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Competitive Dynamics among Cross Regional Hub Ports: Generalised Cost Approach

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1. Introduction

Hub port competition is complicated by numerous decision-making criteria and multiple network structures while accelerating beyond regional boundaries due to the involvement of multiple players and enlargement of vessel size (Veldman, and Buckmann, 2003). Moreover, overlapping origin/destination markets served simultaneously by multiple cross regional hub ports create many alternative choices for shipping lines. Although there are existing port choice/competition studies, none of them focus on cross regional hub ports considering different liner networks with arrange of decision-making criteria. Therefore, this study fulfils the research gap by analysing hub port competitiveness for both hub & spoke and relay networks considering multiple qualitative and quantitative criteria. The network configuration of hub &s poke and relay is illustrated in Figure (1).

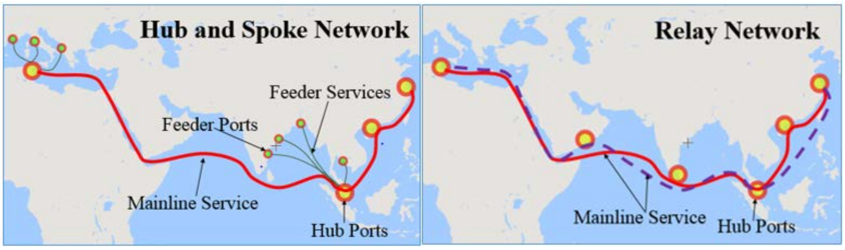

Figure 2: Hub and Spoke and Relay Networks

Despite location advantages, the port of Colombo has serious exposure to a loss of trans-shipment market share due to competitive hub ports being located in surrounding regions.

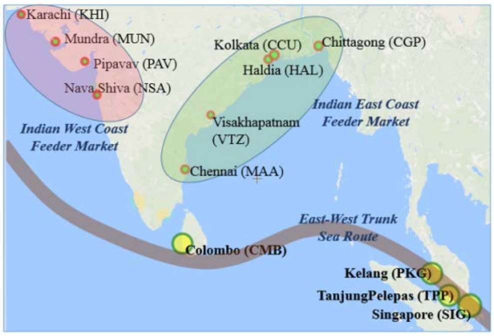

Figure 2: Ports in the Study Area

Moreover, the majority of trans-shipments of the Colombo Port is related to hub &spoke networks while the port does not have an important role in relay networks. Therefore, the study focuses on Port of Colombo located in South Asia, while three hub ports in Southeast Asia, namely Singapore (SIN), Klang (PKG) and Tanjung Pelapas (TPP) are considered its competitors. Competition is analysed for nine feeder ports in two feeder markets each related to the hub &spoke network as mentioned in Figure (2) and to relay networks as a general case.

2. Methodology

The modelling approach based on the generalised cost and logit model used for analysing competition among hub ports is indicated in Figure (3).

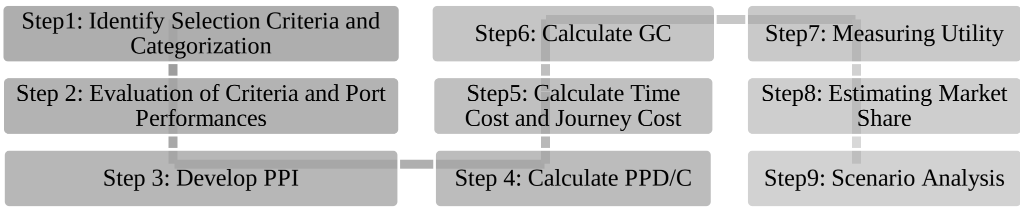

Figure 3: Methodological Flow

Hub port selection criteria identified through literature review and interviews were grouped into five categories such as three criteria in the 'monetary' category, four in 'time', three in 'location', 17 in 'operational', and seven in the 'liner-related' category. Seventeen respondents representing major shipping lines were used as the sample for both interviews and questionnaire survey. The level of importance of criteria was evaluated based on significance scores ranging from 0 (not significant) to 5 (very significant) and hub port performances for criteria mentioned under non-quantitative categories (i.e.,location, operational, liner-related) were evaluated with appreciation scores ranging from -3(worst) to +3(best).The 'Average Significant Score' (ASS) and 'Average Appreciation Score' (AAS) were generated and used to measure the Port Performance Index (PPI)in Equation (1). Components of PPI were converted into monetary terms asPort Performance Discount/Cost (PP D/C) with Equation (5) assuming that positive/negative performances of ports generate monetary discounts or costs to shipping lines.

Hub port performances forquantitative categories (i.e.,monetary, time) were estimated. Time category consists of four criteria, namely‘vessel turnaround’, ‘waiting’, ‘deviation’, and ‘feeder link’,with times estimated and converted into monetary terms incorporatingthe value of time approachin Equation (6) and (7). Moreover, monetary category consists of three criteria, namely ‘deviation’ and ‘feeder link’costsestimated with unique approaches in Equation (8) and (9) as well as ‘port cost’ obtained directly from published port tariffs. Calculated monetary cost of quantitative criteria and PP D/C of non-quantitative criteria were used to measure the generalised cost of each hub port choiceas per Equation (10). Utilities calculated via generalised cost wereincorporatedwith logit model to estimate the market share of hub portsin the relay case and to estimate the market share from each feeder port in the hub &spoke casein Equation (11) and (12) respectively. Moreover, this methodology was used to analyse different scenarios considering the practical implications of the liner shipping industry.

$$PPI\ (A) = LEI\ (A)\ +\ OEI\ (A)\ \ +\ LREI(A) \tag{1}$$

$$LEI(A) = \left[\sum_{i=1}^{i=n} AAS(A, LE) * ASS(LE)\right] /n \tag{2}$$

$$OEI(A) = \left[\sum_{i=1}^{i=n} AAS(A, OE) * ASS(OE)\right] /n \tag{3}$$

$$LREI(A) = \left[\sum_{i=1}^{i=n} AAS(A, LRE) * ASS(LRE)\right] /n \tag{4}$$

$$PP[D/C]\ (A)\ =\ PC(A) * LEI(A)/ASS(PC) +\ PC(A) * OEI(A)/ASS(PC)\ \ + PC(A) * LREI(A)/ASS(PC) \tag{5}$$

$$TC(A) = [VOT(VTT) * Mi * VTT(A)] + [VOT(WT) *\ Mi * WT(A)] + [VOT(FT(A-X)) * Ni * FT\ (A-X)] + [VOT(DT) * Mi * DT\ (A)] \tag{6}$$

$$VOT(i, A) =\ [PC\ (A) * (ASS(i)\ \ / ASS(PC)\ )]/i(Average) \tag{7}$$

$$JC(A) = [Ni * Distance(A-X) * Unit\ Distance\ Value(FC)] + [Mi * Distance(Deviation) * Unit\ Distance\ Value(DC) \tag{8}$$

$$Unit\ Distance\ Value(i) =\ [PC\ (A) * (ASS(i)\ \ /\ ASS(PC)\ )\ ]/i\ (Average) \tag{10}$$

$$GC\ (A) =\ \ PC\ (A) + JC(A) + TC\ (A)\ -\ PP[D/C]\ (A) \tag{9}$$

$$Utility(A) = \frac{1}{\frac{GC\ (A)}{GC(Min)}} \qquad (11)$$

$$EMS(A) = \frac{e^{U(A)}}{\sum_{i=1}^{i=k} e^{U(i)}} \qquad (12)$$

LEI: Location Efficiency Index, OEI: Operational Efficiency Index, LREI: Liner Related Efficiency Index, n:numbers of criteria under category, PC: Port Cost , TC: Time Cost, VTT: Vessel Turnaround Time, WT: Waiting Time, DT: Deviation Time, FT(A-X): Feeder Link Time, VOT: Value of Time, JC: Journey Cost, Distance(A-X): Feeder link Distance, GC: Generalised Cost, Ni: Dummy (1-Hub and Spoke, 0-Relay), Mi: Dummy (1-Hub and Spoke, 2-Relay), EMS: Estimated Market Share, U: Utility

4. Results

For the majority of criteria, hub &spoke obtains higher ASS than relay, with 'berth availability 'being considered most significant for both networks. 'Hub port accessibility', 'frequency of delays', 'records of damages', 'efficiency of husbandry services', and 'availability of dedicated/own terminal' obtain higher ASS for relay while 'port superstructures', 'port's flexibility' and 'financial clearance capability' obtain equal ASS for both networks. In category-wise comparisons, only the time-related category indicates a statistically significant difference between two networks. Moreover, comparisons between each possible pair of categories under same network were done to identify the most important categories. Except for two pairs, namely 'monetary-time' and 'location-operational', all other pairs indicate statistically significant differences in the hub &spoke case. For relay networks, only five pairs, namely 'monetary-liner related', 'time-operational', 'time-liner related', 'location-liner related' and 'operational-liner related' obtain significant differences.

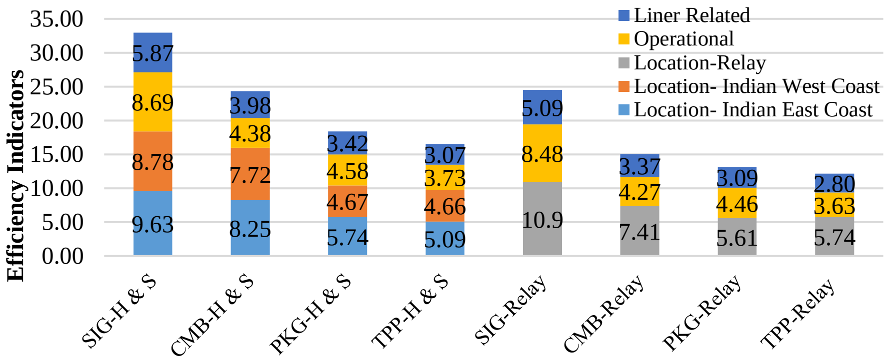

Figure 4: Components of PPIs for Hub and Spoke and Relay

Derived AAs indicates dominant performances from SIG for most criteria except the 'locations with feeder market' criterion dominated by CMB. Importantly, six criteria, namely 'records of damages', 'policies and regulation', 'IT and advanced technology', 'marketing efforts', 'financial clearance capability', and 'location of hub port with services' indicate CMB performing worst. Results of ANOVA highlight significance differences among performances for a majority of criteria. Moreover, highest and least PPIs are indicated from SIG and TPP respectively for both networks, with the PPI of CMB in relay case being lower than in hub &spoke as indicated in Figure (4). Estimated market shares are illustrated in Figure (5), highlighting the dominance of SIG in most cases.

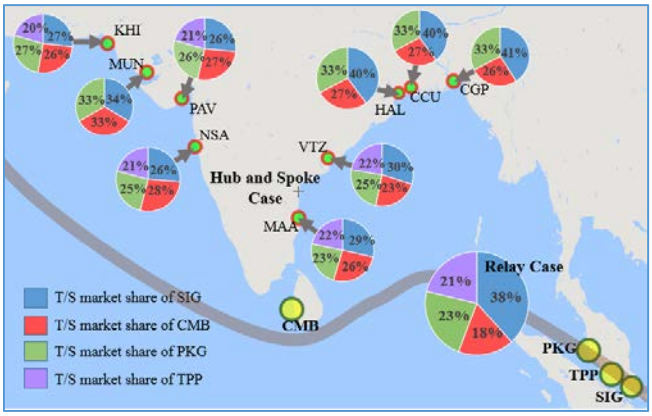

Figure 5: Estimated Market Shares for Hub and Spoke and Relay

Moreover, four different scenarios focusing on 'Colombo Port expansion project', 'best performing port', 'price change impact' and 'Singa project', named scenarios 1 to 4 respectively were analysed. Results indicate higher sensitivity to market share change from the Indian West coast than Indian East coast feeder market in the first two scenarios. Scenarios in relay networks highlight clear differences between the first three scenarios and fourth.

5. Conclusion

The study identifies significant criteria for selecting a trans-shipment hub port while the results indicate visible differences between hub & spoke and relay networks. Dominant performance of SIG is highlighted while the performances of the other three hub ports are varied. Recommendations are made for the Port of Colombo with the analysis of current competition and future scenarios.

6. References

[1] Veldman, S. J. and Buckmann, E. H. (2003) 'A Model on Container Port Competition: An Application for the West European Container Hub-Ports', Maritime Economics and Logistics, 5, pp.3-22.

Keywords: *hub and spoke, relay, transhipments, generalised cost, competition*