hurry up and wait if the demurrage rate (i.e. the penalty payable by charterers for not completing cargo handling operations within the contracted time in port, the laytime) is higher than the earnings from sailing at reduced speed.

In this paper, we test this latter hypothesis empirically. Specifically, we propose a model where demurrage can be viewed as the alternative cost of time spent sailing. We argue that the demurrage rate can reasonably be modelled as a lagged function of the timecharter equivalent (TCE) rate due to rigidity in contractual negotiations. In this case, in a weak/declining freight market, there is an incentive for the shipowner to arrive at the port as early as possible, increasing the probability of demurrage payments. This leads to seemingly suboptimal (too high) vessel sailing speeds compared to the classical case when demurrage is excluded from the optimization. Conversely, in a strong/increasing market, the expected value of demurrage is relatively lower than the earnings from sailing, leading to lower speeds than the classical optimal speed calculation suggests.

This paper utilizes a unique dataset containing over 25,000 VLCC tanker shipments between 2013-2015, with average voyage speeds and port times derived from Automated Identification System (AIS) observations of individual vessel activity.

Our results show no obvious relationship between port time and vessels sailing speed. However, we find that the TCE rate premium (the difference between the current rate and the lagged rate) affects the sailing speed positively, indicating that shipowners/operators speed up and aim at longer waiting time at port so that they benefit from demurrage payment. This research sheds more light on the understanding of vessel speed variations and, in particular, the reasons that shipowners do not appear to optimize the sailing speed according to market conditions. The key policy implication is that the demurrage system combined with a First-In-First-Out berth allocation system is a key barrier to energy efficient vessel operation.

Real energy efficiency in the seaway

François-Charles Wolff, Roar Ådland, Pierre Cariou and Haiying Jia

Sat. 26 Aug.
11:30-13:00
Aud.22

There are increasing economic and environmental incentives for ship owners and operators to develop tools to optimize operational decisions, particularly with the aim of reducing fuel consumption and maximizing profit. However, our understanding of the determinants of observed speed, fuel consumption and emissions in real operating conditions remain limited. This is partly due to the complex and rapid variations in the external environment in which a vessel is operating, and partly due to the challenges and costs of constantly monitoring such forces and output. Even with accurate measurement, the fuel consumption of a vessel will vary with loading condition (trim/draught), weather and wave conditions, and hull and engine condition. We contribute to the literature by estimating the impact and explanatory power of physical conditions (waves/weather), RPM/speed, hull condition, geolocation and other operational variables on a vessels fuel consumption. Our empirical analysis is based on a large sample of noon-report data and third-party weather information for a fleet of 16 oil tankers in global trade. We find that the various sources of uncertainty result in real fuel consumption that are highly volatile, even for the same apparent speed, and substantially higher than the theoretical fuel consumption in idealized conditions (typically by 20 - 50%). Furthermore, we find that incremental fuel consumption in the real seaway is higher at low sailing speeds, which questions the validity of the classical 'cubic rule' in vessel speed optimization. This can partly explain the observed low elasticity of vessel speeds with regards to freight rates and fuel prices. Our findings are important for practical vessel operation and for establishing the impact of maritime policy initiatives such as a global CO2 levy.

Sat. 26 Aug.
11:30-13:00
Aud.22

On the Fuel Consumption Function for a Vessel under Changing Sailing Conditions

Chen Li and Xiangtong Qi

In maritime network planning and vessel routing, it is usually assumed that each leg between two ports has a given fuel consumption function of the vessel speed. Then a speed can be derived for each leg along the route. We argue that this speed should be interpreted as an average speed of the leg when the vessel has opportunities to save fuel by adjusting its speed several times within the leg. This paper aims to investigate the properties of the fuel consumption resulted by adjusting speed as a function of the average speed, with respect to monotonicity and convexity which are often desired in network planning models. We give an armative result to this problem, which at least partially validates the prevailing approaches used in maritime network planning.

S1C - Disruptions & Resilience (Aud.23)
Chair: M. Vidovic

Sat. 26 Aug.
11:30-13:00
Aud.23

Disruption recovery and rescheduling problems in containers drayage

Milorad Vidovic, Nenad Bjelic and Drazen Popovic

Containers drayage involves the delivery of a full container from an intermodal terminal to a receiver and the following collection of an empty container, as well as the provision of an empty container to the shipper and the subsequent transportation of a full trailer or container to the intermodal terminal.

Most of the practical problems as well as published researches deal with the different classes of routing and scheduling problems in containers drayage for the static case, where demand is deterministic, known in advance, and unchangeable. However, in real world systems, very often demand becomes apparent at a late moment, while drayage tasks realization can be threaten by vehicle breakdowns, traffic congestion, accidents or road maintenance. All those situations have negative effects to the previously scheduled container drayage operations, making original schedule infeasible, and in the same time generating need for as fast as possible disruption recovery, and system reconfiguration which minimize deviation costs.

In this paper we identify representative disruption factors and situations in container drayage processes realization and define appropriate actions whose implementation will results with a disruption recovery. Particularly, the idea is to analyze possibility of utilizing centrally coordinated fleet of vehicles in dynamic environment with available real time information provided by advanced ICT. Performances of the proposed algorithms, as well as the effects of recovery strategies are compared on illustrative examples.

Modelling the impact of infrastructure developments on the resilience of intermodal container transport networks: One-Belt-One-Road Case study

Pablo Achurra-Gonzalez, Simon Hu, Konstantinos Zavitsas, Daniel J. Graham, Fengming Su and Panagiotis Angeloudis

Sat. 26 Aug.
11:30-13:00
Aud.23

Infrastructure development initiatives such as terminal expansions and the addition of new corridors are common interventions aiming to increase the efficiency and efficiency of transportation systems. At the same time, it has been demonstrated that in certain cases, such enhancements might prove detrimental to overall performance (Braess paradox), or would increase vulnerability to disruptions due to systemic complexity.

Asia-to-Europe liner services represent one of the key segments of the international container shipping market. The recently established One-Belt-One-Road (OBOR) policy aims to further enhance the performance of this corridor, with a range of initiatives that notably include a set of overland direct rail service between China and Europe. These can halve the transit times ordinarily required by traditional liner services, and as such have the potential reduce overall shipping costs for certain product classes of despite the increased cost of rail service. With the increasing attention attracted by these initiatives, it is crucial to understand their potential impact to the global container transport network. Furthermore, the effects of long-standing concerns, such as transhipment, trade imbalance, modal integration and resilience should be examined in new light.

Methodologies that assess resilience in container transport networks face two key modelling challenges: 1) Lack of historical disruption data on network components and 2) typical size of realistic liner shipping networks. The first challenge limits the implementation of methodologies that require prior knowledge of disruption probabilities to quantify the vulnerability of the network. The second creates the need for models capable of capturing key industry practices such as transhipment, empty repositioning, and vessel ability to skip disrupted ports while at the same time allowing for implementations at realistic global scales.

We address these challenges with a quantitative framework capable of identifying most vulnerable components in large networks with limited or no historical disruption data. We propose a game-theoretic attacker-defender model (ADM) consisting of a two-player, zero-sum game between a global ocean carrier (defender) that aims at minimising container routing costs and malevolent agent (attacker) that aims at maximising disruption costs. The ADM is formulated as a maximin linear program where, at mixed-strategy Nash equilibrium, the weakest links and nodes are identified, and the minimum cost routes for the ocean carrier are selected.

The payoff matrix for both players is generated using a cost-based container assignment model (CBCAM) adapted for the analysis of container networks under disruptions. The CBCAM is formulated as a mixed integer linear program and is used to determine routing costs for the ocean carrier and disruption costs for the attacker on each of the scenarios evaluated.

A numerical case study for the Asia-to-Europe trade is constructed to assess the impact of the OBOR freight corridor on network resilience. Results identify the

most vulnerable network components and interventions that would increase system resilience such as investment on alternative transhipment hubs.

Sat. 26 Aug.
11:30-13:00
Aud.23

Evaluating resilience of port-hinterland road-inland water shipping container transportation network

Nan Liu, Hong Chen and Jasmine Siu Lee Lam

Background

The container transportation network between seaports and the hinterland plays a critical role in supporting regional trade. Considering the advantages in cost reduction and environmental protection, intermodal transportation has received increasing attention during the past decades. Comparing to road-rail intermodal transportation, road-inland water shipping is recognized as having more cost and environmental benefits. However, it is also more vulnerable to natural hazards such as floods and typhoons. This study aims to evaluate the ability of a port-hinterland road-inland water shipping container transportation network (PHRIWSCTN) to withstand climate hazardstermed as resiliencein a comprehensive manner.

Research framework and methodology

Before evaluation, we firstly propose a formal PHRIWSCTN resilience definition by conducting a comprehensive resilience literature review, which consists of four dimensions as vulnerability, absorptive capacity, adaptability, and recoverability. Based on this, the resilience assessment framework is then developed as a 5-level hierarchical structure. The first level is the goal of the framework as to assess a PHRIWSCTN resilience. The second level represents the four dimensions proposed so that the resilience can be evaluated comprehensively from different aspects. Within each dimension, then, the four layers of the networknatural condition, social economic condition, network infrastructures, and network organizational managementare respectively examined to assess the networks ability to achieve resilience, termed as categories in the third level. Next, Level 4 contains the indicators reflecting the categories in Level 3 in detail. Finally, Level 5 contains the alternatives for evaluating and ranking. To implement the evaluation, the ANP-TOPSIS method, allowing dependencies between indicators, is adopted with the assistance of a Delphi expert group to ensure the validity and reliability.

Case studies and expected conclusions

The feasibility of the framework is then illustrated through a comparative case study of two PHRIWSCTNs in China, namely the Yangtze and Zhujiang River systems, where all of the inland water container shipping in China are operated. The evaluation results assist not only private companies (i.e. port operators, inland water shipping companies) and public authorities (i.e. local municipalities) to identify the influential factors of the contextual resilience, but also help the network planner (i.e. the central government) to find out the weak points of a PHRIWSCTN. As such, the network resilience can be enhanced by dealing with the identified weaknesses. In addition, the results can also provide valuable information to the network usersthe cargo owners and freight forwardersin selecting inland water ports and seaports for importing and exporting the containers. Because the resilience performance against

climate hazards can be seen as one aspect of the competitiveness of a PHRIWSCTN, our study can make contributions to both theory and practice.

Natural catastrophe risk index of seaports

Danny Keyi Li, Jasmine Siu Lee Lam and Xinhu Cao

Sat. 26 Aug.
11:30-13:00
Aud.23

Smooth operations of seaports are critical to global supply chains, trade flows and economic growth. However, the unique low-lying coastal location of seaports renders seaports particularly vulnerable to natural catastrophes such as earthquake, typhoon and storm surge. The trading activities of seaports also attract people, businesses and industries, further creating enormous exposed elements at risk and loss potentials. Long-term port disruptions due to natural catastrophes will lead to delays and losses to operators, manufacturers and other stakeholders, resulting in propagation effects on regional economies. To manage and mitigate natural catastrophe risks, proper risk assessment is necessary. It is found that seaport risk is largely evaluated through stochastic modelling and simulations in the literature. However, as a widely-used tool in recognised disaster risk analysis initiatives, risk index system has hardly been applied to seaports. Assessing ports natural catastrophe risks is a challenging task due to the uncertainty of natural hazards as well as the scarcity of seaport data in public domains. Therefore, this paper attempts to overcome these challenges and aims to develop a natural catastrophe risk index system for seaports and assess the risk of the top 20 container ports in the world. It is found that typhoon, as a common hazard type to seaports, has not received the same attention as other natural catastrophes such as earthquake in port risk assessment studies. Thus, by using typhoon hazard as an example, a natural catastrophe risk index system for seaports is developed through literature review and expert validation. Through multi-criteria decision analysis, factors of hazard, exposure and vulnerability are integrated into a risk index. Hazard is measured by examining historical data of hurricane/typhoon events that struck the relevant seaport areas. To achieve this, a seaport typhoon database is built. Exposure is measured through analysing the size, structures of seaports as well as their cargo throughput. Vulnerability is measured based on the harbour types and man-made protection measures. A risk ranking and risk maps of world top 20 container ports are generated. Results demonstrate the studys usefulness for port stakeholders such as port operators, ocean carriers, shippers, and insurers in decision making.

S1D - Ports & Containers 1 (Aud.24)
Chair: Dario Pacino

Sat. 26 Aug.
11:30-13:00
Aud.24

Intelligent Cross-sectional Yard Crane Deployment in a Transhipment Container Hub

Xin Jia Jiang

This paper studies the intelligent cross-sectional yard crane deployment problem in a busy transhipment hub, where a special consignment strategy is applied. Under this strategy, containers to the same destination vessel are usually stored together to facilitate the loading process and reduce the long distance travel of yard cranes. To manage the storage allocation process more efficiently, the port operator organizes the storage yard into several blocks (sections), each containing 5 sub-blocks. The storage allocation is planned considering the practical requirements from traffic control, space capacity and yard crane workload, etc. However, most of the studies on space allocation assumed that yard cranes are always ready whenever needed, while the yard crane deployment problem was neglected. This may lead to not only unnecessary operational cost, but also the infeasibility of some storage allocation plan. In this work, the intelligent cross-sectional deployment of yard cranes is studied to improve the situation.

Sat. 26 Aug.
11:30-13:00
Aud.24

Empirical Evaluation of an Automated Container Terminal with Truck Overpass Structures on the Storage Yard of Parallel Layout

Tae Kwang Kim, Seong Pil Moon and Kwang Ryel Ryu

Most automated container terminals in operation nowadays adopt the storage yard of a perpendicular type where the storage blocks are laid out perpendicular to the quay, which naturally separates AGV traffics from external trucks. In contrast, the storage blocks of many conventional terminals are laid out parallel to the quay because such a layout more naturally allows external trucks as well as yard tractors to come right to the side of the target bay of a block to drop off or pick up a container, thus making the operation of stacking cranes more efficient. To automate this parallel-type terminal by employing AGVs and automated stacking cranes, however, there must be a way of isolating the traffic flow of AGVs from that of external trucks.

A conceptual automated container terminal that we investigate in this paper adopts a parallel-type storage yard with an overpass handling system (OHS) that provides overpass structures exclusively for external trucks, while the AGVs run on driveways at the ground level. The overpass structures not only enable separation of AGVs from external trucks but also reduce traffic congestion. To realize an automated terminal of low carbon emission, the AGVs are all electrically powered and two battery stations are installed at the opposite sides of the storage yard,

where the AGVs can have their batteries replaced. As an additional feature to enhance productivity by decoupling container transport from the storage processes, each storage block of this terminal is provided with two lifting buffer platforms (LBP) at the side, one at the handover point (HP) located at about one third of the block length from the end and another at two third. LBP is a container rack equipped with a lifting mechanism at its rack top. When a loaded AGV arrives at the inside of the rack, its lifter pushes up the container; after the unloaded AGV leaves out, the lifter shrinks back to settle down the container on the rack top. Then, the container can be picked up from LBP at any time by the stacking crane of the block for storage. The retrieval of a container from the block to an AGV can also be done via LBP in a similar way. However, container exchange between an AGV and a stacking crane can also be made at HPs with no LBP whenever favourable efficiency-wise. We report the results of some simulation experiments to compare the productivity of the OHS terminal with that of the conventional terminal of the same capacity and layout except for the overpass structure and LBP. For the experiments we have implemented a minimum-time routing algorithm that can find AGV routes taking a minimum time to the destination. We have also employed an optimization algorithm that finds an optimal setting of drive directions of all the AGV lanes to minimize traffic congestions. For efficient dispatching of AGVs, we have adopted the inventory-based dispatching algorithm by Briskorn et al. (2006) and adapted it to deal with battery replacements as pseudo-jobs to be done by AGVs.

A container fleet sizing problem with combinable containers in liner shipping

Sat. 26 Aug.
11:30-13:00
Aud.24

Koichi Shintani, Akio Imai and Ulrich Malchow

This study addresses the impact of the use of combinable 20-foot container on liner shipping in terms of cost savings. This combinable container can be used as a conventional 20-foot container and two of them are coupled to be used as a single 40-foot container for laden transport and empty repositioning. We model a shipping network consisted of two ports to determine the optimal container fleet size of this combinable container. The analytical model is used to carry out numerical experiments with extremely imbalanced trading scenarios. It is found that the combinable container has a potential to reduce the container fleet cost compared to the conventional container.

Sat. 26 Aug.
11:30-13:00
Aud.24

Block Stowage and Crane Intensity in Stowage Planning

Dario Pacino and Roberto Roberti

With the ever-growing size of container vessels and the fact that the liner shipping industry is surviving off marginal revenue, the relevance of using advanced planning methods is never been more relevant. One of the main revenue drivers in liner shipping is vessel utilization. A number of scientific articles tackle this problem from a strategic or tactical by optimizing fleet size and composition or optimizing the design of the shipping network. On an operational level, the capacity of a vessel and its efficiency at port is dictated by the so-called stowage plan. A stowage plan describes the arrangement of the containers on the vessel. Stowage plans are not easy to create. This is not only due to the large number of containers that needs to be planned, but also due to a complex set of physical restrictions that govern the balance and stability of a vessel. In earlier works, we have shown how industrially representative stowage planning problems can be approached using a hierarchical decomposition, where containers are first arranged into logical sections of the vessel (master planning), to be then assigned a specific position within those sections (slot planning). The master planning phase was particularly suited to be solved with the use of mathematical modeling.

These advances in solution methods have caught the attention of the industry, which is now exploring its possible applications. As many other planning processes that involve the interaction with human planners, or with other planning systems, one is often faced with requirements that are often aimed at simplifying the solution of the optimization or at better approximating specific modeling simplifications. In stowage planning, one such example is the use of two concepts: block stowage and crane intensity. Block stowage is the clustering of containers with the same port of destination. Here the aim is to improve time at port by 1) eliminating overstowage and 2) allowing dual-cycling. Overstowage happens when a container destined to a later port is stowed on top of one to an earlier port. Dual-cycling is a technique used by the container terminals which allows the interchange of load and discharge operations. The other concept, crane intensity, is a KPI which estimates the number of quay cranes needed to handle the vessel. Crane intensity is, however, used as a target rather than a measure.

In this presentation, we will show that the inclusion of crane intensity and block stowage increase the complexity of the planning problem and that current state-of-the-art mathematical models are no longer suitable to solve the problem. Preliminary results from heuristic procedures will be presented alongside a novel benchmark featuring instances based on container vessels with a full set of industrially representative data, such as stress force limits and block locations.

S2: 14:00 – 15:30

S2A - Simulation (Aud.21)
Chair: Holger Schuett

A Modularized Discrete-Event Modeling Approach for High-Fidelity Mega Container Port Simulation

Sat. 26 Aug.
14:00-15:30
Aud.21

Haobin Li, Chenhao Zhou, Hongtao Chi, Loo Hay Lee, Ek Peng Chew, Xiao Feng Yin and Xiuju Fu

In literature and through many practical applications, discrete-event simulation (DES) has been shown to be an effective way to evaluate the performance of alternative industrial systems, and identify the most efficient designs. In our previous study (Li et al. 2016), two simulation models have been developed for a mega container port at corresponding fidelity levels, i.e., up to the movement of vessels for the simple model, and individual containers for the complex model. At both fidelity levels the existing models simulate all equipment, including quay-cranes, yard-cranes, and the fleet of container trucks, as servers in a complex queuing system with corresponding service rates. With O2DES.Net framework (Li et al. 2015), the static and dynamic properties of the system, as well as the events are respectively defined, so as to form the complete models.

Although this a common practice to use standard servers and queues in most DES modeling, there are several shortages in such queuing-based models for the mega container port.

Firstly, it is not sufficient to describe the characteristics of a port equipment using only a distribution of service time. Whereas, the they may consist of many other factors, e.g., the capability and robustness to process containers with various properties such as sizes, weight, if refrigerated, position in the vessel or on the yard); efficiency of handshaking with other equipment; and energy consumption. Those performances may be impacted by alternative equipment designs.

Secondly, the performance of a mage container port does not purely depend on the equipment configuration and the amount of equipment deployed (i.e., the hardware), but also the operational rule that optimizes the allocation of equipment among concurrent tasks (i.e., the software). A high performance port configuration should integrate proper combination of the two perspective, which is hardly to be evaluated by a queuing-based model.

Moreover, considering that a mega container port consists of a large number of similar components, e.g., cranes, berths, and yard blocks, which all have associated static, dynamic properties and dedicated events, it makes the modeling practices much easier if those properties and events belonging to the same functionality cluster can be grouped in hierarchy, and interact only through well-defined interfaces.

In this work, inspired by the DEVS formalism on the atomic and coupled models (Zeigler et al. 2000), we propose a modularized discrete-event modeling approach that extends the O2DES paradigm, with application on simulating the mega container port system. With the composition techniques, the entire port system is modeled through assembly from modules each have a dedicated functionality. Through practical example, we illustrate that the proposed approach could facilitate the

modeling process, and enable collaborative development for complex models. More importantly, it realizes a more practical simulation-based optimization that could rank and select among various equipment designs, integrated with alternative operational rules and optimize both equipment designs and algorithmic parameters.

Sat. 26 Aug.
14:00-15:30
Aud.21

Index based Heuristic Approach for ULD Sorting Operation in Third Party Logistics

LiChenhao Zhou, Aloisius Stephen, Haobin Li, Ek Peng Chew and Loo Hay Lee

With the explosive increase of e-commerce in Singapore, thousands of parcels flow into the city via air and land transportation. The operation efficiency along the whole supply chain becomes the key competitive indicator for a world leading logistics company in Asia pacific (the company). In this study, we aim to explore the improvement on the inbound package sorting operation of an air-land gateway hub owned by the company.

The packages are carried by Unit Loading Devices (ULD). Once the ULD arrives, it will be attached to a workstation where the packages contained in the ULD will be retrieved and placed on the sorting belt by the operators. Each package will be sorted and directed to the corresponding truck by an automatic sorting system. Once the truck finishes loading all the packages assigned to it, it will depart for delivery.

There are two waves of ULDs for the sorting operation. The first wave ULDs are accumulated from the previous days and stored in the regional hub. These first wave ULDs can be handled as soon as the sort operation begins. While the second wave ULDs comes in an aircraft which lands during the sorting operation and the ULDs are offloaded from the aircraft based on the offloading sequence. Since the offloading sequence is known by the company a few hours before the aircraft arrives, we can assume that each ULD has a given ready time for handling by the workstation. Another information that comes along with the offloading sequence is the details of the packages in each ULD. It means that the corresponding relationship between routes and ULDs can be utilized.

There are two major challenges faced by the company, which are to: (1) reduce the total sort operation duration, effectively reducing under-utilization of workstations and personnel, and to (2) minimize the waiting time for route fulfilment in order to reduce congestion at the loading bay. Considering the constraints and objectives, this study is similar to the berth allocation problem (BAP) with hybrid layout and given ready time, according to Bierwirth and Meisel (2010). However, unlike the BAP which looks only at the berth activities, we need to consider the correlation between ULDs and routes.

This study aims to tackle the problem through looking at the ULDs sequence. An index based sequencing heuristic is proposed to order the unloading sequence of ULDs by assigning priority to ULDs based on three metrics: (i) the time when the ULD is ready, (ii) the time taken to unload the given volume of packages in the ULD, and (iii) the ratio of the packages to routes on standby.

To find the best parameters for the three metrics, a simulation optimization based search algorithm MO-COMPASS is applied (Li, Lee, Chew, & Lendermann, 2015). The numerical experiment has shown that the proposed approach shaves off 10% of the sort operation duration, which equates to an annual reduction of about 2500 man-hours, comparing with current company strategy, which is purely based on a First-Come-First-Serve ULDs sequence.

Solving dynamic multi-continuous berth allocation and quay crane scheduling problems simultaneously by using simulation optimization

Gokcecicek Tasoglu and Gokalp Yıldız

Sat. 26 Aug.
14:00-15:30
Aud.21

Nowadays, containerization and globalization have raised the importance of the maritime transportation. Maritime transportation has become an important ring of the global supply chain and this leads a tough competition between the container terminals. In order to gain competitive advantage, container terminals need advanced planning for berths and quay cranes which are critical resources of container terminals. The management of a container terminal usually focuses on reducing the makespan of seaside operations of all vessels in the planning horizon. The makespan refers to the time at which all loading/unloading tasks of all incoming vessels are completed and it is directly affected by berth allocation and crane scheduling decisions. Since berth allocation and crane scheduling problems are strongly interrelated, solving these problems simultaneously is very important in practice. So, this study proposes a simulation optimization based simultaneous solution approach for Dynamic Multi-Continuous Berth Allocation (DMCBA) and Quay Crane Scheduling (QCS) problems. This solution approach integrates the simulated annealing based search procedure with the simulation model of the system.

This study consists of four phases; 1) Developing conflict free QCS algorithm. 2) Developing a general parametric simulation model which represents the seaside operations of a container terminal. 3) Developing a simulated annealing (SA) based simulation optimization procedure. 4) Performing computational analysis for a sample case.

In the first phase, an algorithm is proposed in order to obtain a conflict-free quay crane schedule assuming that identical quay cranes are located on a rail and bypassing each other is not allowed. In addition to this, quay cranes can only move on its specified areas which may overlap. In the second phase, the parametric simulation model is developed by using ARENA Simulation Software. This model simultaneously handles the DMCBA and conflict free QCS based on the proposed algorithm developed in the first phase. In detail, the simulation model assigns both vessels to the berths and cranes to the ship bays and also it determines the schedule of quay cranes dynamically with stochastic handling times. In the third phase, simulated annealing (SA) based simulation optimization procedure is developed on MATLAB and it is integrated with the proposed simulation model in order to minimize the makespan. In this procedure, SA algorithm finds a candidate solution that gives the assignment of vessels to berths and this solution is passed to the simulation model as input. Then, the simulation model runs and computes the completion

time and passes it to the SA algorithm as fitness value. This process continues until termination criterion is met. In the last phase, different problem instances varying in size and complexity are generated and solved by the procedures proposed in the preceding phases. Results revealed that the proposed procedures are effective in minimizing makespan and it can be implemented by the container terminals by adopting their own data in practice. To the best of our knowledge, there is no simulation optimization study which includes all of these properties.

Sat. 26 Aug.
14:00-15:30
Aud.21

Simulation based lectures for students in logistics

Clemet T. Bjorbaek, Oevind Berg and Holger Schuett

Simulation Technology has found its way from processes in the production to the logistics within the last decades. End of the previous century especially the planning of greenfield logistic areas and huge extensions of existing terminals were supported with the means of simulation. Emulation (the connection of real control systems of logistic facilities with a simulation model of the material flow) was developed to generate beds for these IT systems. This led to new ways in train the control staff of terminals, by letting them play around with virtual environments, which are controlled by the real IT system. In this way they may optimize their strategies to run the facility as well as replay bad shift from the past to find out how to do it better next time. And all this works without burning fuel and without disturbing the real operation.

In the field of economics business games are already used in education to show the complexity of the processes. E.g. The Business Game SEED (Simulation of Economics for Entrepreneurs and Deciders) is a board game to the basics of Business Administration and simulates the operational processes associated with Business Accounting.

In a similar way simulation started to be used within the universities to educate young logisticians about the complexity of logistic facilities and especially about the strategies to be used on them:

Equipment allocation

Yard planning (find the best location for the goods)

Stowage planning on the yard, the vessel the truck, etc.

The paper will present how the CHESSCON simulation products are used in the Department of Maritime Technology, Management and Innovation of the University College South East Norway. Besides supporting bachelor and master thesis and research projects the students also learn how to run a container terminal. Within a simulation challenge the students start with the same initial situation and have to increase productivity under consideration of the costs occurring. The success will be shown by presenting a quantitative review of the training from the sight of the students as well a qualitative analysis of the instructors experience with the course.

S2B - Environment & Sustainability 2 (Aud.22)
Chair: Suk Lee

Scrubber: a potentially overestimated compliance method for the Emission Control Areas; The importance of involving operational behavior changes in the evaluation

Sat. 26 Aug. 14:00-15:30 Aud.22

Yewen Gu

The Emission Control Areas (ECA) regulation is introduced to control the environmental and health problems caused by sulphur exhaust from ships. Dierent emission reduction methods are developed to comply with the ECA regulation, but dierent technologies have their pros and cons. Due to the irreversibility of the investment in some of the technologies, the choice of compliance method has a long term nancial impact and thus becomes strategic for a shipping company that needs to sail in the regulated areas. Furthermore, with a certain emission control technology on board, a ship may adapt its sailing pattern to minimize the operational costs. In this paper, we use a mathematical programming model to explore the impact of a ship's operational behavior change (OBC) on the comparison between a scrubber system and a fuel switching approach. In particular, we compare the lifespan cost dierence between the two alternatives in the cases that OBC is ignored and considered. Furthermore, the in uence of port call density inside ECA is investigated as, under the assumption that OBC is taken into account. The results shows that it is critical to involve OBC in the evaluation and comparison process. Otherwise, a signicant overestimation of the value of the scrubber system and, as a consequence, a substantial loss due to an incorrect emission control choice may be witnessed. Moreover, a higher port call density inside ECA provides a larger incentive for the ship to install a scrubber system, while the fuel-switching option is more preferable in the opposite case.

Measures to mitigate and reverse the negative impacts of the low sulphur requirements on short sea shipping in Europe

Sat. 26 Aug. 14:00-15:30 Aud.22

Thalis Zis and Harilaos Psaraftis

In an effort to reduce the environmental impacts of maritime transportation, the International Maritime Organization designated special Sulphur Emission Control Areas (SECA) where ships are required to use low-sulphur fuel. In January 2015, the limit within SECA was lowered to 0.1%, with which ship operators can comply only by using pricier ultra-low sulphur fuel, or investing in abatement technologies such as scrubbers. The exact repercussions of the new sulphur limits are difficult to identify the wake of a significant but unexpected drop in fuel prices for both low-sulphur and heavy fuel oil, however recent research has shown that modal shifts are occurring.

This paper builds on a comprehensive modelling framework that estimates modal shifts between maritime and land-based options available to shippers. The analysis shows that freight rates are the decisive element in a shippers choice of transportation mode. Considering that the freight rates imposed on shippers are sensitive to the fuel price due to the use of bunker adjustment factors, it is evident that the low-sulphur requirements hinder maritime options less appealing than before. The paper considers various fuel price scenarios in a set of case studies on existing services of a leading Ro-Ro operator in Northern Europe. For each scenario the environmental balance of the system is measured in terms of total emissions, and emissions intensity. The profitability of the ship operator is examined as a function of fuel costs and generated revenue per service.

The paper considers measures that the operator can utilize to cope with scenarios where the route is no longer profitable due to loss of cargoes and increases in fuel prices. These measures include reduction of sailing speed, altering the sailing frequency, use of abatement technologies (LNG or scrubber systems), and a new fleet assignment. These measures are ranked in terms of their efficacy in environmental and economic terms. In addition, the paper considers certain policy measures that can be developed in order to ensure that maritime services will remain operational and not lose cargoes to landbased modes, as per the targets set by the European Union. The policy measures examined include the internalization of external costs for all transportation modes, the introduction of tax levies on land-based modes, the provision of subsidies to ship operators so that they can invest in abatement technologies, and finally the provision of subsidies to truck drivers that board vessels in a system similar to the ECO-bonus initiative.

The results indicate that should fuel prices increase to previous levels, many services will be at risk of closure if no measures are taken from both the regulatory bodies and the ship operators. The proposed measures are shown to be able to mitigate the negative effects of the low-sulphur requirements on Ro-Ro operators. The paper finishes off with a discussion on matching the more appropriate measures for the different services, and with what is to be anticipated following the global sulphur cap of 0.5% post-2020.

Sat. 26 Aug.
14:00-15:30
Aud.22

Studying Determinants of Compliance with Maritime Environmental Legislation in the North and Baltic Sea Area: A Model developed from Exploratory Qualitative Data

Thea Freese, Michael Gille, Andrew Hursthouse and John Struthers

Environmental legislation to protect North and Baltic Sea areas from harmful vessel-source emissions has received increased political attention in recent years. With the aim of fostering cleaner ship operations stricter legislation has been passed on the national and international level. Rules on sulphur and nitrogen oxide emissions, the introduction of invasive alien species through ballast water and other sources of pollution is currently being phased in or will come into force in the coming years. Legislative measures are expected to show positive effects on the health of the marine environment and society. Compliance will however increase the costs to industry to

a significant extent. In times of access supply of shipping capacity and dependant consolidation in the industry non-compliance with environmental rules is one way companies might try to stay competitive within their industry and vis--vis other transport modes. Around 5-15% of industry participants are believed to neglect rules on vessel-source pollution willingly or unwillingly. In this study, exploratory in-depth interviews were conducted with 12 experts from various stakeholder groups, including ship owners and operators, environmental organizations, legislative bodies, classification societies, trade associations and shipping personnel. The researchers aim was to collect information on variables influencing compliance rates, including awareness and apprehension, willingness to comply, ability to comply and effectiveness of controls. Semi-structured expert interviews were evaluated using qualitative content analysis. In result a model characterizing determinants of compliance was developed to be presented in this paper.

The large majority of vessel operators endeavour to achieve full compliance with environmental rules, but still some obstacles can be observed. A lack of availability of technical solutions may prove as much an unwilling hindrance to compliance as the feasibility of implementation and operation of systems or connected economic expediency of options. Next to unwilling non-compliance, ineffective systems of control are not persuasively discouraging willing non-compliance. While most ship operators are motivated to comply either by believing it is the right thing to do, or, more often, by believing they have no other option, motivations for non-compliance are also common. In the light of lacking time, financials or the absence of commercial advantages overall compliance levels tend to decrease. These and other variables were inductively developed from qualitative data and integrated into a model on environmental compliance. Results presented form part of a more comprehensive research project on economic effects of environmental legislation for the shipping industry. Insights on mechanisms of compliance might inform policy-makers about actual behavioural effects of environmental legislation and might further the development of a comprehensive legal system for environmental protection.

A comparison between EOQ and S-EOQ by logistics strategies under Emissions Trading System

Mi Rye Kim, Yong Jang Kwon and Suk Lee

Sat. 26 Aug.
14:00-15:30
Aud.22

In line with introduction of Emissions Trading System(ETS) from 2015 in South Korea, the environmental cost became important in logistics business. Hence, CO2 constraints in logistics business will need to be realized in the near future, the environment cost could be expected to reduce. In field of the agriculture logistics, operation cost, which is mainly composed of transportation cost, varies from 19million $/year to 48million $/year depending on whether or not the total cost includes environmental cost. So, for this reason, under the agriculture logistics circumstances, this paper aims at comparison of EOQ and environmental EOQ model under two different logistics strategies. Numerical examples are provided and the EOQ and S-EOQ medels are compared to confirm the differences between two models and provide the new environmental insight. Main results from the numerical examples

show that the S-EOQ model, over two logistics strategies considered, can make much more operation costs if remains traditional strategy.

S2C - Risk management & Real options (Aud.23)
Chair: Cristinca Fulga

Sat. 26 Aug.
14:00-15:30
Aud.23

Modeling and managing risk using portfolio optimization techniques for maritime systems

Cristinca Fulga

In this talk, we present an integrated methodological approach for selecting portfolios which is focused on incorporation of investors preferences in the Mean-Risk framework. Our goal is to propose an alternative methodology for defining, measuring and optimizing risk that addresses some of the conceptual shortcomings of the Mean-Risk framework such as the disregard of investor's attitude towards risk and implicit assumption of neutrality to loss aversion. The key in our proposed methodology is a risk measure called Expected Shortfall with Loss Aversion (ESLA) that, for continuous return distribution functions, can be represented in terms of the conditional expectation of the distribution tail, where the tail is determined by the critical return level characterizing the loss-averse investor. Our contributions can be summarized as follows. We begin by defining ESLA, then we show the relations of the proposed risk measure with Conditional Value at Risk (CVaR), and Lower Partial Moment of first order (LPM1), establish its properties, study the link with stochastic dominance of first and second order criteria, and discuss practical aspects regarding the calculation in the case of scenario-based portfolio optimization. Next, we describe the portfolio selection methodology in two stages in which investor's loss aversion is fully taken into consideration: firstly, the investment opportunity set is determined (in our case, the Mean-ESLA efficient frontier), and secondly, one single preferred portfolio is selected from the efficient frontier. We consider three types of investors characterized by three different classes of utility functions with loss aversion. The empirical study is targeted on assessing the differences between the Mean-ESLA efficient frontier and the classical Mean-Variance, Mean-CVaR and Mean-LPM1 frontiers. We measure the loss of welfare incurred by using another model instead of the proposed one using a proximity index in the Expected Utility framework. Then, in order to assess how much the portfolios really differ in terms of their compositions, we use a dissimilarity index based on the l1 norm. We also were concerned by the role and influence of loss aversion parameters values and constraints. A test was performed to study how the models behave when using various constraints. Firstly, the usual non-negativity constraint was replaced by a set of box constraints. As expected, as a result of shrinking the interval of variation of each security and consequently reducing the feasible region, the similarity increases. For the final test, it is assumed that short selling is allowed. As we expect, in this

case the values of the dissimilarity indices increase compared with the other types of constraints. The analysis shows that the proposed model is not dominated by any of the classical models. Moreover, the optimal/efficient solutions of the Mean-ESLA model differ markedly from the classical models Mean-Variance, Mean-CVaR and Mean-LPM1 as the dissimilarity indices show and, in terms of utility, Mean-ESLA is frequently similar, but also sometimes preferred to classical models. An application of the model to maritime systems is presented.

The Event Study of Oil Price Shocks on Stock Returns of Transportation Industry in Taiwan

Sat. 26 Aug.
14:00-15:30
Aud.23

Tsai Bi-Huei

This paper examines the impact of crude oil price shocks on stock returns of transportation industry, including air, maritime and land transportation companies in Taiwan. By using daily data on average crude oil prices of West Texas Intermediate, Brent, Dubai and Amman from the beginning of January 2010 to the end of December 2014. The increases (decreases) of daily oil prices up to 4% are regarded as substantial oil crude change events and summarize 7 events in our research. We compute abnormal returns and cumulative abnormal returns for 13 transportation companies at the time of the oil price change using the event study methodology. The results show that the significantly positive abnormal returns of transportation companies increase when oil prices decreases. This implies that investors regard oil price drop as a good news and efficiently respond the oil price drop. Investors expect that oil price drop lead to the cost reduction of transportation industry, so the profit and stock price of transportation industry increases. However, the results do not show significantly negative abnormal returns of air, maritime and land transportation companies when oil prices significantly increase. Because the demand elasticity of oil is small, consumers still need to take airlines, bus and boats. When oil prices increases, there is no significant decline of the abnormal returns of transportation companies.

Valuation of Rapid Reconfiguration: A Case from Bulbous Bows in Container Shipping

Sat. 26 Aug.
14:00-15:30
Aud.23

Jon Leonhardsen, Carl Fredrik Rehn, Bjørn Egil Asbjørnslett and Stein Ove Erikstad

In this paper, we investigate the potential economic value of being able to rapidly reconfigure the bulbous bow to handle variations in physical operating conditions in container shipping. The bulbous bows primary purpose is to reduce a ships resistance, by generating a wave pattern with destructive interference properties. Bulbous bows have traditionally been designed and optimized for a fixed intended service speed and draught. However, in real life, these factors vary significantly as ships operate in uncertain markets, taking on a broad spectrum of trades in different

basins. This analysis will focus on speed, which may vary on a trip-to-trip basis, or on longer time scales. An example of the latter is slow steaming, which has led to several bulbous bow retrofits over the past years.

Recent design developments, including retrofits, have been towards designing the bulbous bow for a broader range of operating conditions, i.e. robust design. This strategy is more forgiving over the entire operating profile, but is essentially suboptimal for each speed scenario. In this paper, we present an analysis of the expected saved fuel costs of having a flexible bulbous bow that can be rapidly reconfigured for container ships, and base the analysis on historical Automatic Identification System (AIS) data.

Analyses of AIS data reveal significant variations in operating speed over the whole spectrum of frequencies. There are variations in speed in the shorter-term time domain, from trade to trade and during transits, and in the longer time domain due to fundamental changes in the shipping market, such as slow steaming. A flexible bulbous bow entails a fully reversible reconfiguration option, allowing decision makers to continuously accommodate for changes in the operating environment. Obviously, the level of flexibility is bounded by technical and economical feasibility, and in this analysis, we consider a feasible flexible case and compare it to a benchmark optimized and a robust bulbous bow. The suitable flexibility is driven by the nature of the uncertain operating environment. Hence, this paper suggests a data-driven approach, based on statistical characteristics retrieved from AIS data. The main focus is to address the marginal cost of increased time-lag, that is the reconfiguration completion time, and we evaluate the expected fuel savings for different switching frequencies.

Sat. 26 Aug.
14:00-15:30
Aud.23

Agility and investment lags in fleet expansion a case from bulk shipping

Carsten Christensen, Carl Fredrik Rehn, Roar Ådland, Bjørn Egil Asbjørnslett, Stein Ove Erikstad and Stein-Erik Fleten

The aim of this research is to study the value of agility, and costs of investment lags, for fleets operating in uncertain market conditions. Quickly adapting to changing market conditions is crucial for every firm, and especially in volatile and capital intensive markets. These are two characteristics of the shipping industry. In this paper, a generalized real options approach is developed, where the investment lag is included as a parameter, to study agility and time lags in a bulk shipping fleet expansion case.

Agility represents the ability of a system to change quickly, and an investment lag is the time from the decision is made until the system has changed capabilities. All investments have lags to some degree, which is often disregarded in traditional real options analyses. For systems with relatively long time lags, there is a need to better understand the impact of these lags.

Currently, maritime fleet expansion usually relies on either newbuilding or acquisition on the second-hand market. A time lag of 2-3 years between a newbuilding order and the delivery of the vessel can, through the market uncertainty, change a good investment decision to a bad one. Second hand values can in many occasions

be a substitute with closer delivery, and thus reduce the investment lags and uncertainty. The analysis presented investigates the value of different levels of agility, between immediate change and a three-years lag, and therefore potentially identify new strategies of fleet management in the bulk market. This may include rapid conversion of other vessels, elongation of current vessels, or use of oil bulk and ore (OBO) vessels.

By introducing the investment time lag as a parameter in the real option model, the value of the fleet expansion option can be considered as a function of investment lag. The analysis is conducted in several steps, with increasing degree of complexity. First, through a now-or-never investment analysis, thereafter through including investment timing flexibility based on least squares Monte Carlo simulation. The bulk market is modelled as a stochastic process, calibrated using historical data. The analysis also opens for investigating the historical relationship between newbuilding prices, and the price development of second-hand vessel due to the value of agility.

S2D - Ports & Containers 2 (Aud.24)
Chair: Elen Twrdy

Competition between containers ports in Mediterranean

Elen Twrdy and Milan Batista

Sat. 26 Aug.
14:00-15:30
Aud.24

According to data the European ports with higher growth of container throughput in last ten years are the ports in Mediterranean Sea (Med). The reasons for this were different: impact of globalisation, good geographical location of ports, increasing size of container ships calling this ports, new infrastructure in the hinterland, relocation of industry in Europe. The ports that were able to follow this fast progress and to adjust all technology and process to the new environment now compete with the other main EU ports, like are ports in the Le Havre - Hamburg region.

In this paper we analysed the containers throughput in Med ports by several methods and in this way we obtain useful informations about container market in Med, position of individual port and their possible relationships. Models are prepared based on available containers throughput data and they describe the dynamic of container throughput in selected Med ports. To present a detailed analysis on dynamics of containers in Med ports we used some well know methods as are portfolio analysis, market share analysis and shift-share analysis. To prepare relevant models we used a simple Markov chain method to predict behaviour of this ports with respect to the identified trends in containers traffic and Lotka-Volterra dynamical model to identify possible competition/cooperation relationship between ports.

Sat. 26 Aug.
14:00-15:30
Aud.24

Chassis Management at U.S Container Ports

Manwo Ng and Wayne K. Talley

Recently, marine container chassis have emerged at the forefront of container port operations in the U.S, after shipping lines stopped providing chassis as part of their service. With the operation and management responsibilities transferred to new parties, chassis dislocation has been a major problem across the U.S. To ensure chassis availability, one response has been the creation of so-called neutral chassis pools, introducing new planning and management challenges. This paper presents a mathematical model that can be used to objectively support decision making in an era of neutral chassis pools. An empirical case study is provided to illustrate the model.

Sat. 26 Aug.
14:00-15:30
Aud.24

Value stream mapping of container flows in the Port of Gothenburg

Violeta Roso, Sofie Franzén, Linnea Streling, Christian Finnsgård, Vendela Santén and Martin Svanberg

The port of Gothenburg is the largest container port in Scandinavia, handling approximately 60% of the maritime container traffic in Sweden. The port distinguishes itself as one of the few in the world moving more than 40% of the container volumes to/from the port by rail. APM terminal handles the majority of these containers and despite successful movement of the container in and out of the port, delays occur. Containers not being delivered on schedule cause ripple effects throughout the supply chain. Ports experience an increase pressure to reduce container terminal costs and improve operational efficiency; in addition, shippers generally seek single supplier contracts for carriers that could provide both efficient and cost effective services. As a result, carriers search for ways to reduce costs and efficiency gains at the ports they call at, with single sourcing across ports in terms of port terminal operations becoming more common and thus it is important for ports to become more efficient in their operations. Hence, the main focus on ports should be on creating value rather than costs. In order to improve the efficiency in ports Value Stream Mapping (VSM) could be used. Therefore, the purpose of this study is to identify the considerations for adapting Value Stream Mapping to investigate how the flow of containers at the port container terminal can be improved.

Data for the studies shall be collected through face-to-face interviews with port container terminal employees directly involved in container handling operations and administration, as well as mapping of the actual container flows in the port. Literature reviews related to the subject have been carried out prior to the field study that includes observations as well. In addition, a number of secondary sources were used, such as reports and internal documents.

The paper highlights the potential for use of VSM for container flows at seaports as well as important role lean container flows might play to increase the competitive advantage for the seaports. Furthermore, the study also highlights the effects of containers not being delivered on time either from maritime or hinterland side.

Main references:

Cullinane, K. and Song, D. (2002). Port privatisation policy and practice. Transport Reviews, Vol. 22 No. 1.

Mangan, J., Lalwani, C., & Fynes, B. (2008). Port-centric logistics. The International Journal of Logistics Management, 19(1), 29-41.

Schoyen, H. & Odeck, J. (2016) Comparing the productivity of Norwegian and some Nordic and UK container ports An application of Malmquist Productivity Index. International Journal of Shipping and Transport Logistics, Vol. 1/1.

Serrano Lasa, I., Castro, R. D., & Laburu, C. O. (2009). Extent of the use of Lean concepts proposed for a value stream mapping application. Production Planning & Control, 20(1), 82-98.

Port competition in Northwestern Europe: a case study

Nemanja Milovanovic

Sat. 26 Aug.
14:00-15:30
Aud.24

For a container terminal operator it is always important to stay on top of call size development and port call frequency to stay ahead of competitors. This is especially true with the emergence of the ultra large container ship (ULCS), as the call size is likely to increase, which may strain terminal operators. On top of that, we also expect the use of ULCSs to influence vessel routing, and port call frequency.

In this research, we investigate these suspicions by doing a case study in port competition for Northwestern Europe, where we focus on various factors that we suspect may influence carriers liner network designs, such as fuel price and fluctuations in demand. To this end, a mathematical model is used to construct an optimal liner network, given a certain scenario as input. In this model we do not only take into consideration demand at ports, but we also take into account freight demand in certain Hinterland regions in the Netherlands and Germany, as we suspect that this demand also has an impact on which port is called at in the liner network.

Author Index