

# Annual Report 2010

## Global Centre of Excellence Kyoto University - Centre for Maritime Studies National University of Singapore Transport Logistics Joint Research Centre

(For period 1 April 2010 to 31 March 2011)

This report covers the research activities of the GCOE Kyoto University-CMS NUS Joint Research Centre of Transport Logistics for the period from 1 April 2010 to 31 March 2011. The memorandum of understanding for the research collaboration and establishing of the GCOE-CMS Transport Logistics Joint Research Centre was signed on 1 October 2008.

### 1. Description of Research Areas

The research activities of the Joint Research Centre during the period of review focus on the following four areas: (a) Multimodal freight transport simulation, (b) Electronic road pricing studies, and (c) Quantitative risk assessment on Singapore Port and Straits of Malacca.

#### *(a) Multimodal Freight Transport Simulation*

In this project, the current research emphasis is on simulation of the land-sea intermodal freight handling of a container port. Although there are many commercial simulation softwares such as Arena, Anylogic, Automod, Extend, Em-plant, Flexsim, Promodel, Witness, Swarm, Netlogo, Repast, etc. available in the market, most of them are used for building industrial models. The details of the lower level implementation are hidden to users; and many algorithms especially for realtime decision making algorithms, such as vehicle dispatch, yard crane dispatch, etc. are provided for very limited customization applications. They are short of certain generality and flexibility, such as using plug-and-play alternative algorithms and external mathematical solvers.

The proposed simulation software for port operations is based on the actual layout of terminals. The key elements of this simulation include berth length, container yard, quay cranes, yard cranes and yard trucks. Unlike other simulation software, the proposed simulation software will be developed using open architecture. This will lead to advantages such as flexibility and portability. It will be customized according to user's needs for the port community, with consideration of maintaining a high level user friendliness and time efficiency.

#### *(b) Electronic Road Pricing Studies*

Cordon-based congestion pricing scheme is an effective toll to ameliorate traffic congestions in Central Business District (CBD) of modern cities, in view of many practices in Singapore, London and Scandinavia. A pricing cordon refers to certain area in the CBD, each entry to which is levied by a toll charge. The toll design problem aims to determine toll charge on each entry of the cordons that can optimize a predetermined objective. Some system-wide indexes are

usually taken as such an objective, including total travel time, total social benefit and overall toll revenue. Focusing on the practical implementations of cordon-based congestion pricing scheme, our studies contribute to the toll design problem and theoretically analyze the impacts of congestion pricing on the transportation system.

***(c) Quantitative risk assessment on Singapore Port and Straits of Malacca***

The Straits of Malacca are one of the world's most important and busiest international waterways. This necessitates the conclusion that safety issues are of utmost concern in view of their importance to the global economy. They are a key waterway linking the Indian and Pacific Oceans, offering a convenient shipping passage for sea freight between East Asia and Europe, as well as West and South Asia. In addition, the strategic importance of the straits is significantly enhanced with the presence of excellent port services provided by three major ports along the straits, making it a regional logical logistics hub for the ten Southeast Asian countries, and a global shipping and logistics center serving a shipping traffic network covering Asia, Europe, Australia/Oceania, and Africa.

The globally strategic importance of the Straits of Malacca and Singapore is borne out by the fact that it is the energy, trade and logistics gateway to the world's most populous regions of East Asia, South Asia, and Southeast Asia. About 70,000 ships carrying one-quarter of the world's commerce and half of the world's oil pass through the Straits each year. A disruption of the Straits by either man-made or natural hazards would have wide ranging economic impacts of a global scale.

## **2. Organization of Events**

During the period covered by this report, the GCOE-CMS Joint Research Centre organized the following events:

**(a) Straits of Malacca & Singapore as a Global Maritime Critical Infrastructure Workshop**

This workshop, organized by the Global Centre of Excellence (GCOE) Kyoto University – Centre for Maritime Studies (CMS) National University of Singapore Transport Logistics Joint Research Centre, was held on 30th April 2010, at the CMS Conference Room. Participants came not only from Singapore and Japan, but also from other parts of the world including Malaysia, Indonesia, Korea, Canada, France and Switzerland. They included researchers, academics, industry stakeholders, government personnel, port authority personnel and consultants.

The workshop opened with welcome addresses by the Centre for Maritime Studies and Kyoto University, which also laid the background for the workshop and emphasized the importance and significance of the workshop's topic at hand. Following that was a day of presentations, discussions and sharing of thoughts and insights. A total of 11 speakers made presentations on their relevant area of expertise. The presentations are as listed below.

Presentation 1: Challenges to Governance of Global Critical Infrastructures by Prof. Wolfgang Kroeger.

Presentation 2: Straits of Malacca and Singapore as a Global Maritime Critical Infrastructure by Mr. Arief H. Oegroseno.

Presentation 3: Risk Assessment of Shipping Traffic: Maritime Accidents by Prof. Ibrahim Mohamed.

Presentation 4: An Economic Impact Analysis of a Disruption of an International Port: Towards Disaster Risk Governance of Global Critical Infrastructure by Prof. Hirokazu Tatano.

Presentation 5: Straits of Malacca & Singapore as a Global Maritime Critical Infrastructure by Prof. Sutanto Soehodho.

Presentation 6: Meteorological and/or Climatic Events/Hazards on the Operation of Global Hub-Port System (Busan) by Prof. Cheong-Ro Ryu.

Presentation 7: Conflict Resolution within a System of Systems Engineering Perspective by Prof. Keith W. Hipel.

Presentation 8: External Hazards and Natech Risks by Dr. Ana Maria Cruz.

Presentation 9: Economic Impacts of a Blockade in Straits of Malacca by Prof. Seevaratnam Vijayakala.

Presentation 10: Quantitative Risk Assessment for Maritime Transportation: State of the Art by Dr. Li Suyi.

Presentation 11: Location-Routing Problem for Liner Shipping Service by Dr. Lu Kebo.

**(b) Task Force Meeting for Straits of Malacca & Singapore as a Global Maritime Critical Infrastructure Workshop**

On May 1, 2010, participants were invited to join a post-workshop Task Force Meeting to discuss the following:

- 1) Identifying agenda for 2nd IRGC-KU Policy Dialogue Workshop
- 2) Brainstorming and preparing for the Workshop

A total of 15 participants attended the meeting.

**(c) The Fourth Workshop on Transport Logistics**

Global Centre of Excellence (GCOE) Kyoto University – Centre for Maritime Studies (CMS) National University of Singapore Transport Logistics Joint Research Centre jointly with Kyoto University Global COE Program “Global Center for Education and Research on Human Security Engineering for Asian Megacities organized The Fourth Workshop on Transport Logistics on 27th September 2010 at Katsura Campus, Kyoto University. Several researchers from three institutions, Kyoto University, National University of Singapore and Monash University participated in the workshop.

The workshop started with welcome addresses from Prof. Eiichi Taniguchi (Kyoto University) and Prof. Tien F. Fwa (National University of Singapore). It was then followed by a series of presentations as listed below:

Presentation 1: “City Logistics Policies – Overview” by Prof. Eiichi Taniguchi (Kyoto University)

Presentation 2: “Transport Logistics Issues of Port Cities” by Prof. Tien F. Fwa (National University of Singapore)

Presentation 3: “Method of Extracting Characteristics of Truck Road Usage from GPS Data” by Prof. Takayoshi Yokota (Kyoto University)

Presentation 4: “Model and Algorithm for Intermodal Hub-and-Spoke Network Design with Stochastic Equilibrium Flows” by Prof. Qiang Meng (National University of Singapore)

Presentation 5: “Estimating Personal Physical Activity from Transport” by Dr. Russell G. Thompson (Monash University)

Presentation 6: “Conflict Analysis for Mixed Traffic Flow with Motorcycle” by Prof. Yasuhiro Shiomi (Kyoto University)

Presentation 7: “Exact Solution of the Dynamic Vehicle Routing Problem with Soft Time Windows” by Prof. Ali G. Qureshi (Kyoto University)

Presentation 8: “Speed-based Toll Design for Congestion Pricing” by Mr. Zhiyuan Liu (National University of Singapore)

Presentation 9: “A Route Choice Model based on Evolutionary Game Theory considering the Travel Time Reliability and Traffic Impediments” by Mr. Naohiro Uchiyama (Kyoto University)

Presentation 10: “Fuel Consumption Prediction Model for “ECO” Route Search” by Ms. Mariko Okude (Kyoto University)

**(d) 2<sup>nd</sup> International Workshop on Risk Governance of the Maritime Global Critical Infrastructure**

Global Centre of Excellence (GCOE) Kyoto University – Centre for Maritime Studies (CMS) National University of Singapore Transport Logistics Joint Research Centre jointly with Disaster Prevention Research Institute, Kyoto University (DPRI), International Risk Governance Council (IRGC) organized the 2<sup>nd</sup> International Workshop on Risk Governance of the Maritime Global Critical Infrastructure on 6th to 7th November 2010 at Wood Composite Hall, Uji Campus, Kyoto University.

A total of 44 participants attended the workshop. Participation from private shipping companies and government officials in addition to researchers in the field made the workshop successful to achieve its objectives.

**(e) Research seminars in Transport Logistics**

A research seminar is organized in Kyoto University which was opened to all GCOE members and to JSCE Infrastructure planning group. Also several research seminars are organized in NUS which are open to all academic departments within NUS to encourage interaction and exchange of ideas. Faculty members, researchers, and graduate research students of the following NUS academic departments have participated in the seminar series: Departments of Civil Engineering, Department of Decision Sciences, Department of Economics, Department of Industrial & Systems Engineering, and the School of Computing. The following research seminars were held during the period covered by this report:

<b>DATE</b>	<b>TOPIC &amp; SPEAKER</b>	<b>ATTENDEES</b>	<b>PLACE</b>
1st April 2010	International Container Flow Modeling and Application by Mr Wang Shuaian	16	NUS
15th April 2010	Simulation of Port Operations for Port Analysis Using MicroPort by Ms Bagga Geeta & Miss Fiora Li	18	NUS
23rd April 2010	Implementation of the Emission Trading Scheme in the Maritime Industry: An Experimental Analysis by Mr Chua Thiam Hao	27	NUS
12th August 2010	General Model for Multi-period Sea Cargo Mix Scheduling in Liner Shipping Industry by Dr Li Rongheng	11	NUS
19th August 2010	Quantitative Risk Assessment Model Development for the Straits of Malacca and Singapore by Mr Li Suyi	13	NUS
2nd September 2010	Optimizing Yard Layout in Container Terminals by Dr Lee Byung Kwon	15	NUS
9th September 2010	Bi-Modal terminal and Mid-corridor connect intermodal solutions – A new leap in Freight Productivity		KU
9th September 2010	Maritime Piracy in Somalia & Gulf of Aden: International Legal Challenges by Ms Ticy V Thomas	11	NUS

16th September 2010	A Simulation Framework for Mega-sized Container Terminals by Dr Sun Zhuo	9	NUS
23rd September 2010	Carbon Footprinting Project for Jurong Port Mr Calvin by Tan Jia En	21	NUS
30th September 2010	The Preliminary Overview of Jurong Port by Miss Hu Dan	16	NUS
7th October 2010	Route Design for Liner Shipping Service Dr Lu Kebo	17	NUS
21st October 2010	Sector-based Risk Evaluation for the Singapore Strait by Mr Qu Xiaobo	15	NUS
28th October 2010	The Development of Floating Transshippers as Alternatives to Bulk Terminal in Asia by Mr Chung Chee Kit	22	NUS
4th November 2010	Road Transportation in Singapore by Mr Kusuhiko Okabayashi	12	NUS
	Applying ERP System to Urban Areas in Tokyo by Mr Shogo Ogawa		NUS
11th November 2010	Two Kinds of Fuzzy Logic Controllers for Dynamic Positioning Systems by Mr Chen Xuetao	15	NUS
13th December 2010	Service Trade of Japan: A Critical Survey by Professor Shigeyuki Abe	13	NUS
20th January 2011	Sample Average Approximation Method for SMPEC Problem and CVaR Optimization by Dr Meng Fanwen	9	NUS
21st January 2011	The Seminar on an Instrumented Traffic Information Platform for Human Security Engineering by Dr. Russell G. Thompson and Dr. Majid Sarvi	16	KU
27th January 2011	Emission Accounting and Analysis Framework for Ports by Mr. Li Juxin	13	NUS
17th February 2011	Japanese Port Development and Management System by Dr. Hiroyuki Nishijima	18	NUS
24 February 2011	Changing port-city relations at Amsterdam: A new phase at the interface? by Dr Bart W Wiegman	22	NUS
1 March 2011	Discussion forum: 1. Ports, maritime terminals and deep-sea; 2. Intermodal (inland waterway, rail, inland terminals) by Dr Bart W Wiegman	13	NUS
3rd March 2011	Port and terminal selection by deep-sea container operators by Dr Bart W Wiegman	20	NUS
10th March 2011	A framework of Global Freight Demand Forecasting - begin from Mode Choice Modelling by Dr Yang Dong	18	NUS
17th March 2011	Post Port Visit Discussion by Prof Tan Kok Choon	22	NUS
24th March 2011	Liner shipping network design under hub-and-spoke operation with multiple allocation Dr Zheng Jianfeng	22	NUS
31st March 2011	Quantitative Risk Assessment Model for the Straits of Malacca and Singapore – Model development and case study by Mr Li Suyi		NUS

### **3. Participation in Events**

Researchers of the Joint Research Centre participated in various events during the period of report as recorded below:

#### **Papers presented by NUS researchers**

- 1) Prof Meng Qiang participated in the International Symposium on Maritime Logistics and Supply Chain Systems, 23-24 April 2009, Riverview Hotel, Singapore and presented the following papers: “A Linearized Approach for the Liner Ship Fleet Planning with Demand Uncertainty.”
- 2) Prof Meng Qiang participated in the 8th EASTS Conference, 16-19 Nov 2009, Surabaya, Indonesia and presented a paper on “Development of a Novel Quantitative Risk Assessment Software Tool for Road Tunnels.”
- 3) Dr Lu, K. participated in the GCOE Kyoto University - Centre for Maritime Studies NUS, Transport Logistics Joint Research Centre, Regional Cluster Meeting on Straits of Malacca & Singapore as a Global Maritime Critical Infrastructure (MGCI) held in Singapore 30 April - 1 May 2010 and presented a paper on “Location-routing Problem for Liner Shipping Service.”
- 4) Prof Meng Qiang participated in the 7th Triennial Symposium on Transportation Analysis (TRISTAN), 20-25 June 2010, Rica Ishavshotel, Tromso, Norway and presented a paper on “A Long-term Liner Ship Fleet Planning Problem with Container Shipment Demand Uncertainty.”
- 5) Prof Meng Qiang and Lu, K. participated in the International Association of Maritime Economists (IAME), 2010 Annual Conference of the International Association of Maritime Economists. Lisbon, Portugal 7-9 July 2010 and presented a paper on “Liner Shipping Network Capacity Reliability Analysis.”
- 6) Prof Meng Qiang participated in the 12th World Conference on Transportation Research, 11-15 July 2010, Lisboa Congress Center, Lisbon, Portugal and presented a paper on “Availability of Trial-and-effort Method for the Cordon-based Congestion Pricing Scheme with Probit-based Stochastic User Equilibrium Constraints.”
- 7) Prof Meng Qiang participated in the 1st International Conference on Logistics and Maritime Systems held in Busan, South Korea, 15-17 Sept 2010 and presented a paper on “Liner Ship Fleet Deployment with Container Transshipment and Demand Uncertainty.”
- 8) Prof Meng Qiang participated in the 90th Annual Meeting of Transportation Research Board held in Washington, D.C. 23-27 January 2011 and presented a paper on “Schedule Design and Container Routing in Liner Shipping.”

## **Papers presented by Kyoto University researchers**

- 1) Ms. Antal van Kolck participated in the The 3<sup>rd</sup> International Conference on Transportation and Logistics held in Fukuoka, Japan, 6-8 September 2010 and presented a paper “Multi-agent model for a dynamic urban distribution center.”
- 2) Prof. Eiichi Taniguchi participated in the 24th ARRB Conference held in Melbourne, Australia, 12-15 October 2010 and presented on “Sustainable network capacity – In case of freight transport” in the Plenary session.
- 3) Prof. Yasuhiro Shiomi participated in the AIT-KU Joint Symposium on Human Security Engineering for Asian Megacities held in Bangkok, Thailand, 25-26 November, 2010 and presented paper on “Conflict analysis for traffic flow dominated by motorcycles based on video image data”.
- 4) Dr. Kunnawee Kanitpong participated in the AIT-KU Joint Symposium on Human Security Engineering for Asian Megacities held in Bangkok, Thailand, 25-26 November, 2010 and presented paper on “Driver typology and speeding behavior in speed enforcement zone”.
- 5) Prof. Eiichi Taniguchi participated the 90th TRB Annual Meeting held in Washington D. C. USA, 23-27 January 2011 and presented a poster on “Estimating benefits of considering travel time variability in urban distribution”.

## **4. Published Papers**

### **Papers by NUS researchers**

- 1) Meng, Q. and Wang, T.S., 2010. A chance constrained programming model for short-term liner ship fleet planning problems. *Maritime Policy and Management*, 37(4), pp.329-346, 4 July 2010.
- 2) Meng, Q. and Khoo, H. L. (2010). A Pareto optimization Approach for A Fair Ramp Metering. *Transportation Research Part C Emerging Technologies*, 18, No.4, 489-506, August 2010.
- 3) Lee, D.H. and Meng, Q. (2010). Origin-Based Partial Linearized Method for the Stochastic User Equilibrium Traffic Assignment Problem”. *Journal of Transportation Engineering-ASCE*, 136, no. 1 (2010): 52-60. (United States).
- 4) Wang, X. and Meng, Q., The impact of landbridge on the market shares of Asian ports. *Transportation Research Part E*. (2011) 190-203.
- 5) Meng, Q. and Wang, T. , A Scenario-based dynamic programming model for multi-period liner ship fleet planning. *Transportation Research Part E*. (2011) 401-413.



- 6) Meng, Q. and Wang, S., Liner shipping service network design with empty container repositioning. *Transportation Research Record*. (2011) Accepted in Press.
- 7) Meng, Q. and Wang, X.C., Utility-based probabilistic port hinterland estimation for intermodal freight transportation networks. *Transportation Research Record*. (2010).

### **Papers by Kyoto University researchers**

- 1) Qureshi, A. G., Taniguchi, E. and Yamada, T. (2010). A column generation based approach for the dynamic vehicle routing and scheduling problem with soft time windows. *TRISTAN VII*. June 20-25, Tromso, Norway.
- 2) Ando, N., Arima, K., Taniguchi, E. and Yamada, T. (2010). Evaluating routes on urban road network using mean-variance approach. *4th International Symposium on Transportation Network Reliability*. June 22-23, Minneapolis, USA.
- 3) Uchiyama, N. and Taniguchi, E. (2010). A route choice model based on evolutionary game theory considering the travel time reliability and traffic impediments. *12th WCTR*. July 11-15, Lisbon, Portugal.
- 4) Qureshi, A. G., Taniguchi, E. and Yamada, T. (2010). An analysis of VRPTW exact solutions based on realistic logistics instances. *EProceedings of The 3rd International Conference on Transportation and Logistics*. September 6-8, Fukuoka, Japan.
- 5) Maruyama, A., Taniguchi, E., Yamada, T. and Ando, N. (2010). 近赤外分光法を用いた脳血流動態測定による都市内道路の走りやすさ評価に関する研究. *第30回交通工学研究発表会論文集*. September 21-22, Tokyo, Japan.
- 6) Yamaba, Y., Taniguchi, E. and Qureshi, A. G. (2010). A study on evaluation of distribution policies considering behavior of transportation companies. *Proceedings of 9th ITS Symposium*. December 10-11, Kyoto, Japan.
- 7) Qureshi, A. G., Taniguchi, E. and Yamada, T. (2010). Column generation-based heuristics for vehicle routing problem with soft time windows. *Journal of the Eastern Asia Society for Transportation Studies*, 8, 827-841.
- 8) Pradhananga, R., Taniguchi, E. and Yamada, T. (2010). Optimization of vehicle routing and scheduling problem with time window constraints in hazardous material transportation. *Journal of the Eastern Asia Society for Transportation Studies*, 8, 790-803.
- 9) Pradhananga, R., Taniguchi, E. and Yamada, T. (2010). Ant colony system based routing and scheduling for hazardous material transportation. *Procedia-Social and Behavioral Sciences*, 2(3), 6097-6108.

- 10) Ando, N., Arima, K., Nakamura, Y., Yamada, T. and Taniguchi, E. (2010). A route choice model considering mean travel time and its variance on road networks. *Infrastructure Planning Review*, 27(4), 779-785.
- 11) Qureshi, A. G., Schreiner, S., Taniguchi, E. and Yamada, T. (2010). Vehicle routing problem with soft time windows and path choice. *Infrastructure Planning Review*, 27(4).
- 12) Thompson, R. G., Taniguchi, E. and Yamada, T. (2011). Estimating benefits of considering travel time variability in urban distribution. *Transportation Research Record*. Accepted (In press).

## **5. Progress and Findings of Research**

The progress and findings of the research activities in the main focus areas of the Joint Research Centre are presented in this section.

### ***(a) Multimodal Freight Transport Simulation***

The simulation software being developed is called MicroPort. A “Workspace” has been developed which contains ‘Modules’, ‘Data’ and ‘Maps’. ‘Modules’ loads all the library files needed for simulation. All the shape files (.shp) are loaded under ‘Data’. Maps under workspace provide layers for image and shape files. There is also a “Message window” that shows the result of simulation. In addition, a “Properties window” shows the property of the object selected in Workspace. A “Map window” serving as the main window is for loading image, resizing it and viewing the simulation.

The menu bar on the top of the image contains ‘File’, ‘Modules’, ‘Map’ and ‘window’. All the fields describe the general function of the Microport. User can click and explore the menu bar fields.

Currently, Microport mainly supports several data files: ESRI Shapes file (\*.shp), Grids file (\*.sgrd), Table file (\*.dbf) and Tab separated txt file (\*.txt). These data file can be opened and manipulated through data window and controlled by Microport Script thereafter. It will be very convenient to use a project file (\*.mprj) to save or load a set of data files, module files and all their settings. There is a sample project (sample.mprj) for testing which is located at samples folder in the MicroCity install directory.

### ***(b) Electronic Road Pricing Studies***

Different toll charges would affect the commuters’ pre-trip route plans and thus lead to different equilibrium flows. Thereby, investigations of commuters’ travel behavior are crucial for the toll design problem. In our studies, a simple and rational assumption is made on the commuter’s travel behavior that they would select the path with minimal travel cost. A normally distributed

error is allowed for the commuters' perceived travel time. In addition, the toll charges have different impacts to each commuter, due to their diverse income level. Thus, a continuously distributed value-of-time is further assumed to reflect this diversity. A convergent algorithm is proposed to solve the equilibrium flow in such a context based on any given toll-charge pattern, and it also enables the analysis of mode share of public transport system.

***(c) Quantitative risk assessment on Singapore Port and Straits of Malacca***

This research conducted a thorough search of the existing research work on suppressing hazards in the Straits of Malacca and Singapore. It employs a structured analysis of failures, including accidents and disasters, to establish the lessons learned. Risk assessment of such hazards, covering the occurring chances of each form of hazard, the likely degree of disruption, and the possible scale of their impacts will be determined. A methodology has been established to facilitate the determination of actions that would help to prevent a repetition by dealing with contributory root causes. It also provides a high level introduction of reliability assessment methods, including fault tree analysis, failure mode and effects analysis, consequence modelling and evaluation of the computed results. It also presents a methodology to identify the ownership of safety and risk.

**6. Planned Activities for 2011**

The following activities have been planned for the Joint Research Centre in 2011:

**(a) Publication of GCOE Text Book “Urban Transport and Logistics for Human Security”**

The joint research center brought out the first draft of the GCOE text book “Urban transport and logistics for human security” during GCOE-CMS Short- Course in Urban Transport and Logistics for Human Security organized in September, 2009 in Kyoto University. The joint research center has planned to finalize all contents and publish the text book in year 2011. However, the exact date of publication is still unknown.

**(b) AIT – ITB – NUS Joint Symposium**

The research center jointly with other GCOE overseas cooperation bases Asian Institute of Technology (AIT) and Bandung Institute of Technology (ITB) will organize a symposium in Bangkok, Thailand. The 2 day symposium will be organized at AIT in 17-18 November 2011.

**(c) The Fifth Workshop on Transport Logistics**

Following the four previous workshops on Transport Logistics, the joint research center will organize the fifth workshop on transport logistics in the year 2011. The details of the workshop including the exact date and venue will be decided soon.