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Introduction

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The global maritime network underpinning the world economy is currently facing critical challenges. These include, inter alia, relatively stagnant economic and trade activity, China's growing impact on international trade, changes in the structural pattern of international trade as a consequence of emerging free trade agreements, the need to further integrate maritime logistics systems, fierce port competition and the influence of mega carriers, terrorist attacks and other security issues, natural disasters and the need for enhanced resilience, as well as global warming and other environmental concerns. Within the context of a globalized world economy, the continued emergence of new developments which fundamentally affect it (such as China's growing engagement in Africa and South America) and aspects such as the pursuit of an integrated logistics environment, the competitiveness of alternative production bases, the potential for the relocation of production lines, and the associated establishment of new supply chains have all attracted the attention of manufacturers, maritime logistics providers, academics, and policymakers. This is the context which has prompted the production of this book entitled *Dynamic Shipping and Port Development in the Globalized Economy*. Consisting of two volumes, the first concentrates on aspects of maritime economics and logistics which revolve around *Applying Theory to Practice in Maritime Logistics*. The second volume is entitled *Emerging Trends in Ports*. As the name suggests, it brings into sharp focus the impact on ports of the contemporary practices in maritime logistics which have been discussed and analyzed in Volume 1. The two volumes encompass a total of 15 contributions from 23 visionary scholars of international repute, which together provide a truly comprehensive scientific, practical, and contemporary perspective on the developments and challenges that have necessitated *Dynamic Shipping and Port Development in the Globalized Economy*.

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Volume 1 of this book brings together an eclectic collection of papers which seek to apply a range of different theories to contemporary issues affecting the shipping and port industries. In so doing, a number of new concepts pertinent to maritime logistics have emerged. The first contribution by Jasmine Siu Lee Lam (Chapter 2) is a discourse on strategies for developing transhipment hub status and is based on a case study of the Port of Singapore, the world's largest transhipment hub in terms of overall container throughput. With more than 80% of its total container throughput being transhipment containers, the Port of Singapore faces several challenges in an increasingly competitive business environment. Among the various types of cargoes handled by ports, transhipment containers are considered the most "footloose" in that they are not naturally bound to any specific port. Therefore, as the author points out, transhipment ports probably encounter the most severe inter-port competition. In other words, Singapore and other transhipment ports must continuously improve their performance by providing higher standards of service at competitive prices in meeting the needs of port users. The author's analysis adopts a variety of perspectives in order to identify the key success factors required for achieving and maintaining transhipment hub status. In relation to the Port of Singapore, she highlights its strong links to the global shipping network and its consequent high level of connectivity (Cullinane and Wang, 2012; Wang and Cullinane, 2014) which generates significant benefits for port users. In addition, the author attributes much of the success achieved by the Port of Singapore to several measures introduced by both the Port of Singapore Authority (PSA) Corporation and the Maritime and Port Authority of Singapore (MPA) which have led to its emergence as a highly efficient terminal operator, a customer-centric service provider, a proactive investor in both infrastructure and superstructure within the port, and an innovator and leader in research and development, particularly with respect to the introduction of the port's electronic port community system – Portnet. All of this has strengthened the Port of Singapore's status as a transhipment hub.

In Chapter 2, Lam further highlights key success factors of the Port of Singapore in addressing green port policies and sustainable terminal operations and expansions. These success factors are credited to the port's governance system and its interaction with, and relationship to, national maritime policy. They are quite similar to the key success factors of the Port of Singapore which were identified by Tongzon (2005): strategic location, high level of operational efficiency, high port connectivity, adequate infrastructure/info-structure, and a wide range of

port services. Lam emphasized that several challenges remain for the Port of Singapore. The first comes from neighboring countries – for example, Malaysia and Indonesia – which are developing container port infrastructure, in tandem with national policies, to establish load and logistics centers. Consequently, the Port of Singapore may lose some of its transhipment cargoes. Another challenge the Port of Singapore faces is to develop a policy for the country to achieve the status of a premier international maritime center so that the port can mitigate fierce inter-port competition within the region through port diversification and differentiation. In so doing, the author recommends a double-pronged policy of growing both the transhipment hub and maritime services at the same time, by offering four types of maritime cluster in association with maritime ancillary services including marine insurance, ship finance, and ship broking.

Highlighting China's fast-growing engagement in Africa and South America over the last two decades, Paul Tae-Woo Lee (Chapter 3) addresses emerging markets in maritime logistics and in the shipping and port sectors. Greater liberalization and more free trade agreements in the context of regional economic blocs, such as IBSA (India, Brazil, and South Africa), the Regional Comprehensive Economic Partnership (RCEP) led by China and the Association of Southeast Asian Nations (ASEAN) + 3 (China, Japan, and Korea), have contributed to increasing and robust container cargo volumes, causing structural changes in trade patterns on the newly emerging route of China–Africa–South America (CASA). Moreover, these developments have led China to expand her economic and political influence in the emerging markets of Africa and South America. As a result, a new maritime geography is developing on the world maritime map. The author emphasizes the necessity to analyze the impact of greater trade liberalization on container trade volume on the basis of 20-foot equivalent units (TEUs) rather than container value. This is because data on container volume in TEUs and container cargo flows among major trading partners yield greater insights and are more valuable, therefore, for fleet deployment and management, container network development, and port capacity planning. The author introduces an approach for converting trade value data acquired from the Computable (Applied) General Equilibrium (CGE) or Global Trade Analysis Project (GTAP) models into container volumes in TEUs by combining them with UNCOMTRAD data. Examples of how to estimate container cargo volume by container cargo type and flow route on the basis of a series of his research team's work are also provided (e.g., Lee and Lee, 2012; Lee et al., 2008; Lee et al., 2012; Lee et al., 2013). A

series of applications of the conversion model to the South Africa case and CASA trade route confirm that the continents of sub-Saharan Africa (SSA) and South America do constitute emerging markets in shipping, port, and maritime logistics. In addition, the confirmed robust increase in the estimated container cargo volume on the CASA route drives stakeholders to consider several challenges and responses, such as the location of logistics distribution centers (LDCs), feeder services in SSA, a relay service between SSA and South America, a multiple gateway port system in South Africa, and China's strategic options.

Following his work on data conversion, Lee explores the best location for LDCs to develop transhipment hub ports, as well as to promote South Africa's engagement with China in SSA, serving the sub-Saharan region and relaying container cargoes to South America. Looking ahead, another objective is to answer the question: What are the likely challenges China is facing, and what are China's options and likely responses? The author concludes that trade liberalization and connectivity developments among regional economic blocs and their members contribute to increasing maritime cargo flows and that, on the basis of several measures such as degree of centrality, betweenness centrality, and clustering coefficients of the hub and gateway functions of ports, South Africa can be seen as a rising container hub in SSA. The author regards the Port of Ngqura as the best location for locating an LDC and as a transhipment hub for China's trade, providing it can create a new dynamic maritime clustering system that combines a maritime and trade cluster with manufacturing and assembly companies, as well as research and education. This is because such a center can lead stakeholders in the private and public sectors to work together and integrate maritime logistics actors, the port, third-party logistics providers, the single window system (SWS), the port management information system, electronic data interchange (EDI), and radio-frequency identification (RFID) into a one-stop service, based on a platform of fusion technology.

Based on recent studies by his research team (Chang et al., 2013, 2014), Young-Tae Chang in Chapter 4 addresses the green issues facing the contemporary shipping and port sectors. The vast majority (95%) of the world's shipping fleet runs on diesel which emits a range of pollutants, not only when operating on the high seas, but also within ports. Because of the impoverished quality of the fuels used, even the most modern marine engines produce higher emissions per power output than regulated on-road diesel engines (Corbett and Farrell, 2002; Cullinane and Bergqvist, 2014). Based on the methodology applied in Corbett et al. (2009) and Chang and Wang (2012), the author estimates

greenhouse gas (GHG) emissions within the Port of Incheon in South Korea in order to understand how best to assess emissions in ports in terms of vessel types, stage of vessel movement, and vessel characteristics. The second element of this chapter goes on to assess the emissions of noxious gases (specifically, SO_2, NO_x, and PM) from vessel operations in the Port of Incheon by applying the Tier 3 methodology developed by the European Energy Agency (Chang et al., 2014). Although there currently exist no International Maritime Organization (IMO)-designated Emission Control Areas (ECAs) in Korea, the author examines how much these noxious emissions could be reduced within any future ECA that is applied within the Port of Incheon. Alternative scenarios are tested with variations in maximum allowable ship speed, the size and boundaries of the ECA, and the sulfur content of ship fuel. In a third element of the chapter, Chang measures the pollution abatement cost at ports in currently designated ECAs. By building on the environmental directional distance functions he derives to drive his model, and switching from an additive to a multiplicative version of his model, he measures what volume of cargo and passengers may have been lost at ports due to the imposition of ECA regulations. By taking the Port of Incheon as a reference, together with the vanguard ECA ports within the European Union, the work reported in this chapter addresses some of the major and growing concerns of various stakeholders in seeking to reduce the emissions of GHG and noxious gases in ports.

The contribution from Koichiro Tezuka and Masahiro Ishii (Chapter 5) analyses the applicability of game theoretical models to port policies, by utilizing a case study of Japanese container ports. The authors first identify the types of port competition problems that might be solved using game theory – both cooperative and non-cooperative games – through a comprehensive literature review. De Borger et al.'s (2008) is acknowledged as the first work which investigated the general competition between ports using a two-stage game, and this work has stimulated a series of studies that have modified these models to depict more specific situations among competitive ports. The authors review these subsequent related studies to reveal the relationships and interactions among factors and variables associated with port competition. Tezuka and Ishii move on to briefly outline recent Japanese port policies, namely the Super Core Port (SCP) policy and the International Strategic Container Ports policy, which were introduced to improve the competitiveness of Japanese ports within the East Asian context. By reference to economic structure and, in particular, the nature of the congestion, hinterlands, and vertical supply chains in the region, the authors go on to explain

the gap which exists between the actual competitive situation which prevails among East Asian ports and the outputs derived from the game theoretical models they have reviewed. Moreover, the authors focus on the ownership and operational structures of a port to verify the assumptions underpinning the game theoretic models they have reviewed and to evaluate their robustness. Having taken the above into consideration, they examine how to apply the results of game theoretic models to actual situations of inter-port competition and draw inferences relating to congestion and capacity constraints, the final point of demand and port governance structure. In so doing, they account for Japanese port policies in the context of inter-port competition, particularly in relation to that which exists between the Port of Busan in Korea and the SCP ports in Japan. It is interesting to note that lack of capacity is not a problem in the region. Rather, severe price competition occurs because of overcapacity. In addition, because the Japanese central government uses grants and regulations to support container ports which are owned and operated by local governments, recently privatized companies do not necessarily have the discretion to determine port charges. As a consequence, the authors claim that not only should the appropriateness of the objectives of Japanese port competition policy be confirmed and reset, but also the appropriateness of the assumption that a single port entity is simply a private profit maximizer should be questioned.

Recognizing that the study of maritime security as a new dimension of enhancing maritime safety is attracting growing international attention, Zaili Yang, Jin Wang, and Adolf K.Y. Ng (Chapter 6) propose a new conceptual methodology for determining the security requirements of shipping and ports. This work aims to prompt a paradigm shift in maritime security management and advancing the state-of-the-art to a point where robust quantitative security assessment is feasible. The authors draw together and review pioneering research on the analysis of piracy data, maritime security regulations, security risk quantification, the use of uncertainty methods in maritime safety assessment, and the innovative use of economic evaluation in security management. In so doing, the authors apply eclectic methods comprising an extended Analytic Hierarchy Process (AHP) and an heuristic approach which is based on techniques such as Bayesian networks, entropy, the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS), and System Dynamics in order to develop a novel maritime security assessment (MSA) methodology. The newly proposed MSA methodology contributes to integrating several studies focusing on maritime security

risk quantification and safety management, consisting of the identification of threats and vulnerabilities, subjective security risk estimation, security risk mitigation and protection, security cost and benefit analysis, dynamic security-economic evaluation, and security inspection and maintenance. Having said that, the significance of the newly proposed MSA methodology lies in, among other things, the fact that it presents a scientific framework capable of realizing quantitative security risk analysis under uncertainty to aid decision making and rationalizing maritime security management under economic constraints. In addition, the development of this new MSA framework for shipping and ports not only promotes the standardization of the currently diverse practices and standards applied to "secure" facilities in different states around the world, but also facilitates a shift in maritime security management toward a proactive risk-based regime that realizes the optimal use of security resources for maritime security improvement. As such, this chapter lays down a solid and crucial platform for researchers, policymakers, industrial practitioners, and other stakeholders of the maritime sector to collaborate meaningfully to deliver maritime security effectively.

For the purposes of their analysis, Stephen X.H. Gong, Michael Firth, and Kevin Cullinane (Chapter 7) define a "financing method" as representing a joint decision on both governance structure and available financing mechanisms. Based on this premise, the authors propose a new analytical framework for the analysis of financing methods that, it is suggested, should replace the more traditional and orthodox perspective that is usually adopted in neoclassical finance theory. A review of the alternative theories that seek to explain the corporate choice of capital structure leads the authors to conclude that, in terms of explaining real-life behavior in shipping finance decisions, an approach based on transactional cost economics (TCE) due to Williamson (1988) is likely to prove superior to one based either on the capital structure irrelevance propositions (Modigliani and Miller, 1958) or on the pecking order theory (Myers, 1984). The authors go on to outline and advocate an approach to the analysis of financing methods in the shipping industry that fundamentally revolves around the TCE paradigm, but which is informed by a range of eclectic influences from other areas of economics and, most poignantly, by real-life behavior. Specifically, they suggest that the TCE paradigm helps explain the combinations of capital structure and corporate governance decisions that are found to exist in the wider transport industry. The reason why this is the case is because asset specificity, the characteristics of the product (service)

market under consideration (in particular, in the case of the shipping industry), and the nature of the seekers and providers of finance in this arena are all fundamentally transactional characteristics that exert a considerable influence on what decisions are taken.

Arguing that a port generates freight traffic by means of its interconnectedness with inland trade routes and with other regional and international ports, Francesca R. Medda and Simone Caschili (Chapter 8) estimate the Port Attractiveness Index (PAI) for the South Pacific Islands in order to identify possible policy recommendations to attract private finance into port investments. The authors define the PAI, which is rooted in the causality relationships among the determinants of port attractiveness, as the combination of the productive capacity of a port and its level of international competitiveness, which together provide direct and indirect economic and financial benefits. In the PAI, the authors assume that the higher the value of endogenous, exogenous, and subjective variables, the higher will be the PAI and hence the consequent increase in a port's capacity to attract private investment. The authors apply the concept to the South Pacific Islands, where shipping is the dominant mode of transport for their international trade, using a combination of port and national data such as throughput, maximum draft, logistics performance index (efficiency of customs), Internet usage, the liner shipping connectivity index, and the ease of doing business. Their test results show that ports in the South Pacific Islands have very low port attractiveness compared to other Asian ports. The South Pacific Island ports with the highest PAIs are Lae in Papua New Guinea, Suva in Fiji, and Noumea in New Caledonia, but they are certainly lower than that of Busan Port which is used as a benchmark comparator in this study. The authors' analysis finds that the capacity of a port to be integrated in the international shipping network is a key determinant for the reputation of a port. They, therefore, maintain that in order to increase port attractiveness and private investments, port operators need to develop a wide network of commercial relationships with other ports and, in particular, improve access and connectivity to international markets. From this perspective of the interconnectivity of ports, the authors also make another interesting observation that the South Pacific Islands need to ensure the provision of adequate access for domestic markets and to implement further coordination between ports, including the consolidation of traffic, for better access to international markets. The authors conclude that the governments in the South Pacific Islands should, therefore, loosen regulations and

foster port privatization, with the aim of reducing domestic monopoly positions, prompting greater competition, improving efficiency, and, ultimately, enhancing the participation of private finance.

Maritime logistics in international trade is concerned with flows of cargo, information, finance, and image among stakeholders comprising shippers, consignees, forwarders, third-party logistics providers, land and sea carriers, ports, and government agents including customs offices. In this regard, Paul Tae-Woo Lee and Tsung-Chen Lee (Chapter 9) propose new concepts of *economies of flow*, *economies of connection*, and *economies of fusion technology* arising in relation to the maritime logistics of container cargoes. The seamless and smooth flow of container cargoes between stakeholders contributes to lowering logistics costs and, as a result, to improving the competitiveness and productivity of each individual stakeholder, as well as the national economy with which they are associated. Information technology (IT) such as RFID, global positioning systems, cargo tracking systems, and EDI (Lee et al., 2000) have all been applied to maritime logistics. In addition, the SWS, in tandem with collaboration between private and public sectors in Singapore and Korea, has contributed to accelerating the flow of container cargoes and sharing container information among the stakeholders involved. The SWS is a facility that allows parties involved in trade and transport to lodge standardized information and documents at a single point of entry in order to fulfill all import, export, and transit-related regulatory requirements. The authors propose a concept of *economies of fusion technology* with IT, in tandem with nanotechnology (NT) and biotechnology (BT), all being fused with each other in order to achieve efficient maritime logistics. The authors point out, however, that the SWS is not well-developed in other Asian container ports, particularly those in China (Lee and Lam, 2015; Lee et al., 2013). This leads to increased logistics costs and, as a result, to a deterioration in international trade competitiveness. The authors argue that from their case studies of Busan and Singapore ports, the key benefits to be derived from the three concepts of *economies of flow*, *economies of connection*, and *economies of fusion technology* can be identified. Among other things, these key benefits are the lowering of logistics costs; reducing the handling time of container cargoes; the sharing of knowledge and information among stakeholders; capturing economies of synergy; promoting joint research and development efforts between government and the private sector; obtaining mutual benefits from the combined use of complementary assets and knowledge; and overcoming (or mitigating) social impediments such as

bureaucracy and corruption. The authors point to the limitation of these new concepts in that statistical and empirical evidence confirming their presence in, and relevance to, maritime logistics, as a sine qua non, has not yet been developed. However, Lee and Lee argue that this shortcoming does not necessarily invalidate the significance of the new concepts, because the intuitive logic underpinning them is sound. In other words, these *economies* provide a raison d'être for developing efficient maritime logistics systems in tandem with promoting international trade flows, particularly in the ASEAN region where several obstacles exist within customs, immigration, and quarantine processes. The authors suggest that future studies may deal with deriving a tractable formulation for hub and spoke networks and/or inland transport that explicitly accounts for the effects of these three new *economies* concepts, by taking into account factors such as cost, time (e.g., service completion speed), and the number of face-to-face contacts between agents and service users.

References

Chang, C.C. and Wang, C.M. (2012) Evaluating the Effects of Green Port Policy: Case Study of Kaohsiung Harbor in Taiwan, *Transportation Research Part D: Transport and Environment*, 17(3), 185–9.

Chang, Y., Roh, Y. and Park, H. (2014) Assessing Noxious Gases of Vessel Operations in a Potential Emission Control Area, *Transportation Research Part D: Transport and Environment*, 28, 91–7.

Chang, Y., Song, Y. and Roh, Y. (2013) Assessing Greenhouse Gas Emissions from Port Vessel Operations at the Port of Incheon, *Transportation Research Part D: Transport and Environment*, 25, 1–4.

Corbett, J.J. and Farrell, A. (2002) Mitigating Air Pollution Impacts of Passenger Ferries, *Transportation Research Part D: Transport and Environment*, 7(3), 197–211.

Corbett, J.J., Wang, H. and Winebrake, J.J. (2009) The Effectiveness and Costs of Speed Reductions on Emissions from International Shipping, *Transportation Research Part D: Transport and Environment*, 14, 593–8.

Cullinane, K.P.B. and Bergqvist, R. (2014) Editorial: Emission Control Areas and Their Impact on Maritime Transport, *Transportation Research D: Transport and Environment*, 28, 1–5. http://dx.doi.org/10.1016/j.trd.2013.12.004.

Cullinane, K.P.B. and Wang, Y. (2012) The Hierarchical Configuration of the Container Port Industry: An Application of Multiple Linkage Analysis (MLA), *Maritime Policy & Management*, 39(2), 169–87.

De Borger, B., Proost, S. and Van Dender, K., (2008) Private Port Pricing and Public Investment in Port and Hinterland Capacity, *Journal of Transport Economics and Policy*, 42(3), 527–61.

Lee, P.T.W. and Lam, J.S.L. (2015) Container Port Competition and Competitiveness Analysis: Asian Major Ports. In Lee, C.Y. and Meng, Q. (Eds.), *Handbook of Ocean Container Transport Logistics: Making Global Supply Chain Effective, International Series in Operations Research & Management Science*, Vol. 220, New York: Springer, pp. 97–136.

Lee, P.T.W., Flynn, M., Notteboom, T., Chang, Y.T., Huang, C.H., Chen, T., Lee, T.C. and Chasomeris, M.G. (2008) *Port Economics Study*, Report of Flynn Consulting Ltd., Hong Kong.

Lee, P.T.W., Lee, T.C. and Yang, T.H. (2013) Korea-ASEAN Free Trade Agreement: The Implications on Seaborne Trade Volume and Maritime Logistics Policy Development in Korea, *Journal of International Logistics and Trade*, 11(1), 43–65.

Lee, T.C. and Lee, P.T.W. (2012) South-South Trade Liberalisation and Shipping Geography: A Case Study on India, Brazil, and South Africa, *International Journal of Shipping and Transport Logistics*, 4(4), 323–38.

Lee, T.C., Lee, P.T.W. and Chen, T. (2012) Economic Impact Analysis of Port Development on the South African Economy, *South African Journal of Economics*, 80(2), 228–45.

Lee, P.T.W., Park, N.-K., Joint, J.F. and Kim, W.-K. (2000) A New Efficient EDI System for Container Cargo Logistics, *Maritime Policy & Management*, 27(2), 133–44.

Modigliani, F. and Miller, M.H. (1958) The Cost of Capital, Corporation, Finance and the Theory of Investment, *American Economic Review*, 48, 261–97.

Myers, S.C. (1984) The Capital Structure Puzzle, *Journal of Finance*, 39, 575–92.

Tongzon, J. (2005) Key Success Factors for Transhipment Hubs: The case of the Port of Singapore. In Lee, P.T.W. and Cullinane, K.P.B. (Eds.), *World Shipping and Port Development*, New York: Palgrave Macmillan, pp. 162–80.

Wang, Y. and Cullinane, K.P.B. (2014) Traffic Consolidation in East Asian Container Ports: A Network Flow Analysis, *Transportation Research A: Policy and Practice*, 61, 152–63.

Williamson, O.E. (1988) Corporate Finance and Corporate Governance, *Journal of Finance*, 43(1), 567–92.