Research Highlight 1: Multi-Criteria Evaluation Approach to Select a Suitable Market-Based Measure for Reducing CO2 Emissions in International Shipping, by Research Engineer Lee Xin Ni (Track Leader: Associate Professor NG Szu Hui)

Introduction

International Maritime Organization (IMO) has adopted the Initial IMO Strategy on reduction of GHG emissions from ships in efforts to curb the increasing CO2 emissions from international shipping sector. Essentially, the Strategy aims for carbon intensity of international shipping to decline and for GHG emissions from international shipping to peak and decline. Unfortunately, existing technical and operational measures for the sector are unlikely to achieve these ambitions. In order to meet the shortfall, the sector would need to consider alternate fuels and Market-Based Measures (MBMs). This study focuses on MBM as a policy to reduce CO2 emissions in international shipping.

The key principle of MBMs is carbon pricing, which involves placing a price on activities that do not reflect environmental damages in price and may be under-charged from an environmental perspective. Such activity produces negative externality because the environmental pollution indirectly affects market players such as ship owners, ship operators, end consumers and so on. Hence, there is a need to factor the price of carbon emission into operations to internalize the external costs of emissions.

To understand how MBMs work, it is necessary to see their relationships with operational/behavior changes and technical measures. It is important to recognize that actual CO2 reduction can only take place via better technology use and behavior/operation changes. MBMs, by itself, does not directly reduce CO2 emissions. Rather, MBMs influence technology development by providing financial resources for R&D to advance low Technology Readiness Level (TRL) technologies to high TRL, alter the cost attractiveness of high TRL technologies to incentivize adoption of these technologies, or encourage behavior/operational changes that may reduce CO2 emission. These relationships are represented in the top white arrows in Fig 1. Legislation (such as Energy Efficiency Design Index or a CO2 reduction target) imposed directly on CO2 reduction will also create pressure for stakeholders to change behavior, adopt green technologies and/or conduct R&D. This effect is represented by the bottom black arrows in Fig 1.

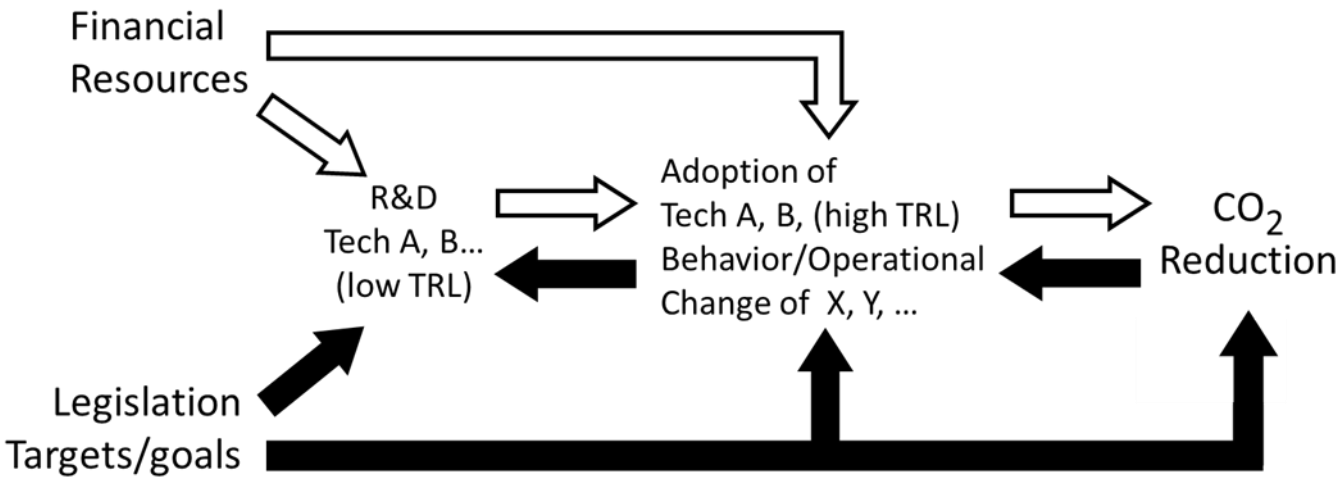

Fig 1: A Systems Perspective to Market-Based, Operational and Technical Measures

Research Objective and Approach

This study aims to determine a suitable MBM for international shipping. Generally, there are two types of MBM – tax

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Research Objective and Approach

and Emission Trading System (ETS). However, in literature, there are different propositions on a suitable MBM for international shipping – some support tax, others support ETS while the last group has a neutral stand. Hence, this study aims to find out – which MBM is suitable to reduce CO2 emissions for international shipping?

We approach the research by first, defining two fundamental types of MBIs for international shipping – bunker levy, a form of tax on fuel, and ETS. Next, key criteria used to assess MBMs are consolidated from various sources. Finally, we will evaluate the two MBMs based on these criteria to identify a suitable MBM for international shipping.

Defining Bunker Levy and Emission Trading System for International Shipping

To make a meaningful comparison between bunker levy and ETS for international shipping, it is essential to state their definitions and assumptions explicitly. This study defines bunker levy and ETS with the assumptions in Table 1. The assumptions are based on common practices and logical designs of existing carbon tax and ETS schemes, as well as relevant components of MBMs proposed at IMO. It is worth noting that the distribution of funds collected can be similar while the two differ in how they operate.

Table 1: Definitions and assumptions of bunker levy and ETS

Design elements	**Bunker levy** **Fixed CO_2 price but uncertain amount of emission**	**ETS** **Fixed cap on emission but uncertain CO_2 price**
Responsible entity	Bunker suppliers, port authorities	Shipping companies, new entity to administer[1], flag
Operation	• Bunker supplier pays port regulator a fixed $ per ton fuel sold. • Port regulator report $ collected to IMO[2].	• Ships are allocated credits for free at the start of the scheme. After a while, the credits are allocated through a mixture of free allocation and bidding. No revenue is generated when the credits are allocated for free to companies. • If emissions > credits surrendered at end-of-year, companies pay a fine X times of the carbon price or buy credits from other companies. • If emissions < credits, companies can bank credits for next year (with a finite life). • Possibility to set price floor and ceiling in carbon market • Ship owners are responsible to maintain a record of CO_2 emission (based on fuel used). • Flag states are responsible to conduct audit. • A new international entity is set up to administer the system.
Distribution of funds collected by IMO	• Shipping companies that adopt green technology • Countries that may be affected by this (e.g. end of route states, etc.) • Invest funds collected in R&D	

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Defining Bunker Levy and Emission Trading System for International Shipping

[1] ETS proposals submitted by Norway, UK and France suggests that emission credits will be surrendered by ship owners or ship operators. Norway has also suggested for a new international administration body to be set up to maintain the ETS Registry.

[2] MEPC 60/4/8 International GHG fund proposed a Contribution to Fund based on tonnes of bunker fuel purchased imposed on ship owner or bunker fuel supplier. Port State are to be involved in enforcement, collecting fees and passing it on to GHG Fund.

Creating Single-dimensional Operationalized Criteria for Comparison

To capture criteria that apply to international maritime and obey fundamental economic theories, important and common criteria from a range of institutes, including IMO and economics research organizations with deep research focus on territorial-based emissions, are consolidated. Based on literature, we have synthesized the following criteria. These criteria were operationalized into single-dimensional and measurable metrics, as shown in the shaded blue text boxes in Fig 2, to make meaningful and more conclusive comparison of the two MBMs.

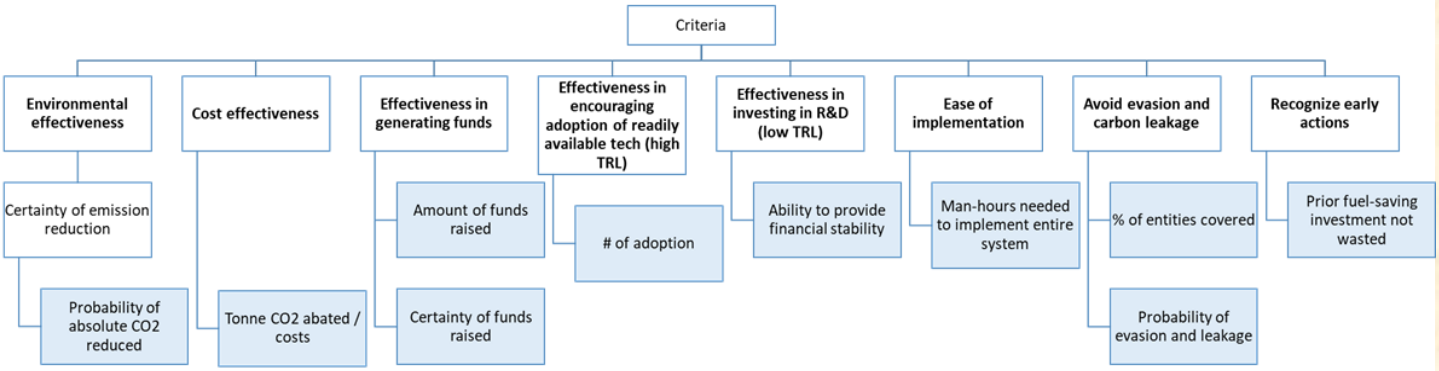

Fig 2: Overview of Single-dimensional Operationalized Criteria

Evaluation Results and Discussion

The defined bunker levy and ETS are compared along each single-dimensional operationalized criteria, as described in Table 2. A graphical summary of the comparison is presented in Fig 3.

Table 2: Criteria Evaluation of Bunker Levy and ETS

Criteria	Metric	Bunker levy	ETS	Note
Certainty of emission reduction	Probability of absolute CO_2 reduced	Reduction in absolute emissions is uncertain, but emission per unit of activity (e.g. mile travelled) might improve.	Certain emission with setting of cap and emission credits (if covered emitters fully complied).	ETS can allow more certain emission reduction level.
Effectiveness in generating funds	Amount of funds raised	Depends on the levy imposed and the amount of bunker sold.	Depends on total emissions reduction cap for the industry, transaction price of credit auctioned and fine imposed.	Inconclusive. It depends very much on the details. Based on economic theory, both can raise

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Evaluation Results and Discussion

Table 2: Criteria Evaluation of Bunker Levy and ETS (cont'd)

Effectiveness in generating funds (cont'd)	Certainty of funds raised	High certainty because of the fixed levy imposed on fuel sold.	Uncertain and depends on how the system is implemented i.e. % of credits auctioned: If credits are allocated for free, there is no revenue generated. If credits are allocated through auction, the revenue will depend on the outcome of the auction, and if a price floor is set. Given links with freight demand and CO_2 emissions, the CO_2 price is likely to follow same tendencies as the freight market.	the same amount of revenue. Bunker levy has a higher certainty.
Effectiveness in encouraging adoption of readily available tech (high TRL)	# of adoption	Depends on (cost and non-cost) attractiveness of technologies. Generally, ship owners and operators prefer certainty in order to make long-term capital investment.	Due to large carbon price uncertainty, investors are less able to do long term investment planning. Such delay can be costly due to the cumulative effect of CO_2.	From a business perspective, investors greatly value long-term carbon price stability for long term and large capital investment hence bunker levy is preferred.
Effectiveness in investing in R&D (low TRL)	Ability to provide financial stability	Ship owners, operators, and technology suppliers prefer certainty to make long-term R&D investment decision.	The uncertainty may deter ship owners and technology suppliers in pursuing promising R&D that are long term.	It seems that bunker levy, because of its higher certainty, is more likely to encourage long-term
Cost Effectiveness	Tonne CO_2 abated/total costs	Depends on the technology and operational measures adopted as actual CO_2 reduction can only happen via technology and behaviour/operational changes.		Inconclusive

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Evaluation Results and Discussion

Table 2: Criteria Evaluation of Bunker Levy and ETS (cont'd)

Ease of implementation	Man-hours needed to: 1. Set up procedures and MRV system 2. Train expertise in MRV 3. Collect fund 4. Distribute fund 5. Conduct MRV 6. Review 7. Adjust market price / quantity	According to IHS, there are 1041 bunker suppliers in the world.	Additional procedure of issuing the allowances, trading, monitoring compliance, avoiding fraud and others. ~50,000 ships trading internationally (Jan 16). For reference, EU ETS, largest ETS, covers ~11,000 installations. Large variability in fuel consumption of each ship requires a lot of man-hours to justify a fair allocation of credits.	Bunker levy is a lot easier to implement due to less entities involved and less man-hours needed.
Avoid evasion and carbon leakage	% of entities covered	Minimum carbon leakage if apply to all IMO-ships globally (via bunker suppliers).	Minimum carbon leakage if apply to all IMO-ships globally.	If apply to all applicable ships globally, there is minimum leakage.
	Probability of evasion and leakage	Subject to how well MRV can be implemented on bunker supplier.	Subject to how well the carbon credits can be fairly allocated, and how well MRV can be implemented.	Bunker levy is likely to have less problems with MRV because of the smaller number of entities involved.
Recognize early actions	Prior fuel-saving investment not wasted	All prior effort to improve energy efficiency will not be "discounted" because the bunker levy is imposed on the amount of fuel used. E.g., A ship made efficient prior to the enforcement of bunker levy will still benefit from requiring less bunker.	If credit allocation is set based on the best-performing ships, then ships that have adopted fuel efficiency early would be more likely to meet or be under the "cap".	While both schemes recognize early actions, the situation is more straightforward in bunker levy as no additional work is required.

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Evaluation Results and Discussion

Recognize early actions (cont'd)			However, ships may operate in very different environment each year and thus there might be no universal benchmark or 'cap' that can apply even to ships in the same category. If credit allocation is only based on previous yearly emissions of the ship, the policy would hardly recognize early actions.	In ETS, to recognize early actions, effort needs to be invested, potentially for every single ship.

Table 2: Criteria Evaluation of Bunker Levy and ETS (cont'd)

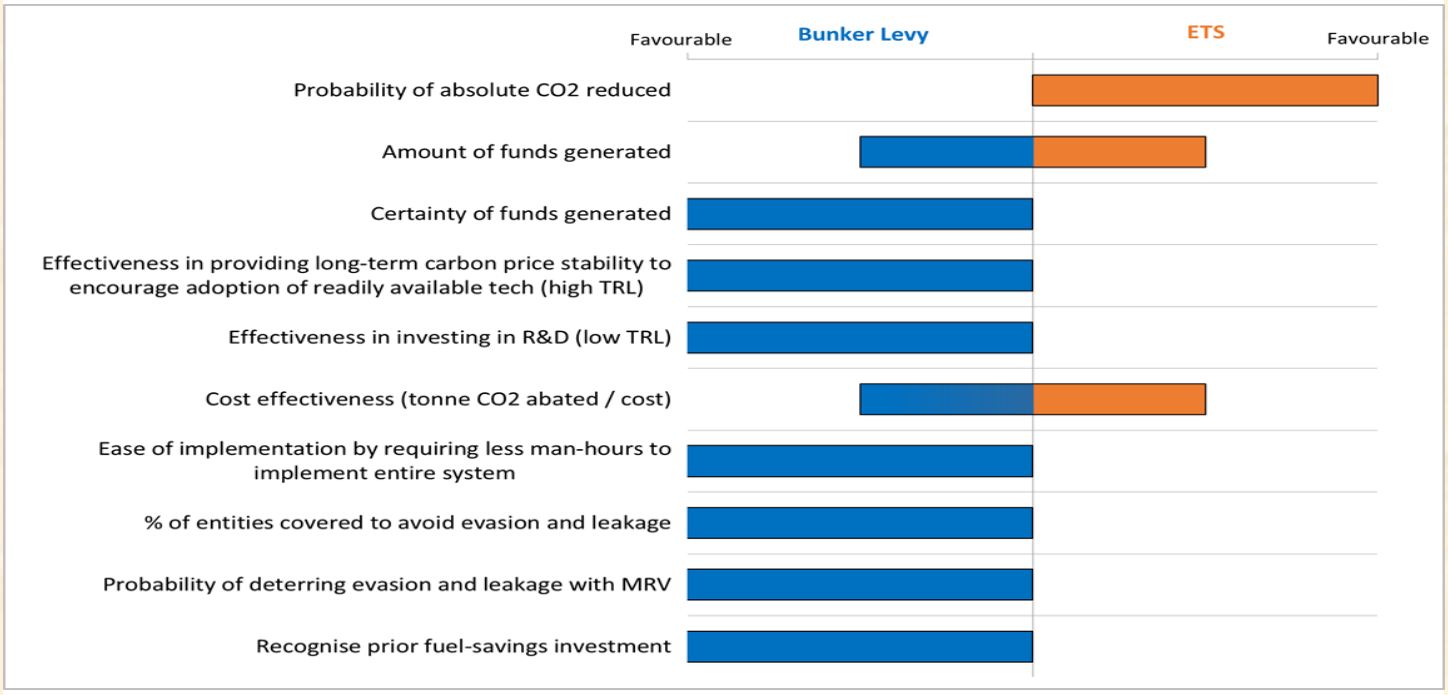

Fig 3: Graphical Summary of Evaluation Results

It appears that ETS is superior to bunker levy in its certainty of absolute CO2 reduction while bunker levy is superior in encouraging adoption of measures, encouraging R&D and is easier to implement. In view of the sector's lack of available T&O measures to achieve its targets, it is proposed that bunker levy is more suitable for reducing CO2 emissions in international shipping.

Research Highlight 2: Reform Ideas and Main Research Issues on Warehouse Design for Packaging Dangerous Goods at Present Stage, by Visiting Scholar Associate Professor ZHANG Fangwei (Track Leader: Professor MENG Qiang)

Introduction

Dangerous goods in warehouse mainly include bulk dangerous goods, bulk liquid dangerous goods, packing dangerous goods etc.. The project team mainly studied the storage of the packaging dangerous goods. Meanwhile, according to the characteristics of stocking in and out processes of packaging dangerous goods, the idea of packaging dangerous goods warehouses design is proposed. China's dangerous goods warehouses have experienced a slew of safety-related accidents, including the devastating explosions at Tianjin port in 2015. The most prominent issues that have led to these accidents are the poor geometric design of the warehouse, low connectivity through the Internet of Things (IoT), and the obsolete computer skills of employees. These problems have become the bottleneck in storing the rapidly increasing volume of dangerous goods and pose challenges in improving the overall technological status of the supply chain. One-sided emphasis on safety and cost is not feasible. Changing the geometric design and internal structure of the warehouse can better coordinate the relationship between efficiency, cost and safety. To better manage the rhythm of the stock in and out processes of dangerous goods, optimize the efficiency of the stock in and out processes, and to analysis the implement conditions and opportunity cost of the various warehousing operation methods, the project team gives some solutions based on the heuristic algorithm.

Dangerous Goods Warehouses Reform Ideas

Almost all existing dangerous goods warehouses in China are conventional double-door warehouses. The benefit of this design is its high degree of space utilization. The remaining space can be utilized to store goods by providing a passageway for a forklift. In the double-door warehouse, only one forklift can operate in the warehouse. At the same time, the forklift cannot return to the inbound container directly in the warehouse when carrying out the storage operation and must go out from the other door and go around the warehouse to return to the container. When the storage of dangerous goods warehouses increases, the efficiency of forklift trucks entering and leaving the warehouse under double-door warehouse conditions is low, which cannot meet the increasing storage requirements. Therefore, we first proposed the concept of an interconnected warehouse, that is, two double-door warehouses were opened and the isolation door was installed. When the isolation door is closed, the interconnected warehouse is isolated into two separate double-door warehouses；when the isolation door is opened, the intercom warehouse becomes a large four-door warehouse, providing more space for forklift operation, allowing multiple forklifts to work in the warehouse. In the condition of interconnected warehouses, in order to provide more solutions for the operation of forklifts, we have proposed the concept of the isolated-wall. The wall is divided into three parts, the upper and lower parts are isolated-doors, and the middle part is a solid wall. The setting of the isolated-wall has greatly increased the number of applicable choices for warehousing activities to solve specific warehousing problems. On this basis, in order to combine the advantages of high efficiency of interconnected warehouses and large reserves of double-door warehouses, we propose the concept of temporary stacking. When the dangerous goods flow is small, the isolated door is used to cut off the connection between the double-door warehouses and place the storage position beside the isolated door, which is called the key position because it directly affects the use of the isolation door. Set up a temporary stack in front of a door in the original double-door warehouse. This stack is used to place goods that need to be displaced from the critical position when dangerous goods are efficiently transported into the warehouse. When the temporary stack is placed with the goods, the position on both sides are called the relevant stacks. At this time, it is not allowed to go into and out of the warehouse. This can achieve the corresponding disposal in the case of pressure. It is stored as a double-door warehouse mode during normal situation to maximize space utilization; when a pressure situation occurs, the goods on the key stack are moved to the temporary stack, and the isolation door is opened to make the warehouse become an interoperable warehouse to quickly perform the inbound and outbound operations. In order to better select the operation mode according to the actual situation, the project team proposed to judge the operation mode under different circumstances according to the opportunity cost. It provided theoretical support and guidance for the concrete implementation of the

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Dangerous Goods Warehouses Reform Ideas

interoperable dangerous goods storage plan.

Related Problems and Problem-Solving Ideas in Interconnected Dangerous Goods Warehouse

Isolated-doors using decision

In order to improve the operation efficiency of the dangerous goods warehouse system under the premise of ensuring safety, we also further study the usage rules of isolated-doors in the interconnected dangerous goods warehouse. We refine the use of dangerous goods warehouse isolation doors to multi-indicator decision-making under the four indicators of economic cost, time cost, efficiency, safety, etc.. Then, according to the principles of using interconnected dangerous goods warehouses, and based on the Testis-hypercube segmentation method and the hesitant comprehensive relative distance set algorithm with parameters, the isolated-doors in the two decision-making environments with no given index weights and given index weights are studied respectively. Finally, the preferred model is given.

Isolated-walls using decision

With the upgrading of building materials, the wall of conventional dangerous goods warehouses has been replaced by push-pull isolated-walls, which may create conditions for the dynamic layout of warehouse stacks. The wall consists of three parts, the upper and lower is the isolated-door, and the middle is the solid wall. The condition of the isolated-doors is decided by the need. Because the isolated-wall has two upper and lower isolated-doors to choose, it can provide more optimization solutions for the forklift, and it will make the optimization and decision-making problems more complicated. Under this condition, the diversification of the forklift running line will also promote the combination of optimization theory and decision theory to solve the specific problem of entering and leaving the warehouse. In order to improve the operation efficiency of the dangerous goods warehouse system under the premise of ensuring safety, we also further study the usage rules of isolated-doors in the interconnected dangerous goods warehouse. We refine the use of dangerous goods warehouse isolation doors to multi-indicator decision-making under the four indicators of economic cost, time cost, efficiency, safety, etc.. Then, according to the principles of using interconnected dangerous goods warehouses, and based on the Testis-hypercube segmentation method and the hesitant comprehensive relative distance set algorithm with parameters, the isolated-doors in the two decision-making environments with no given index weights and given index weights are studied respectively. Finally, the preferred model is given.

Implementation conditions and opportunity cost analysis of various new warehousing operations

The concept of dangerous goods interconnected warehouse has increased many dangerous goods storage operations. Under the given storage conditions, according to the use of the isolated-doors, a variety of dangerous goods storage solutions can be designed. Evaluating and optimizing the most reasonable interconnected dangerous goods warehouse use plans in various schemes can improve the comprehensive benefits of the storage company, realize the superiority of the interconnected dangerous goods warehouse, and ensure the safety and efficiency of the forklift operation. Therefore, we refine the use of dangerous goods warehouse isolation doors to multi-indicator decision-making under the four indicators of economic cost, time cost, efficiency and safety. Therefore, we have turned the use of dangerous goods warehouse isolated-doors into multi-indicator decision-making under the four indicators of economic cost, time cost, efficiency and safety. At the same time, according to the principle of using the dangerous goods warehouse, based on the Topsis-hypercube segmentation method and the hesitant comprehensive relative distance set algorithm with parameters, the isolation gates in the two decision-making environments with no given index weight and given index weight are studied respectively. Subsequently, the project team focused on the uncertainty of the time-consuming changes in the warehouse layout under the conditions of shrinking warehouses and the cascaded amplification characteristics of the two types of opportunity costs. We divide the dangerous goods into and out of the warehouse in a

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Related Problems and Problem-Solving Ideas in Interconnected Dangerous Goods Warehouse

specific environment into two levels, and establish a first-level warehousing optimization model that considers only efficiency, safety, direct cost, and direct opportunity cost, and considers efficiency, safety, and direct costs. The direct opportunity cost and the indirect opportunity cost of the secondary inbound and outbound plan optimization model. Then, according to the principle of using the wall, we comprehensively consider the safety of the forklift operation, the operating efficiency and the economic cost generated. Three assignments of the forklift running line are proposed based on the interconnected dangerous goods warehouse with the wall. The model and the improved neural network algorithm are used to solve the optimal route, which achieves the purpose of improving the efficiency of dangerous goods entering and leaving the warehouse.

Conclusion

This study expands on the existing dangerous goods double-door warehouses of Shanghai as the fundamental basis to catalyze this research and proposes the concept of the interconnected dangerous goods warehouse. Meanwhile, the heuristic algorithm is used as a tool to solve a series of problems such as the optimization of forklift running lines involved in the interconnected dangerous goods warehouse, the decision to use the isolation door and the pricing of dangerous goods storage.

CMS Research Seminars

1. Game models of US-China waste paper transportation under the background of empty container allocation , by visiting scholar Associate Professor Zhang Fangwei (Track leader: Professor Meng Qiang)

Seminar Abstract:

China is the largest destination country of US mixed waste paper exports, with exports accounting for about three quarters of its total exports. It is interesting that the transportation price of US-China waste paper is much lower than that of conventional goods. In order to find out the generation mechanism in the price of waste paper transportation and study the impact of the latest waste paper import policy in China on US-China waste paper transportation, this study uses cooperative game theory as tool to study the price of waste paper transportation. Firstly, this study puts the United States empty container transportation issues and US waste paper transportation problem in a unified framework. Secondly, this study takes the concept of core and Shapley value in cooperative game as the two fundamental tools and gives the price range of waste paper transportation. Thirdly, this paper predicts the development trend of US-China waste paper transportation price through studying the effect of the import policy of waste paper in China on the upper bound of the price range of waste paper transportation. Finally, this study verifies the effectiveness of the novel models by taking the "Los Angeles - Shanghai" paper transportation of a plant in Changshu, China as an example.

2. Ship traffic capacity estimation methods for the Singapore Strait, by researcher Dr. Kang Liujiang (Track leader: Professor Meng Qiang)

Seminar Abstract:

This seminar introduces the risk-based planning-level traffic capacity models for the Singapore Strait. The planning-level traffic capacity of the strait is defined as the maximum number of vessels that can pass through a crossing section along the strait during a specific time interval, e.g., one day or one week. In this project, we propose two methods to estimate the planning-level traffic capacity of the Singapore Strait: (i) fundamental diagram based capacity estimation method, which is based on the ship traffic's speed-density relationship; and (ii) the Fuji-model based capacity estimation method, which utilizes the distribution of the minimum safe distances among different vessel types.

3. Simulation and optimization of Queuing system at FairPrice Finest Clementi, by researcher Mr. Huang Jinjing (Track leader: Associate Professor Ng Szu Hui)

Seminar Abstract:

Extended queuing time to check out in the supermarket during peak hour is a common phenomenon in Singapore market. The common methods that supermarkets to adopt to resolve the problem of congestion is to install multiple counters like the regular, express, and self-checkout counters. Through studying the case of FairPrice Finest in the Clementi Mall, this project aims to have a deeper understanding of the supermarket queuing system and thus provide possible improvements to enhance operational efficiency and increase customer satisfaction.

The research is conducted by collecting data daily for 2 consecutive weeks and then building a simulation model for scenario analysis. Next, the research proposed improvements for the checkout system and simulated. Key performance indicators such as average queueing time of a typical customer were studied to compare the effectiveness of the proposed methods.

CMS Research Seminars

4. Bunker Levy Operationalisation in International Shipping, by researcher Ms. Lee Xin Ni (Track Leader: Associate Professor Ng Szu Hui)

Seminar Abstract:

Building upon an earlier proposition that a Bunker Levy is preferred over an Emission Trading System, this seminar studies how a bunker levy can be operationalised in international shipping in terms of levy collection and distribution. As adopted by IMO in its initial strategy, measures need to be cognizant of both the No More Favourable Treatment (NMFT) and Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC) principles. Furthermore, the industry prefers funds collected to remain in the industry. We propose that a bunker levy can operationalise the NMFT principle during levy collection while the CBDR-RC principle and preference for funds to remain in the sector can be operationalised during fund distribution.

To study the operational details, the possible levy collection and fund distribution options are first defined, then assessed. For levy collection, three options are identified: (1) ship owners / operators pay levy to bunker suppliers, who transfer funds to IMO; (2) ship owners / operators pay levy to bunker suppliers, who transfer funds to national governments and then to IMO; (3) ship owners / operators pay levy to IMO. Assessment suggests that (2) could provide strongest MRV checks and deterrence against evasion, leading to highest certainty of funds collected and highest likelihood of encouraging R&D in the sector. For funds distribution, factors to decide the rebate amount are studied – namely GDP per capita, connectivity to trade routes and importer or exporter categorisation of oil and bulk trade. Considering these factors, a possible formula to calculate rebate for each country is proposed.

5. GHG Emission Reduction Pathway in International Shipping – Available Mitigation Measure, by researcher Dr. Sou Weng Sut (Track Leader: Associate Professor Ng Szu Hui)

Seminar Abstract:

International shipping is the backbone of globalization and predominantly the facilitator of the global trade. The greenhouse gas (GHG) emissions from international shipping will grow rapidly (increasing from 50% to 250% by 2050 as compared to 2012 level. In view of adverse impacts of global warming to the planet, the International Maritime Organization (IMO) has finally reached an agreement on an "initial strategy" for the reduction of CO2 emissions from shipping. The Initial Strategy states that to peak GHG emissions from international shipping as soon as possible and to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008 whilst pursuing efforts towards phasing them out. The goal of this Initial Strategy is in line with the Paris Agreement, aiming to keep the global temperature rises this century well below 2°C or if possible to a level of 1.5°C above pre-industrial level. However, it remains uncertain in how to achieve the proposed target and the associated pathways to reach the targets. This seminar introduces a list of proposed mitigation measures that could contribute in reducing CO2 emissions from shipping industry.

6. Two Novel Parameters for Ship Conflict Assessment based on Dynamic Ship Domain, by researcher Mr. Wei Xiaoyang (Track Leader: Professor Meng Qiang)

Seminar Abstract:

Ship conflict assessment is vital to make the decision for ship collision avoidance and evaluate the effectiveness of risk mitigation measures, therefore, it is important for ship traffic management, crisis management, and planning rescue resources and operations. There are significant deficiencies in current parameters for ship conflict assessment that can lead to serious errors in assessing ship conflict levels. To address this issue, this paper proposes two

CMS Research Seminars

novel parameters for ship conflict assessment based on dynamic ship domain (DSD). Firstly, the DSD model is developed based on big real Automatic Identification System (AIS) data, and a systematical methodology to calibrate the model parameters is proposed. Next, ship conflict is defined in this study, and two parameters are formulated based on DSD model to measure ship conflict levels from spatial-temporal perspectives. Then, comparisons between proposed and existing parameters are conducted to demonstrate the former's advantage in accuracy for assessing ship conflict levels. Finally, the limitation of the proposed parameters is discussed and suggestions are provided for further studies.

7. Analysis of impact of Pakistan Railways Main Line 1 (ML-1) on the "North China-EU" export transit, by visiting scholar Associate Professor Zhang Fangwei (Track Leader: Professor Meng Qiang)

Seminar Abstract:

With the development of "The Belt and Road Initiative", Pakistan's Railways Main Line (ML-1) which serves as one of the main channels that connect the land and maritime silk road, once completed, will inevitably play a pivotal role in promoting trade and economic exchange between China and other countries along the routes, especially between China and Europe. Based on the historical trade data between China and Europe over the past 12 years, we set up a new multi-logit model by introducing variables such as freight rate, time economic value and corresponding time preference coefficients. The main characteristic of this study is it explores the impact of expansion and operation of Pakistan's ML-1 railway line on the choices of transportation route, especially on the shipping channel between China and EU. The main innovation of this study is it analyzes the influence of different control variables on the distribution of routes, including time preference coefficients, freight rates of channels in Pakistan and sea. Additionally, it is assessed that the impact of the Pakistan channel on the freight pattern through the indicators such as probabilistic route assignment and changes in freight volume, and provides a comparison between different channels at price levels. Finally, the study applies the freight rates of Pakistan channel and sea channel as variables to establish the income functions of Singapore and Pakistan and analyzes the pricing game and its Nash Equilibrium solution.

8. Deep reinforcement learning obstacle avoidance for marine vessels, by invited speaker Mr. Lin Haozhi

Seminar Abstract:

Obstacle avoidance is a major challenge for autonomous marine vessels. However, as the complexity of the marine system, it is difficult to modeling an autonomous ship. And the slight changes of obstacles and the disturbance of the environment may lead to model's failure. With the rapid development of artificial intelligence, it brings researchers powerful algorithms to characterize and control the extremely complex system under the changing environment. Comparing with prior knowledge based traditional algorithms, deep reinforcement learning (DRL) is with greater capacity to adapt complex system environment while it is capable of self-learning that can be applied in obstacle avoidance for marine vessels. This seminar introduces the basic theory of reinforcement learning and deep reinforcement learning which combined the deep learning of neutral network. And how deep reinforcement learning apply on obstacle avoidance for marine vessels would also be discussed.

