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Cascading Barriers of Panamax Containerships in the Intra-regional Markets

by

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1. A Short Introduction of Containership Cascading

In the past decades, ocean vessel sizes across all types have experienced continuous growth. Overall, global liners maintain the focus on large container vessels. They are ordering the ever-larger containerships which are deployed to the main Asia-Europe trade routes, pushing the old "smaller" vessels to other routes. Rather than led directly by trade increasement, it is more of a natural result that smaller, medium sized vessels have to be deployed somewhere. As a result, larger containerships are replacing smaller ones on almost all the trade lanes. This **cascading** phenomena has a variant of spreading impacts: namely, 1) overcapacity on all the trade lanes; 2) further surplus of small sized ships; 3) requirements of upgraded cranes at terminals; 4) tighter turnaround time and higher peaks in the number of containers to be handled at the ports; 5) more competition for cargo volumes and needs for coalitions and vessel sharing; 6) less direct port calls and more feeder services, etc.

The cascading issue has spreading effects in all aspects of global shipping business. It will test ports' limits in terms of water depth, crane capacities, hinterland connections, etc., and resilience of the global supply chain networks. In the end it is the ultimate choice of shipping companies who decide how to optimize their global and regional network configurations.

It is not a goal of this study to predict what will be the right distribution of vessel sizes and the according impacts on the market, but rather we will focus on analyzing the barriers for the larger vessels to replace smaller vessels. In another word, how much threatened are the feeder-size vessels to be replaced by larger vessels in particular regions?

More specifically, we focus on the **cascading effect from the Panamax vessel sector (around 4200 TEU) on the feeder vessel sector**. The old generation Panamax is under pressure of not only larger containerships but also the impact of Panama Canal expansion at the same time. As a result, they are mostly affected in terms of being replaced and will be further cascaded to other trade routes, further threatening their smaller peers — the feeder vessels.

Specifically, we will focus on **two main barriers to the cascading of the Panamax vessels to the feeder market**: (1) Physical constraints at the ports in those markets, and (2) trade volume constraint. These two factors are focused on because they represent the regional differences. Other influencing factors such as oil prices and charter prices have globally almost uniform impacts, and therefore are not specifically compared in this study[1].

While the physical constraints of the ports to serve those large vessels with enough berth length and draft and enough crane facilities are straightforward, the trade volume is a bit trickier. Shortly speaking, the "threat" of cascading by larger vessels in a region is **positively related with** the total regional port throughput volume and flow balance between the ports, while **negatively related with** the total number of

[1] Because the "real slot cost" (operating cost per TEU-carried) comparison between using Panamax vessels or smaller vessels is what really matters, and a larger vessel usually has higher total cost, a larger vessel is only economical to be applied when it carries enough cargo. Thus, enough trade volume in the region is a critical issue to be considered. However, the total cost difference between the Panamax vessels and smaller vessels will become much smaller when the oil prices are low, especially when currently the charter prices of the 4000TEU one and 2500TEU one, for example, are roughly all around 10 thousand dollars. If this is the case, the trade volume will become a less significant issue.

ports in the region and the average port distance[2]. Without listing all the influencing factors, and to keep the problem solvable, we make reasonable assumptions that there is generally no big difference in terms of flow balances and average port distances in the study regions. Thus, for **trade volume constraint**, the most critical factors are the total port throughput volume and the total number of ports counted, which can be measured by the **average TEU volume** (total port throughputs divided by total ports counted).

2. Port statistics

The targeted feeder vessel sizes (size below 4200 TEU) are mainly deployed in intra-regional trades. The study chooses the three regions to check individually: (A world map with the three regions circled is shown in Appendix Figure A1)

- Intra-Far East (FE):
  - Greater China (China and Hong Kong)
  - North Asia (Japan, Korea, Taiwan, and other East Russia)
  - South East Asia (9 countries)
- Intra-Europe (EU):
  - East Med & Black Sea (13 countries)
  - Northern Europe (16 countries)
  - West Med & North Africa (7 countries)
- Intra-Central America and Caribbean (CA):
  - Central America and Caribbean (14 countries)
  - East Coast South America (3 countries)
  - West Coast South America (3 countries)

Totally we collected information on 234 ports with both maximum draft information and intra-regional TEU flow data in 2017. The data statistics are summarized in Table 1 and Table 2[3].

Table 1: Weekly intra-regional container flows in 2017

	# of ports	*Total TEU*	*Average TEU*	*Max TEU*	*Min TEU*
CA	55	70,717	1,286	9,110	0
EU	123	215,997	1,756	15,835	0
FE	57	2,033,699	35,679	212,751	43
Total	**235**	**2,320,413**	**9,874**	**212,751**	**0**

[2] The common measurement of port throughputs is an exaggerated measurement for regional trade volume and vessel capacity requirements. One container shipment demand from Location A to Location B might be handled several times at several ports, each handling counting 1 TEU throughput at the port and even 2 TEU-throughput if it is transshipped at the port. Depending on the network designs, e.g. hub-and-spoke network or point-to-point network, the results can be very different. Furthermore, the more balanced between the origins and destinations of the trade flows, the larger vessels can be used, holding everything else constant (e.g. constant trade volume, same port calls per TEU trade, etc.)

[3] Data from Container Trade Statistics 2017 and Peter Döhle Schiffahrts-KG

Table 2: Port maximum draft statistics

	# of ports	*Average max-draft (m)*	*Max max-draft (m)*	*Min max-draft (m)*
CA	55	11.69	18.10	7.90
EU	123	13.96	30.00	7.20
FE	57	14.75	27.50	6.10

For details, the maximum water draft (Draft) and the average weekly TEU throughput in 2017 (Demand) for 196 ports are plotted in Figure 1.

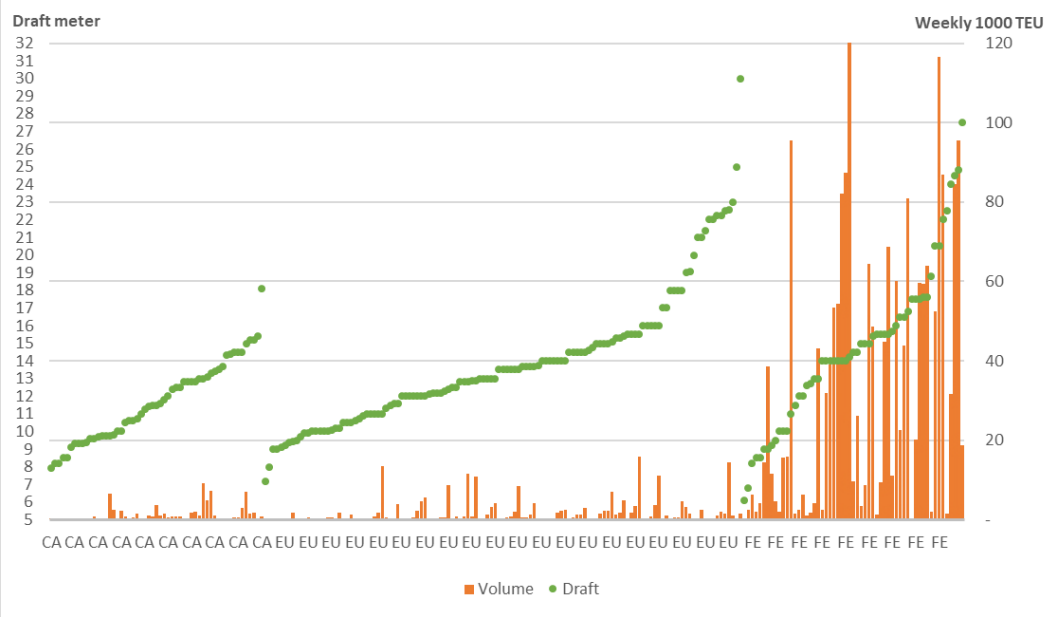

Figure 1: Average weekly TEU volume vs. water draft at port

Clearly, FE has much larger volume for intra-regional shipments, and, therefore, is expected to be the largest market for feeder vessels. There is not so much difference in terms of Draft size distributions in FE and EU. But the CA region does not have deep-draft feeder ports (most below 15 meters).

3. Capacity and Demand Constraints

To roughly estimate whether a port has demand or capacity constraint, two general assumptions are made:

1. If a port has a maximum draft $\leq$ 12 meters, it has a capacity constraint for Panamax containerships (around 4000 TEU). (The general transfer method is shown in Appendix Table A1.)
2. If a port has weekly throughput volume less than 8000 TEU (in and out totally), it has a demand constraint for a Panamax vessel (just currently, without changing of the shipping networks).

The Draft information is transferred to the maximum vessel size that a port can handle, shown in Figure 2.

Based on this, about 31 ports (56%) in CA, 42 ports (34%) in EU, 16 ports (28%) in FE do NOT have enough maximum water draft for Panamax vessels, shown as the Blue sections in Figure 2.

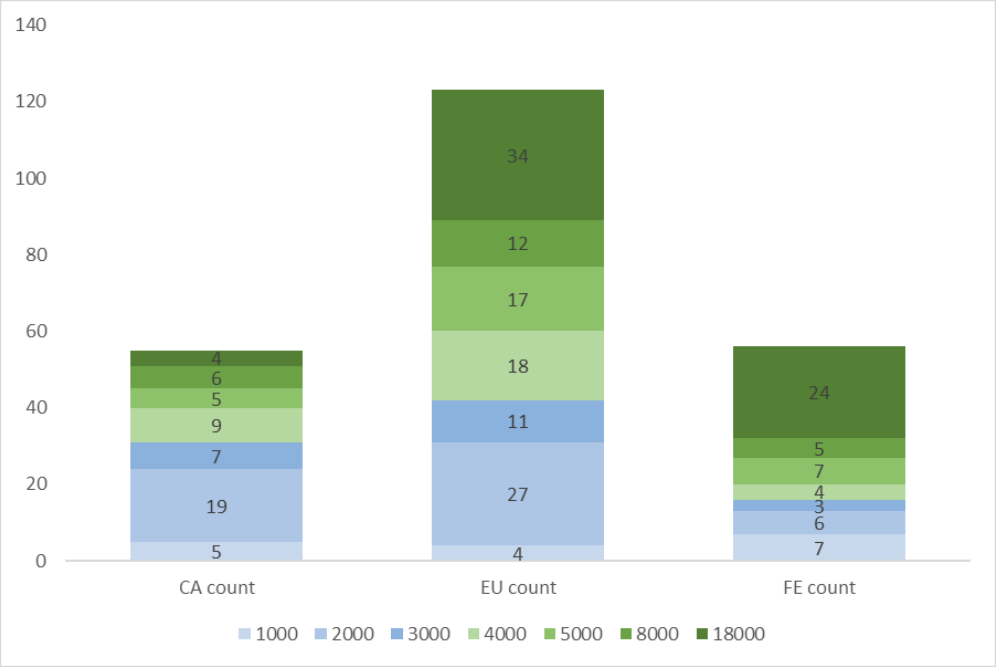

Figure 2: General port draft limits in TEU size

Next, the weekly trade volume and draft-based capacity size are compared with the same unit (TEU) for the three study regions, shown by Figures 3 to 5. Tables 3 to 5 list the ports in each region that have draft or demand constraints.

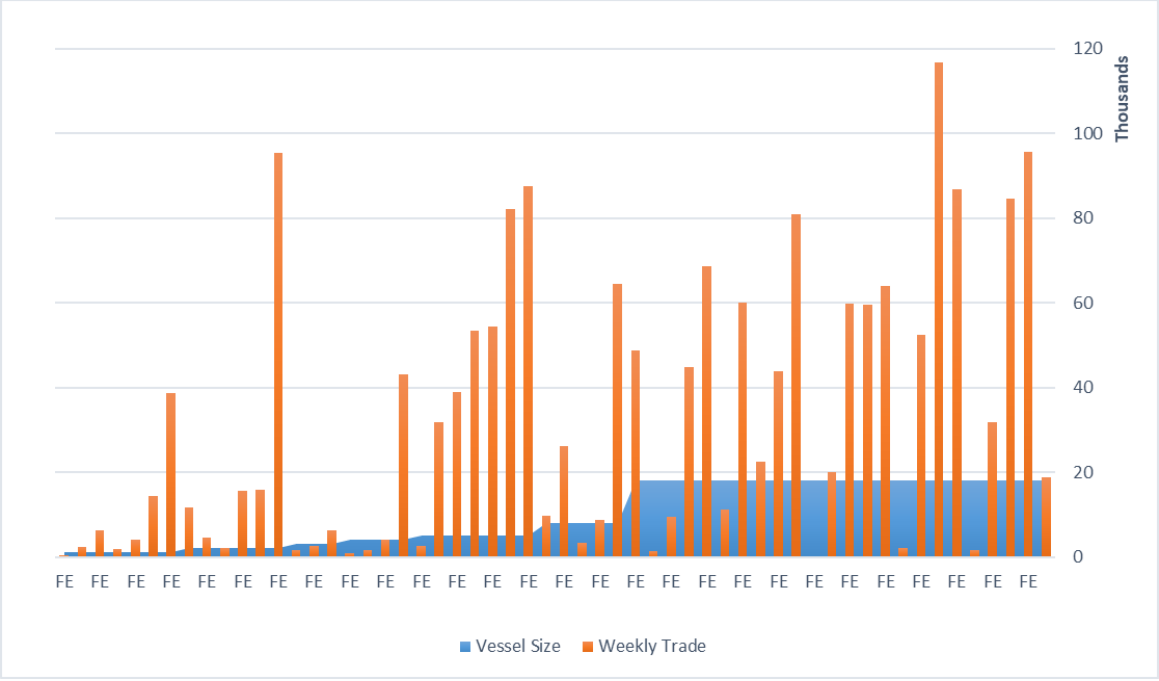

Figure 3: FE Ports: Weekly trade volume vs. maximum draft size (TEU)

Table 3: FE ports with draft or demand constraints

Num	*Country*	*Port*	*Draft constraint*	*Demand constraint*	*Bottleneck*
1	Indonesia	Palembang	yes	Yes	Draft
2	Japan	Hiroshima	yes	Yes	Draft
3	Philippines	Cebu	yes	Yes	Draft
4	Thailand	Songkhla	yes	Yes	Draft
5	Vietnam	Vung Tau	yes	Yes	Draft
6	Cambodia	Sihanoukville	yes	no	Draft
7	Indonesia	Belawan	yes	no	Draft
8	Indonesia	Semarang	yes	no	Draft
9	Malaysia	Penang	yes	no	Draft
10	Myanmar	Yangon	yes	no	Draft
11	Vietnam	Ho Chi Minh	yes	no	Draft
12	Brunei	Muara	yes	Yes	Demand
13	Malaysia	Kuantan	yes	Yes	Demand
14	Malaysia	Kuching	yes	Yes	Demand
15	Malaysia	Sibu	yes	Yes	Demand
16	Vietnam	Danang	yes	Yes	Demand
17	China	Da Chan Bay	no	Yes	Demand
18	China	Yantai	no	Yes	Demand
19	Indonesia	Panjang	no	Yes	Demand
20	Japan	Hachinohe	no	Yes	Demand
21	Japan	Shimizu	no	Yes	Demand
22	Japan	Tomakomai	no	Yes	Demand
23	Malaysia	Labuan	no	Yes	Demand
24	Philippines	General Santos	no	Yes	Demand
25	Philippines	Subic Bay	no	Yes	Demand

1. FE ports: There are 25 feeder ports (out of 56 in the sample) in FE region that are not ready for larger containerships with more than 4000 TEU capacity (**Table 3**).
    a. Among those, 16 ports have draft limitations.
    b. 19 ports have trade constraints. However, since there are a lot of cargo volume in the FE region overall, this constraint can be easily resolved. (The average TEU throughput in FE is 35,679.)
    c. Especially interesting is the ports with NO draft limitations but demand constraints, that is 2 ports in China, 3 ports in Japan, 2 ports in Philippines, and 1 port in Indonesia and 1 in Malaysia. They are mostly likely to switch to larger vessels in the future. These 9 ports had together 17,461 TEU intra-regional throughputs in 2017 weekly.
    d. The other 32 FE ports with no demand or draft limitations had total intra-regional 1.793 million TEU, that is roughly 179 Panamax vessels (5000TEU)'s weekly service volume.

2. CA ports: There are 54 feeder ports (out of 55) in CA region that are not ready for larger containerships with more than 4000 TEU capacity.
    a. Among them, 31 ports have draft limitations, and 54 ports have trade constraints.
    b. For the CA region, the main constraints are from trade volume.
    c. There are 23 ports with **NO** draft limitations but demand constraints (Listed in **Table 4**). These ports could switch to larger vessels in the future, if the liner companies would reduce call frequency or merge some feeder service routes. Some feeder ports may be dropped from current services while the others will get more throughputs to support using larger Panamax vessels. These 23 ports had totally 35,867 TEU intra-regional trade volume in 2017 weekly.
3. EU ports: There are 115 ports (out of 123) in EU region that are not ready for larger containerships with more than 4000 TEU capacity.
    a. Among them, 42 ports have draft limitations, and 113 ports have trade constraints.
    b. There are 73 ports with **NO** draft limitations but demand constraints (Listed in **Table 5**). Similarly like the CA ports, these ports could switch to larger vessels in the future, if the liner companies merge some feeder service routes. These 73 ports had totally 84,847 TEU intra-regional trade volume in 2017 weekly.
    c. The other 8 EU ports with no demand or draft limitations had total 87,740 TEU intra-regional volume.

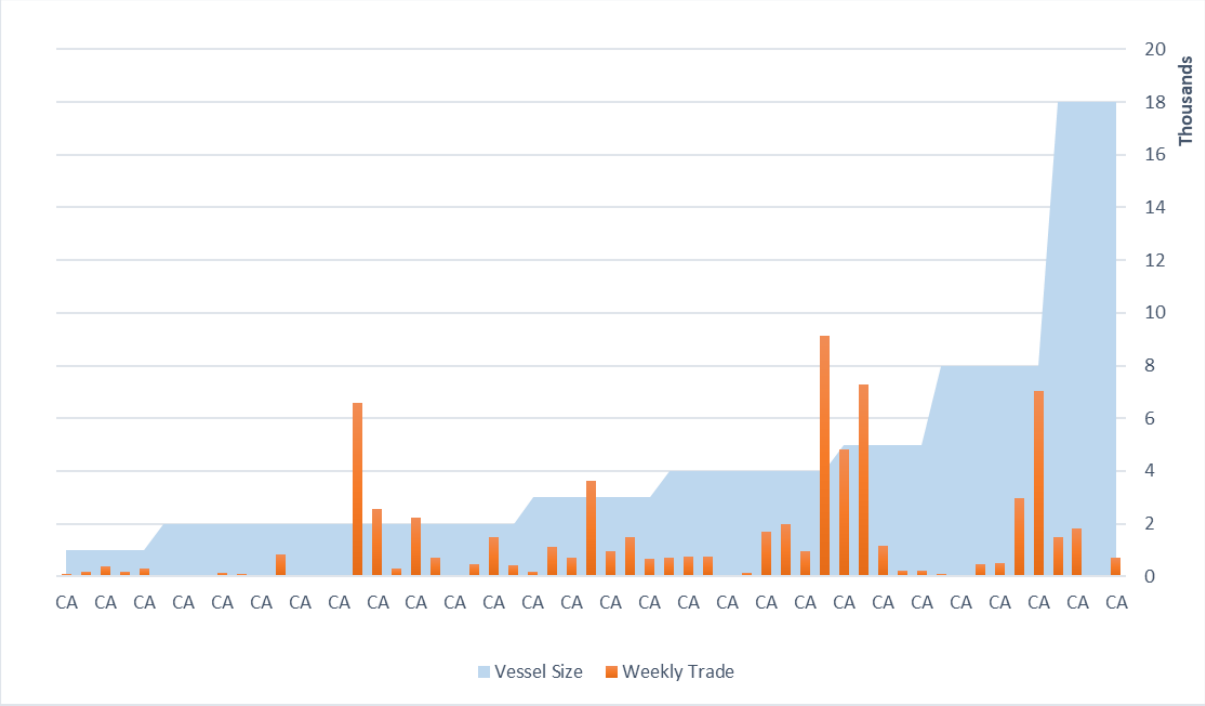

Figure 4: CA ports: Weekly trade volume vs. maximum draft size (TEU)

Table 4: CA ports with NO draft constraint but demand constraints

Num	*Country*	*Ports*	*Draft constraint*	*Demand constraint*	*Bottleneck*
1	Colombia	Cartagena - Colombia	No	Yes	Demand
2	Colombia	Santa Marta	No	Yes	Demand
3	Jamaica	Kingston	No	Yes	Demand
4	Netherlands Antilles	Willemstad	No	Yes	Demand
5	Panama	Cristobal	No	Yes	Demand
6	Panama	Manzanillo Panama	No	Yes	Demand
7	Venezuela	La Guaira	No	Yes	Demand
8	Argentina	Bahia Blanca	No	Yes	Demand
9	Brazil	Paranagua	No	Yes	Demand
10	Brazil	Sao Francisco do Sul	No	Yes	Demand
11	Brazil	Rio Grande	No	Yes	Demand
12	Brazil	Itapoa	No	Yes	Demand
13	Brazil	Rio De Janeiro	No	Yes	Demand
14	Brazil	Santos	No	Yes	Demand
15	Brazil	Suape	No	Yes	Demand
16	Brazil	Pecem	No	Yes	Demand
17	Brazil	Itaguai	No	Yes	Demand
18	Chile	Arica	No	Yes	Demand
19	Chile	San Vicente	No	Yes	Demand
20	Chile	Puerto Angamos	No	Yes	Demand
21	Chile	Coronel	No	Yes	Demand
22	Chile	San Antonio	No	Yes	Demand
23	Chile	Lirquen	No	Yes	Demand

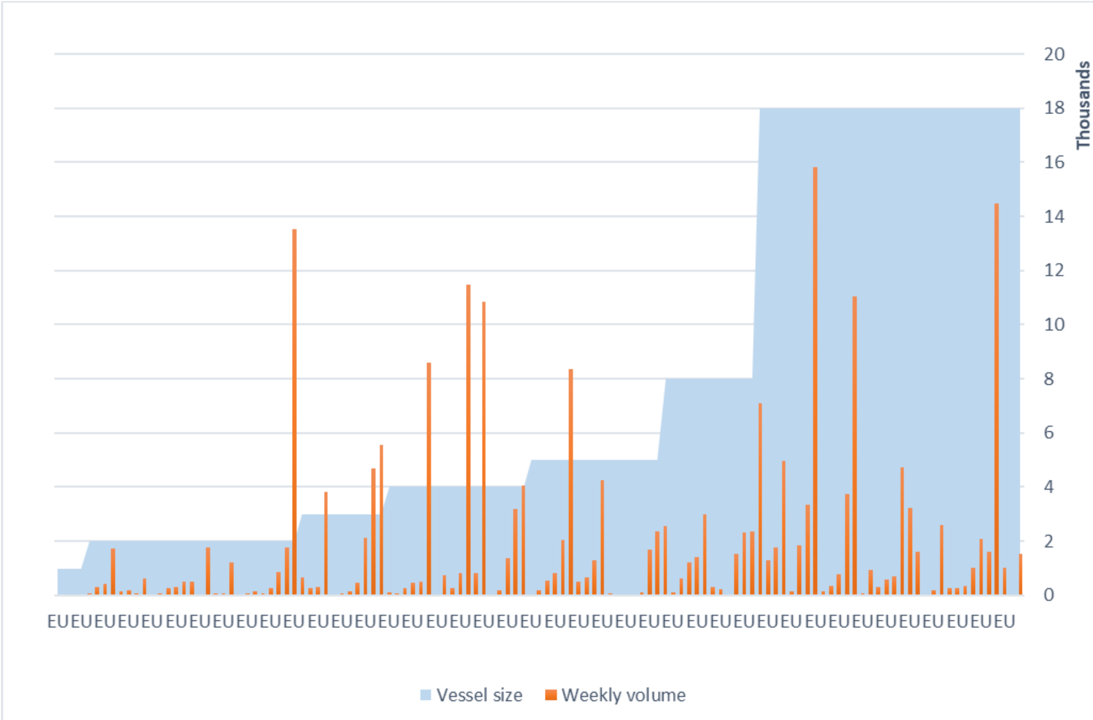

Figure 5: EU ports: Weekly trade volume vs. maximum draft size (TEU)

Table 5: EU ports with NO draft constraint but demand constraints

Num	*Sub-region*	*Country*	*Ports*	*Draft constraint*	*Demand constraint*
1	East Med & Black Sea	Bulgaria	Burgas	No	Yes
2	East Med & Black Sea	Croatia	Rijeka	No	Yes
3	East Med & Black Sea	Cyprus	Limassol	No	Yes
4	East Med & Black Sea	Egypt	Port Said	No	Yes
5	East Med & Black Sea	Greece	Piraeus	No	Yes
6	East Med & Black Sea	Lebanon	Beirut	No	Yes
7	East Med & Black Sea	Russia	Novorossiysk	No	Yes
8	East Med & Black Sea	Slovenia	Koper	No	Yes
9	East Med & Black Sea	Turkey	Kumport	No	Yes
10	East Med & Black Sea	Turkey	Ambarli	No	Yes
11	East Med & Black Sea	Turkey	Iskenderun	No	Yes
12	East Med & Black Sea	Ukraine	Odessa	No	Yes
13	Northern Europe	Belgium	Zeebrugge	No	Yes
14	Northern Europe	Denmark	Aarhus	No	Yes
15	Northern Europe	Denmark	Fredericia	No	Yes
16	Northern Europe	Eire	Cork	No	Yes
17	Northern Europe	Finland	Kotka	No	Yes
18	Northern Europe	France	Bassens	No	Yes
19	Northern Europe	France	Le Havre	No	Yes
20	Northern Europe	France	Dunkerque	No	Yes
21	Northern Europe	France	Cherbourg	No	Yes
22	Northern Europe	Germany	Bremerhaven	No	Yes
23	Northern Europe	Latvia	Riga	No	Yes
24	Northern Europe	Lithuania	Klaipeda	No	Yes
25	Northern Europe	Netherlands	Amsterdam	No	Yes
26	Northern Europe	Norway	Alesund	No	Yes
27	Northern Europe	Norway	Bergen	No	Yes
28	Northern Europe	Norway	Heroya	No	Yes
29	Northern Europe	Norway	Brevik	No	Yes
30	Northern Europe	Norway	Haugesund	No	Yes
31	Northern Europe	Norway	Stavanger	No	Yes
32	Northern Europe	Poland	Gdynia	No	Yes
33	Northern Europe	Poland	Gdansk	No	Yes
34	Northern Europe	Portugal	Lisbon	No	Yes
35	Northern Europe	Portugal	Sines	No	Yes
36	Northern Europe	Spain	Vigo	No	Yes
37	Northern Europe	Spain	Gijon	No	Yes
38	Northern Europe	Spain	Bilbao	No	Yes
39	Northern Europe	Sweden	Helsingborg	No	Yes

40	Northern Europe	Sweden	Malmo	No	Yes
41	Northern Europe	Sweden	Norrkoping	No	Yes
42	Northern Europe	Sweden	Gothenburg	No	Yes
43	Northern Europe	United Kingdom	Portbury	No	Yes
44	Northern Europe	United Kingdom	Liverpool	No	Yes
45	Northern Europe	United Kingdom	London Gateway	No	Yes
46	Northern Europe	United Kingdom	Tilbury	No	Yes
47	Northern Europe	United Kingdom	Southampton	No	Yes
48	Northern Europe	United Kingdom	Teesport	No	Yes
49	Northern Europe	United Kingdom	Thamesport	No	Yes
50	West Med & North Africa	France	Marseille	No	Yes
51	West Med & North Africa	France	Fos-sur-Mer	No	Yes
52	West Med & North Africa	Italy	Bari	No	Yes
53	West Med & North Africa	Italy	Ancona	No	Yes
54	West Med & North Africa	Italy	Venice	No	Yes
55	West Med & North Africa	Italy	Naples	No	Yes
56	West Med & North Africa	Italy	Palermo	No	Yes
57	West Med & North Africa	Italy	La Spezia	No	Yes
58	West Med & North Africa	Italy	Genoa	No	Yes
59	West Med & North Africa	Italy	Gioia Tauro	No	Yes
60	West Med & North Africa	Italy	Cagliari	No	Yes
61	West Med & North Africa	Italy	Trieste	No	Yes
62	West Med & North Africa	Italy	Taranto	No	Yes
63	West Med & North Africa	Malta	Valletta	No	Yes
64	West Med & North Africa	Morocco	Tanger MED	No	Yes
65	West Med & North Africa	Spain	Cadiz	No	Yes
66	West Med & North Africa	Spain	Tenerife	No	Yes
67	West Med & North Africa	Spain	Tarragona	No	Yes
68	West Med & North Africa	Spain	Valencia	No	Yes
69	West Med & North Africa	Spain	Barcelona	No	Yes
70	West Med & North Africa	Spain	Malaga	No	Yes
71	West Med & North Africa	Spain	Cartagena - Spain	No	Yes
72	West Med & North Africa	Spain	Las Palmas	No	Yes
73	West Med & North Africa	Spain	Algeciras	No	Yes

The general conditions of the 3 regions are summarized in Table 6. And Alphaliner data were further checked to get a general condition of current intra-regional liner services in these regions, summarized in Table 7.

For example, within the European region, North Europe has 149 services with 297 containerships ranging from 56 TEU to 4253 TEU. Intra-Mediterranean region has 167 services for with totally 325 vessels currently in service. There is one route (Spain-France-Aegean Sea+Morocco-Spain) applying 5 vessels between 4k to 5k TEU, and another one with 6 vessels between 5k to 7k TEU, and one route with 7 vessels of 4200TEU. North Europe-Mediteranean has 23 services for with 30 vessels above 5000TEU and 49 below. The USEC/Caribbeans & North Coast of South America + Local Caribb./NCSA services region has totally 118 services with 211 vessels. There is one service with 10 vessels between 4600 to 5000 TEU and one service with 5 vessels around 4200TEU. The ECSA, WCSA and WCCA domain has 46 services with 87 vessels. There is one service applying 5 vessels 3700 to 4800TEU, one service with 3 vessels between 3700 to 5560 TEU.

Table 6: Regional summaries

	EU	*CA*	*FE*
Total ports	123	55	57
Ports with barrier(s)	115	54	25
Ports with barrier-Draft	42	31	16
Ports with barrier-Demand	113	54	19
Ports with barrier-Demand Only	73 (84,847 TEU-handling)	23 (35,867 TEU-handling)	9 (17,461 TEU-handling)
Ports with No barrier	8 (87,740 TEU-handling)	1 (9,110 TEU-handling)	32 (1,793,000 TEU-handling)

Table 7: Current intra-regional liner services

	Services	*Vessels*	*Vessels>4200TEU*
North EU	149	297	0
Med	167	325	18
North EU-Med	23	79	30
EU	**339**	**701**	**48**
NE/SE	503	1086	22
China domestic (including Taiwan)	141	711	35
FE	**644**	**1797**	**57**
USEC/Caribbeans & North Coast of South America + Local Caribb./NCSA	118	211	10
ECSA,WCSA, WCCA	46	87	3
CA	**164**	**298**	**13**

4. General findings and discussions

Shippers moving goods on smaller trade lanes that used to be served by feeder vessels (below 4200 TEU) should be prepared for less frequent service and port congestion, as part of the cascading impact that carriers want to deploy larger ships on those routes by merging some current port calls if the physical constrains permit at the ports. This will be especially serious for Far East intra-regional shipments, as there is enough regional trade volume while the percentage of ports with draft constraints is smallest (29%), compared to intra-European (34%) and Central American (56%). Central America has the strongest draft constraints, as well as trade constraints (96%) in contrast to EU (91%) and FE (34%).

- There are 25 feeder ports (out of 56 in the sample) in FE region that are not ready for larger containerships with more than 4000 TEU capacity. Among those, 16 ports have draft limitations. 19 ports have trade constraints. Only 9 ports have NO draft limitations but demand constraints. However, since there are a lot of cargo volume in the FE region overall, the trade constraint can be easily resolved. (The average TEU throughput in FE is 35,679.)
- There are 115 ports (out of 123) in EU region that are not ready for Panamax containerships. Among them, 42 ports have draft limitations, and 113 ports have trade constraints. There are 73 ports with **NO** draft limitations but demand constraints, which could switch to larger vessels in the future, if the liner companies merge some feeder service routes. Some feeder ports may be dropped from current services while the others will get more throughputs to support using larger Panamax vessels.
- For CA ports, there are 54 feeder ports (out of 55) that are not ready for Panamax ships. Among them, 31 ports have draft limitations, and 54 ports have trade constraints. There are 23 ports with **NO** draft limitations but demand constraints which could switch to larger vessels in the future, if services will be merged.

In the end, it should be mentioned again, that the cascading barriers and vessel distribution developments in the future will be greatly affected by how the liners will re-configurate the service networks, and new port projects to expand current facilities at some of the ports. Both are not covered by this current report.

Appendix A

Figure A1: Intra-regional shipment regions (Source: image copied from Alphaliner.com)

Table A1: Draft requirement to vessel size conversion

Draft (m)		*Estimate size (TEU)*
from	*to*	
5	9	1,000
9	11	2,000
11	12	3,000
12	13	4,000
13	14	5,000
14	15	8,000
15	50	18,000

Source: compiled based on Rodrigue (2017)[4]

[4] Rodrigue, J.-P. (2017) The Geography of Transport Systems, fourth edition. Routledge, New York.