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Coalition in Utilization Capacity in Container Transportation Services

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Abstract: Freight forwarders are the crucial partner for the carrier to utilize its capacity. Carrier will be prepared the capacity while freight forwarder is generated demand, which is intended to use the capacity. Carrier, firstly, offers capacities to the freight forwarder before selling those under spot market mechanism. Therefore, prior to the distribution process, freight forwarders booked some amount of capacities and they are trying to sell those to shippers that have the shipping demand. They generate profit from each of the capacity that has been sold. Since freight forwarders had been booked just before demand arise, then they are faced two kinds of risk. Either freight forwarders are dealing with the overbooked capacity or shortage capacity. This article provides the optimum capacity-booking model that derivate from freight forwarder expected profit model. Freight forwarders will earn a maximum profit at a particular number of capacity booked. Further study is extended in the coalition scenario to response demand uncertainty. Under the proposed scenario, freight forwarders have the opportunity to share capacity without any discrimination rate. The overbooked and shortage capacity tends to decrease and it will improve the profitability. The result demonstrated that coalition is not only affected the expected profit but also impact to the quantity of capacity booked.

Keywords: Coalition; freight forwarder; capacity booked; optimum capacity-booking

1. Introduction

In the maritime shipping industry, the freight forwarder is commonly known as an intermediary between carrier and shippers. With their logistics skills, freight forwarder has the ability to collect and arrange demand easily. Freight forwarder also has the privilege to book a number of capacity from carrier to satisfy demand. As a commitment, freight forwarders may pay a fixed amount in advance for the number of capacity booked, or pay the booking fee in the beginning period then pay off the remainder at the end of the period. Even though, in some condition, a freight forwarder allowed to postpone the payment until capacity already utilized [1].

As an intermediary, the freight forwarder earns profit from the difference between selling capacity rate that is charged to shippers and buying rate that is paid to the carrier for capacity utilization. A profit may arise once capacity had utilized. Otherwise, each unutilized capacity is

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becoming revenue loss and cost for the freight forwarder. Capacity here can be considered as a newsvendor inventory problem since the unutilized capacity will be wasted once the vessel departed to its destination. As a newsvendor, freight forwarder must decide the amount of capacity to book to satisfy demand optimally without sacrificed his profit.

Clearly that a freight forwarder generates profit from capacity utilization. Unfortunately, shipping demand is fluctuated [2], that leads to unstable utilization. The diminishing demand resulted in a high level of capacity wasted and lower revenue, while over demand resulted in additional capacity that caused higher cost. Those affect to freight forwarder's profit. Furthermore, profitability improvement is becoming the next issue for the freight forwarder. Since the business model indicates relatively low margins and is highly sensitive to demand volume, therefore freight forwarder needs to increase his revenue and reduce purchasing cost to survive in the business [3].

It is not easy for the freight forwarder to neither increase capacity-selling rate nor reduces capacity-buying rate. In practice, a freight forwarder is unable to influencing and create demand [4] however, the large freight forwarders have more advantages to control capacity utilization, due to their wider resources and a good market's reputation. The small-medium freight forwarders are advised to set up a cooperation to survive in this business and leverage their profits [1,5–9].

Most researchers study capacity management from the perspective of individual freight forwarder. Gupta [1] proposed a flexible capacity contract for an adjusted number of capacity booked. Bing and Bhatnagar [10] divided the booking time into several periods to balance capacity and demand. Li and Zhang [11] suggested the model for re-selling capacity to another freight forwarder. Lin, Lee, and Yang [12] used a buy-back mechanism for the remaining capacity.

In contrast to the above studies, the paper that discuss a cooperation to utilize capacity in the shipping industry is still rare. Krajewska and Kopfer [5] and Krajewska, Kopfer and Laporte [6] consider collaboration planning for exchanging shipping demand. To satisfy the demand, freight forwarders may choose the strategy that brings more benefit, either self-fulfilment or sub-contracting. Their proposed collaboration model is suitable for a coalition of freight forwarder firms in the same market.

This paper has focused on maximum expected profit that similar to previous researches. However to improve profitability, unlike the previous researchers, this paper proposes cooperation to share capacity under the same rate (coalition). Moreover, this paper has two goals. First, it develops a formal model of optimum capacity booking which can be used to find the particular booking number to give a maximum profit. Since the demand is uncertain, then the model must consider any potential number of capacity wasted and abandon demand at the same time. Note that the real number of capacity usage usually realizes at the end of the period. The second goal, this paper proposes a coalition scenario that can be embedded to mitigate the negative effect of uncertain demand. For the oversold, freight forwarder has an opportunity to get additional capacity automatically from others without worry for the higher rate. While for the overbooked, the excess capacity is automatically shared with other. Therefore, by implementing the proposed strategy, the freight forwarder can adjust the overbooked or oversold to a minimum number.

The rest of the paper is organized as follows: Section 2 presents the problem formulation in this research. In Section 3, a model for optimum capacity booked is presented. Section 4 constitutes numerical experiments and is followed by a conclusion in Section 5.

2. Problem formulation

This paper considers capacity utilization for a single origin-destination route. A shipping system is, usually, consisting of one carrier and many freight forwarders (FF_n), where n is indicating the number of freight forwarder ($n = 1, 2 ...$). The carrier sells capacity at a single rate (r_0) for all freight forwarders. Then freight forwarders re-sell it with some specific shipping rate (R_n) to the shippers. Though the real demand has not appeared yet, each freight forwarder must book the number of capacity immediately (q_n) based on historical data. For each unit capacity booked, carrier charged the booking fee (βr_0). Furthermore, for each additional capacity from the spot market, carrier charged some extra cost (γr_0) to the freight forwarder. The basic system of capacity utilization is illustrated at Figure 1.

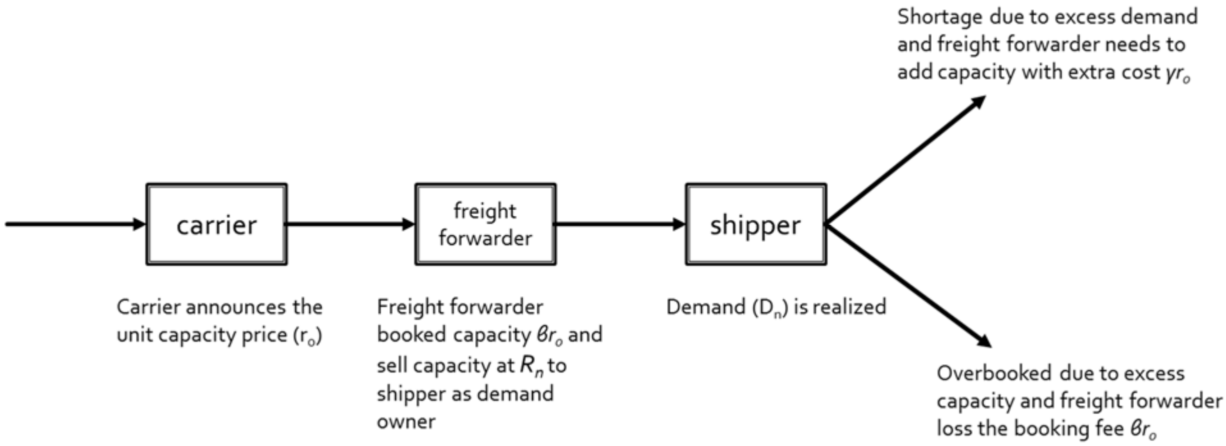

Figure 1. Basic utilisation capacity

With uncertainty demand, freight forwarder may deal with two unideal situations. If capacity booked is higher than realized demand (D_n) or $q_n > D_n$, then freight forwarder is facing the overbooked. The freight forwarder will be lost some of the booking fees that already paid before. Otherwise, the freight forwarder is experiencing shortage when capacity booked lower than demand or $q_n < D_n$. Additional capacity will deduct the freight forwarder's margin. Those two situations will affect the profit (Π_{FFn}).

Since the freight forwarder is a profit maximizer, it must consider the overbooked and oversold altogether. Given that freight forwarder has the capacity constraint, the expected profit could be formulated:

$$\Pi_{FFn} = E[(R_n - r_0)min(q_n, D_n) - \gamma r_0[D_n - q_n]^+ - \beta r_0[q_n - D_n]^+] \quad (1)$$

where

$$[D_n - q_n]^+ = \begin{cases} D_n - q_n & if(D_n - q_n) > 0 \\ 0 & if(D_n - q_n) < 0 \\ 0 & if(D_n - q_n) = 0 \end{cases}$$

to accommodate the shortage capacity condition, and

$$[q_n - D_n]^+ = \begin{cases} q_n - D_n & if(q_n - D_n) > 0 \\ 0 & if(q_n - D_n) < 0 \\ 0 & if(q_n - D_n) = 0 \end{cases}$$

to accommodate the overbooked capacity condition.

To improve the profitability, freight forwarder must reduce the number of overbooked or shortage capacity. That will be easier to achieve if the freight forwarder has the opportunity to give away its excess capacity to other parties. For example in a shipping system that is consisting of one carrier and two freight forwarders (FF_1 and FF_2). FF_1 is facing overbooked when his capacity booked is higher than the number of demand or $(q_1 – D_1) > 0$. The number of that overbooked can reduce if FF_2 is having the capacity shortage or $(D_2 - q_2) > 0$. The system is illustrated in Figure 2.

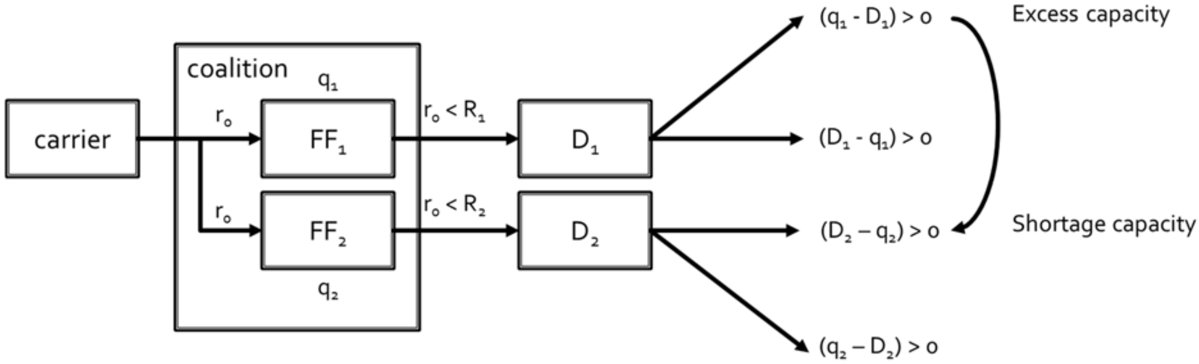

Figure 2. Coalition to share excess capacity

The system will change the number of overbooked and oversold. The overbooked for freight forwarder #1 will be defined as $\left((q_1 - D_1) - (D_2 - q_2)\right) > 0$ and the shortage capacity will be defined as $\left((D_1 - q_1) - (q_2 - D_2)\right) > 0$. While freight forwarder #2 faced overbooked if $\left((q_2 - D_2) - (D_1 - q_1)\right) > 0$ and faced shortage capacity when $\left((D_2 - q_2) - (q_1 - D_1)\right) > 0$.

This paper assumed that demand is generated based on a fitted normal distribution of practical data. Usually, the carrier has enough capacity to fulfilled total demand from all freight forwarder. Capacity sharing occurs at the end of the period where total real demand has been declared.

3. Optimal solution

The optimum booking capacity in this paper is derived from the Equation (1). For freight forwarder #1, the expected profit is preserved by the equation as below:

$$\Pi_{FF1} = E[(R_1 - r_0)min(q_1, D_1) - \gamma r_0[D_1 - q_1]^+ - \beta r_0[q_1 - D_1]^+] \tag{2}$$

where

$$[D_1 - q_1]^+ = \begin{cases} D_1 - q_1 & if(D_1 - q_1) > 0 \\ 0 & if\ (D_1 - q_1) < 0 \\ 0 & if\ (D_1 - q_1) = 0 \end{cases}$$

$$[q_1 - D_1]^+ = \begin{cases} q_1 - D_1 & if(q_1 - D_1) > 0 \\ 0 & if\ (q_1 - D_1) < 0 \\ 0 & if\ (q_1 - D_1) = 0 \end{cases}$$

Thus, Equation (2) can be rewritten as follow:

$$\Pi_{FF1} = (R_1 - r_0)\left(\int_0^{q_1} D_1 f_1(D_1)dD_1 + \int_{q_1}^{\infty} q_1 f_1(D_1)dD_1\right) - \gamma r_0 \int_{q_1}^{\infty} (D_1 - q_1)f_1(D_1)dD_1$$
$$-\beta r_0 \int_0^{q_1}(q_1 - D_1)f_1(D_1)dD_1 \tag{3}$$

With $f_1(D_1)$ is the demand density function. It used to determine the probability of the random variable that falls within a particular range of a capacity level. To find the optimal capacity booked, equation (3) needs to derivate with respect to q_1:

$$\frac{d\Pi_{FF1}}{dq_1} = (R_1 - r_0)\big(1 - F_1(q_1)\big) + \gamma r_0\big(1 - F_1(q_1)\big) - \beta r_0\big(F_1(q_1)\big) = 0 \qquad (4)$$

By rearranging the equation, the optimal number capacity booked for freight forwarder #1, can be determined as:

$$q_1 = F_1^{-1}\left(\frac{R_1 - r_0 + \gamma r_0}{R_1 - r_0 + \gamma r_0 + \beta r_0}\right) \qquad (5)$$

where F_1^{-1} is the inverse cumulative distribution function of the demand faced by freight forwarder #1. It is eligible to take maximum profit at q_1.
The similar mechanism used to determine the formulation of q_2 that maximizes the profit of freight forwarder #2. The expected profit for freight forwarder #2 expressed as:

$$\Pi_{FF2} = E[(R_2 - r_0)min(q_2, D_2) - \gamma r_0[D_2 - q_2]^+ - \beta r_0[q_2 - D_2]^+] \qquad (6)$$

The optimal number capacity booked for freight forwarder #2, can be determined as:

$$q_2 = F_2^{-1}\left(\frac{R_2 - r_0 + \gamma r_0}{R_2 - r_0 + \gamma r_0 + \beta r_0}\right) \qquad (7)$$

Under a coalition scenario, freight forwarders have the opportunity to share their remaining capacities. Cost reduction will occur as a result of a declining number of overbooked or oversold. In a coalition scenario, the expected profit for freight forwarder #1 is modified as:

$$\Pi_{FF1} = E[(R_1 - r_0)min(q_1, D_1) - \gamma r_0[(D_1 - q_1) - (q_2 - D_2)]^+ - \beta r_0[(q_1 - D_1) - (D_2 - q_2)]^+] \qquad (8)$$

While expected profit for freight forwarder #2 is expressed as:

$$\Pi_{FF2} = E[(R_2 - r_0)min(q_2, D_2) - \gamma r_0[(D_2 - q_2) - (q_1 - D_1)]^+ - \beta r_0[(q_2 - D_2) - (D_1 - q_1)]^+] \qquad (9)$$

Since the number of overbooked and oversold are decrease then the expected profit may increase easily.

4. Numerical experiment

The model was tested by simulation in Microsoft EXCEL with 5,000 demand data generated under a normal distribution. Based on the practical data, there are two demand patterns for freight forwarder #1 and #2: D_{FF1}~N (200, 90) and D_{FF2}~N (170, 70) respectively. The number of optimum capacity booked at 262 TEUs (standing for twenty-foot equivalent unit, a common unit to measure capacity in the container vessel) for freight forwarder #1 and 220 TEUs for freight forwarder #2. In the booking period, the carrier offers each capacity for \$700 and, from that rate; freight forwarder needs to put \$210 as the booking fee. In the spot market, additional capacity will be charged \$1,050 without any obligation for booking fee.

Each freight forwarder runs for 20 iterations to find the average expected profit. The result shows that the maximum average expected profit for freight forwarder #1 and #2 at \$36,128 and \$35,518 respectively. Then, a set of number, which is diverged than a number of optimum capacity booked, is tested to validate the model. The result can be found in Table 1 and Table 2 for freight forwarder #1 and freight forwarder #2 respectively.

Next step is used as the same input to find the average profit for coalition scenario. Through coalition, the maximum average expected profit could be reached at \$39,973 for freight forwarder

#1 and $39,208 for freight forwarder #2. The result can be found in Table 3 and Table 4 for freight forwarder #1 and freight forwarder #2 respectively.

Table 1. Average profit for freight forwarder #1

	A set of number (in TEUs)														
	Decreasing optimum capacity number							Optimum capacity number	Increasing optimum capacity number						
	117	157	187	212	232	247	257	262	267	277	292	312	337	367	407
Iteration 1	(1,278)	16,405	26,201	31,723	34,573	35,788	36,164	36,228	36,220	35,992	35,124	33,150	29,665	24,495	16,481
2	(1,109)	16,725	26,603	32,078	34,688	35,691	35,955	35,961	35,884	35,525	34,532	32,440	28,960	23,893	15,969
3	(1,805)	15,860	25,563	31,174	34,065	35,286	35,709	35,811	35,829	35,630	34,811	32,977	29,626	24,580	16,642
4	(1,062)	16,788	26,588	32,163	34,996	36,176	36,536	36,610	36,607	36,372	35,507	33,456	29,902	24,766	16,765
5	(1,516)	16,185	26,110	31,777	34,532	35,667	35,993	36,044	36,027	35,792	34,951	32,983	29,596	24,519	16,544
6	(1,131)	16,831	26,830	32,534	35,354	36,520	36,847	36,890	36,856	36,578	35,669	33,597	30,035	24,856	16,882
7	(1,621)	16,302	26,208	31,892	34,610	35,719	36,048	36,093	36,070	35,823	34,981	33,096	29,780	24,803	16,961
8	(1,397)	16,219	26,026	31,702	34,469	35,595	35,931	35,975	35,938	35,660	34,753	32,817	29,392	24,291	16,395
9	(982)	16,484	26,093	31,670	34,422	35,545	35,871	35,898	35,851	35,562	34,659	32,664	29,209	24,053	16,045
10	(1,316)	16,454	26,394	32,100	34,890	36,087	36,455	36,520	36,509	36,285	35,439	33,516	30,125	25,087	17,121
11	(1,356)	16,419	26,279	31,955	34,744	35,907	36,250	36,297	36,256	35,967	35,017	33,021	29,572	24,485	16,488
12	(1,220)	16,478	26,201	31,735	34,532	35,638	35,952	35,986	35,936	35,616	34,700	32,758	29,385	24,393	16,452
13	(1,460)	16,278	26,037	31,667	34,596	35,931	36,377	36,468	36,476	36,287	35,463	33,567	30,186	25,113	17,174
14	(991)	16,700	26,471	32,137	34,847	35,942	36,267	36,303	36,253	35,952	35,084	33,131	29,717	24,596	16,586
15	(1,155)	16,414	26,076	31,492	34,206	35,343	35,703	35,770	35,753	35,481	34,564	32,588	29,172	24,097	16,097
16	(1,235)	16,366	26,277	31,932	34,663	35,722	36,014	36,046	36,008	35,712	34,773	32,796	29,389	24,328	16,377
17	(755)	16,816	26,563	32,027	34,620	35,538	35,722	35,702	35,605	35,228	34,202	32,122	28,615	23,456	15,464
18	(1,391)	16,298	26,112	31,748	34,556	35,709	36,051	36,098	36,071	35,821	34,963	33,013	29,544	24,372	16,387
19	(1,629)	16,235	26,180	31,915	34,800	35,968	36,313	36,363	36,337	36,073	35,209	33,213	29,777	24,774	16,851
20	(1,079)	16,422	25,935	31,369	34,027	35,120	35,445	35,491	35,462	35,190	34,291	32,238	28,731	23,585	15,591
Average expected profit FF1	(1,274)	16,434	26,237	31,840	34,610	35,745	36,080	36,128	36,097	35,827	34,935	32,957	29,519	24,427	16,464

Table 2. Average profit for freight forwarder #2

	A set of number (in TEUs)														
	Decreasing optimum capacity number							Optimum capacity number	Increasing optimum capacity number						
	75	115	145	170	190	205	215	220	225	235	250	270	295	325	365
Iteration 1	(11,527)	10,168	22,792	30,172	33,722	35,093	35,450	35,466	35,385	34,957	33,734	31,242	27,156	21,429	13,245
2	(11,922)	9,997	22,866	30,384	34,151	35,719	36,153	36,216	36,189	35,865	34,744	32,346	28,341	22,606	14,419
3	(11,828)	9,807	22,331	29,626	33,212	34,719	35,173	35,244	35,208	34,854	33,724	31,327	27,361	21,757	13,681
4	(11,785)	10,010	22,608	29,912	33,580	35,034	35,458	35,517	35,480	35,150	34,112	31,779	27,829	22,206	14,021
5	(11,447)	10,390	23,003	30,283	33,740	35,013	35,358	35,387	35,314	34,914	33,729	31,300	27,250	21,572	13,399
6	(11,505)	10,110	22,683	30,068	33,663	35,016	35,389	35,422	35,368	34,978	33,808	31,338	27,227	21,546	13,383
7	(11,446)	10,141	22,563	29,759	33,292	34,644	35,007	35,038	34,958	34,528	33,294	30,835	26,798	21,140	12,993
8	(11,975)	10,029	22,861	30,404	34,209	35,749	36,160	36,196	36,148	35,784	34,653	32,250	28,237	22,527	14,319
9	(11,667)	9,980	22,582	29,923	33,462	34,839	35,219	35,251	35,187	34,790	33,671	31,300	27,280	21,628	13,453
10	(11,779)	10,083	22,707	29,990	33,606	35,035	35,434	35,485	35,446	35,071	33,908	31,456	27,483	21,889	13,744
11	(11,870)	9,789	22,377	29,737	33,541	35,135	35,627	35,723	35,727	35,437	34,359	31,960	27,899	22,180	13,968
12	(11,221)	10,270	22,628	29,705	33,100	34,418	34,745	34,771	34,716	34,341	33,178	30,722	26,623	20,890	12,764
13	(11,131)	10,752	23,382	30,449	33,837	35,108	35,406	35,398	35,299	34,823	33,478	30,849	26,679	20,903	12,711
14	(11,557)	10,197	22,730	29,985	33,594	34,994	35,365	35,407	35,352	34,986	33,866	31,439	27,414	21,727	13,580
15	(11,821)	9,943	22,476	29,815	33,481	35,054	35,546	35,621	35,601	35,275	34,125	31,679	27,667	21,956	13,751
16	(12,169)	9,588	22,223	29,614	33,375	34,980	35,507	35,626	35,655	35,418	34,432	32,104	28,083	22,447	14,307
17	(11,476)	10,231	22,798	30,075	33,661	35,040	35,424	35,477	35,433	35,057	33,907	31,475	27,436	21,684	13,445
18	(12,032)	9,879	22,773	30,285	34,002	35,511	35,948	36,007	35,968	35,597	34,422	31,959	27,872	22,177	14,034
19	(12,035)	9,601	22,308	29,663	33,369	34,856	35,318	35,393	35,367	35,013	33,854	31,466	27,502	21,833	13,659
20	(11,763)	10,063	22,739	30,047	33,713	35,245	35,655	35,724	35,691	35,318	34,119	31,605	27,580	21,968	13,841
Average expected profit FF2	(11,698)	10,051	22,672	29,995	33,616	35,060	35,467	35,518	35,475	35,108	33,956	31,522	27,486	21,803	13,636

Table 3. Average profit for freight forwarder #1 in the coalition with freight forwarder #2

	A set of number (in TEUs)														
	Decreasing optimum capacity number							Optimum capacity number	Increasing optimum capacity number						
	117	157	187	212	232	247	257	262	267	277	292	312	337	367	407
Iteration 1	326	19,876	30,846	36,886	39,651	40,536	40,586	40,483	40,293	39,677	38,208	35,528	31,396	25,828	17,826
2	647	20,049	30,913	36,789	39,286	40,002	39,974	39,838	39,627	38,946	37,394	34,672	30,521	24,855	16,785
3	742	19,989	30,624	36,467	39,040	39,764	39,750	39,603	39,365	38,665	37,122	34,356	30,160	24,549	16,530
4	1,190	20,467	31,110	36,789	39,206	39,818	39,697	39,498	39,230	38,478	36,872	34,056	29,787	24,081	16,011
5	595	19,903	30,789	36,879	39,592	40,348	40,325	40,170	39,933	39,227	37,685	34,947	30,747	25,153	17,117
6	1,358	20,596	31,203	36,866	39,174	39,724	39,563	39,349	39,052	38,246	36,613	33,802	29,615	23,905	15,820
7	1,073	20,203	30,794	36,413	38,692	39,323	39,260	39,083	38,831	38,105	36,562	33,795	29,609	23,949	15,899
8	738	19,997	30,727	36,529	38,982	39,691	39,686	39,543	39,314	38,614	37,111	34,391	30,244	24,606	16,551
9	962	20,267	30,909	36,673	39,090	39,774	39,740	39,579	39,342	38,640	37,110	34,433	30,261	24,639	16,635
10	548	19,940	30,548	36,366	38,986	39,773	39,773	39,633	39,404	38,736	37,239	34,546	30,453	24,884	16,889
11	1,177	20,438	30,998	36,684	39,054	39,575	39,432	39,242	38,968	38,227	36,648	33,878	29,648	24,016	15,996
12	937	19,982	30,544	36,170	38,665	39,387	39,367	39,225	39,012	38,347	36,848	34,094	29,915	24,261	16,225
13	673	20,111	30,911	36,824	39,407	40,172	40,175	40,030	39,798	39,111	37,584	34,861	30,665	25,004	16,972
14	732	20,153	31,107	37,121	39,624	40,338	40,343	40,207	39,970	39,278	37,757	35,092	31,023	25,443	17,423
15	165	19,761	30,880	37,086	39,844	40,673	40,687	40,538	40,305	39,627	38,073	35,319	31,164	25,589	17,592
16	594	20,316	31,371	37,331	40,031	40,853	40,844	40,689	40,449	39,760	38,215	35,467	31,290	25,638	17,629
17	327	20,235	31,396	37,367	39,949	40,763	40,789	40,644	40,430	39,795	38,342	35,644	31,449	25,781	17,750
18	1,421	20,333	30,955	36,622	38,955	39,511	39,362	39,154	38,869	38,085	36,395	33,484	29,206	23,460	15,375
19	772	20,218	31,018	36,779	39,288	39,933	39,878	39,714	39,465	38,755	37,219	34,476	30,314	24,723	16,725
20	632	19,822	30,404	36,181	38,762	39,508	39,498	39,361	39,149	38,507	37,060	34,398	30,269	24,650	16,593
Average expected profit FF3	780	20,133	30,902	36,741	39,264	39,973	39,936	39,779	39,540	38,841	37,303	34,562	30,387	24,751	16,717

Table 4. Average profit for freight forwarder #2 in the coalition with freight forwarder #1

	A set of number (in TEUs)														
	Decreasing optimum capacity number							Optimum capacity number	Increasing optimum capacity number						
	75	115	145	170	190	205	215	220	225	235	250	270	295	325	365
Iteration 1	(9,038)	14,465	27,836	35,244	38,472	39,377	39,337	39,156	38,863	37,999	36,219	33,092	28,392	22,242	13,845
2	(9,210)	14,712	28,431	35,803	38,918	39,763	39,688	39,500	39,223	38,385	36,584	33,431	28,722	22,600	14,184
3	(9,143)	14,432	27,962	35,286	38,345	39,163	39,092	38,879	38,560	37,680	35,865	32,698	28,008	21,926	13,537
4	(9,319)	14,342	28,049	35,520	38,668	39,538	39,562	39,408	39,157	38,368	36,589	33,409	28,686	22,527	14,112
5	(9,017)	14,376	27,806	35,083	38,249	39,119	39,059	38,851	38,542	37,700	35,903	32,789	28,141	22,055	13,657
6	(8,858)	14,657	28,006	35,300	38,365	39,175	39,106	38,908	38,599	37,739	35,880	32,669	27,986	21,862	13,458
7	(8,803)	14,570	27,966	35,168	38,148	38,959	38,873	38,678	38,371	37,472	35,585	32,324	27,543	21,398	12,998
8	(9,083)	14,611	28,022	35,155	38,179	39,014	38,981	38,826	38,578	37,812	36,085	32,968	28,264	22,154	13,735
9	(8,697)	14,678	27,844	34,901	37,816	38,662	38,657	38,489	38,222	37,383	35,548	32,414	27,649	21,471	13,049
10	(9,346)	14,265	27,906	35,418	38,677	39,621	39,640	39,488	39,230	38,442	36,679	33,577	28,920	22,832	14,432
11	(8,838)	14,422	27,644	34,831	37,864	38,646	38,569	38,382	38,103	37,296	35,517	32,354	27,708	21,609	13,222
12	(8,960)	14,693	28,258	35,685	38,889	39,765	39,727	39,552	39,274	38,439	36,626	33,396	28,640	22,461	13,997
13	(8,739)	14,553	27,755	34,979	38,115	38,972	38,892	38,685	38,374	37,511	35,651	32,429	27,654	21,497	13,090
14	(8,863)	14,519	28,028	35,337	38,433	39,260	39,164	38,952	38,644	37,793	35,976	32,797	28,119	21,989	13,583
15	(8,731)	14,850	28,329	35,585	38,557	39,306	39,158	38,924	38,596	37,681	35,791	32,531	27,782	21,668	13,275
16	(8,476)	15,131	28,544	35,664	38,623	39,353	39,258	39,051	38,749	37,867	36,002	32,814	28,051	21,841	13,445
17	(8,992)	14,712	28,211	35,463	38,463	39,276	39,223	39,036	38,756	37,896	36,031	32,819	28,122	22,021	13,628
18	(8,575)	14,764	28,003	35,246	38,203	38,936	38,825	38,594	38,263	37,324	35,413	32,113	27,334	21,125	12,696
19	(8,926)	14,620	28,070	35,266	38,346	39,142	39,054	38,835	38,523	37,631	35,768	32,575	27,927	21,828	13,401
20	(8,954)	14,627	27,970	35,196	38,266	39,113	39,055	38,876	38,594	37,749	35,941	32,798	28,132	22,083	13,724
Average expected profit FF2	(8,928)	14,600	28,032	35,307	38,380	39,208	39,146	38,954	38,661	37,808	35,983	32,800	28,089	21,959	13,553

Figure 3 and Figure 4 show the graph of average expected profit of freight forwarder #1 for non-coalition and coalition scenarios. In a non-coalition scenario, the maximum expected profit achieved at the optimum number of capacity booked. Nevertheless, in a coalition scenario, the maximum expected profit could be achieved with less number of capacity booked. The optimum booked number stayed away to the left side of q_1.

Similar with freight forwarder #1, in a coalition scenario, the maximum expected profit for freight forwarder #2 could be achieved with less number of capacity booked. The coalition affected the optimum booked number stayed away to the left side of q_2. Figure 5 and Figure 6 show the graph of average expected profit of freight forwarder #2 in non-coalition and coalition scenarios.

The result shows that both freight forwarders have a similar coalition's implication in the capacity utilization. Based on these experiments, the average expected profit tends to increase, to 11%, under the coalition's scenario. The maximum expected profit can be reached with the less number of capacity booked when freight forwarders built a coalition. The number of capacity booked can be reduced by 7% because of capacity sharing mechanism among freight forwarders.

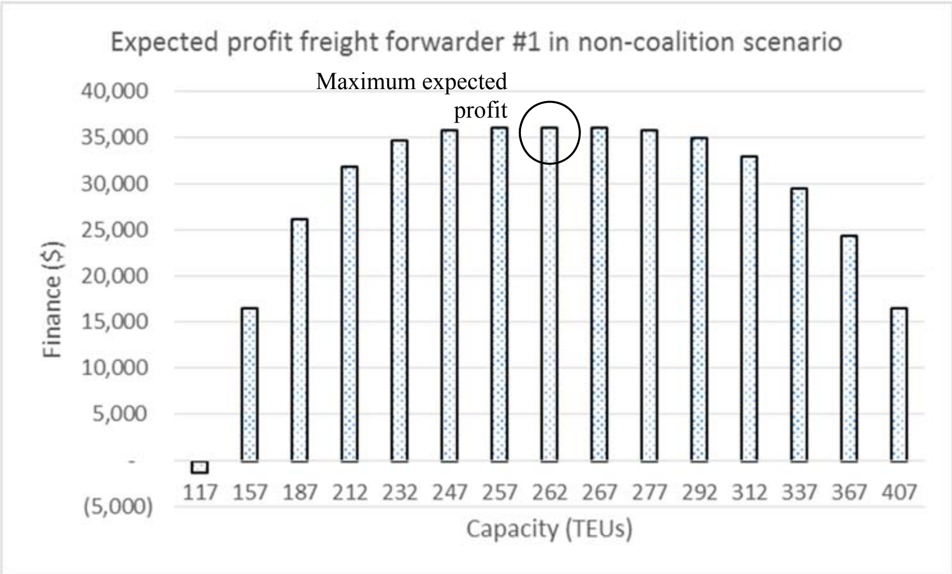

Figure 3. Average expected profit freight forwarder #1 in a non-coalition scenario

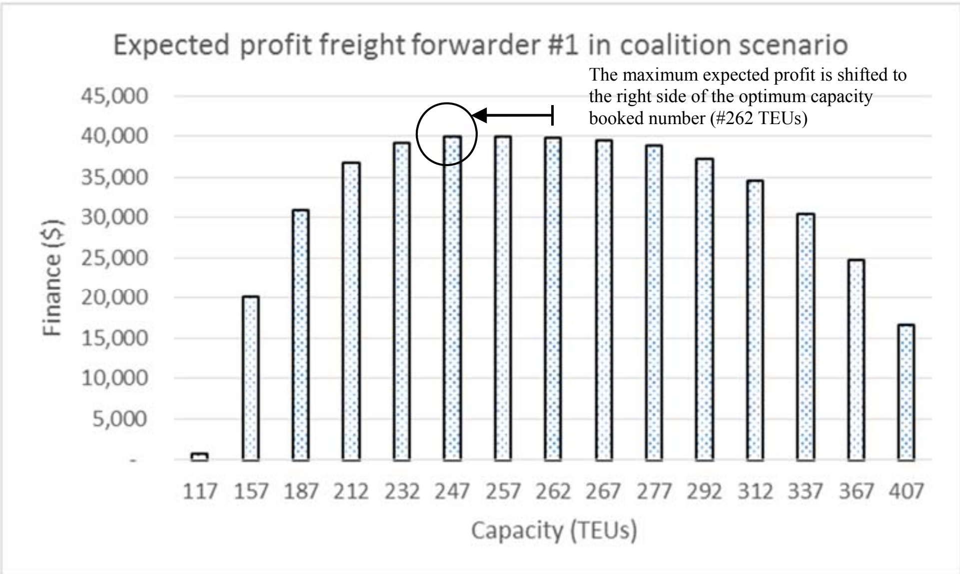

Figure 4. Average expected profit freight forwarder #1 in a coalition scenario

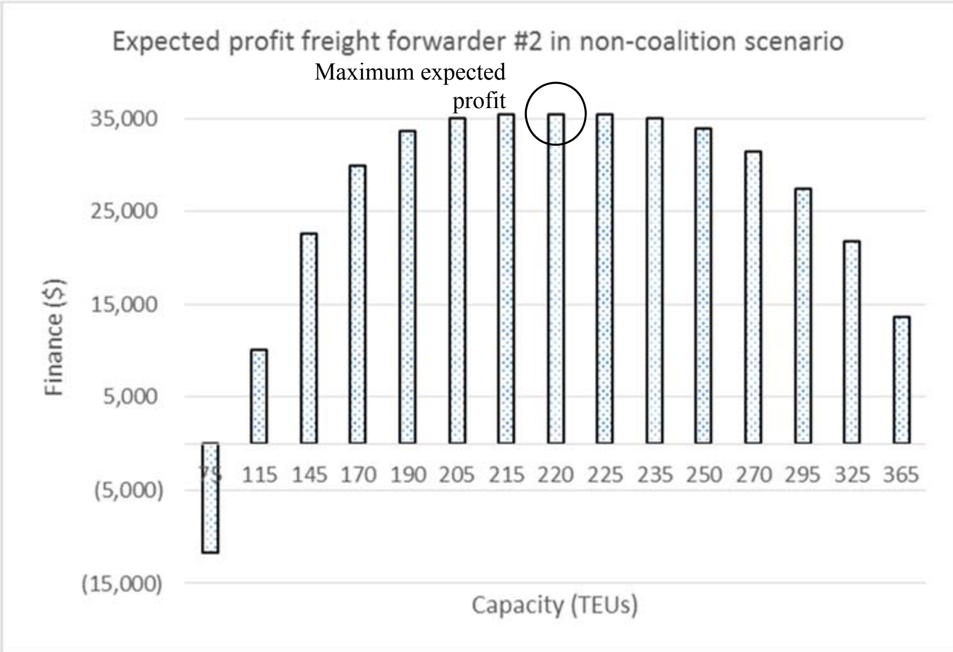

Figure 5. Average expected profit freight forwarder #2 in a non-coalition scenario

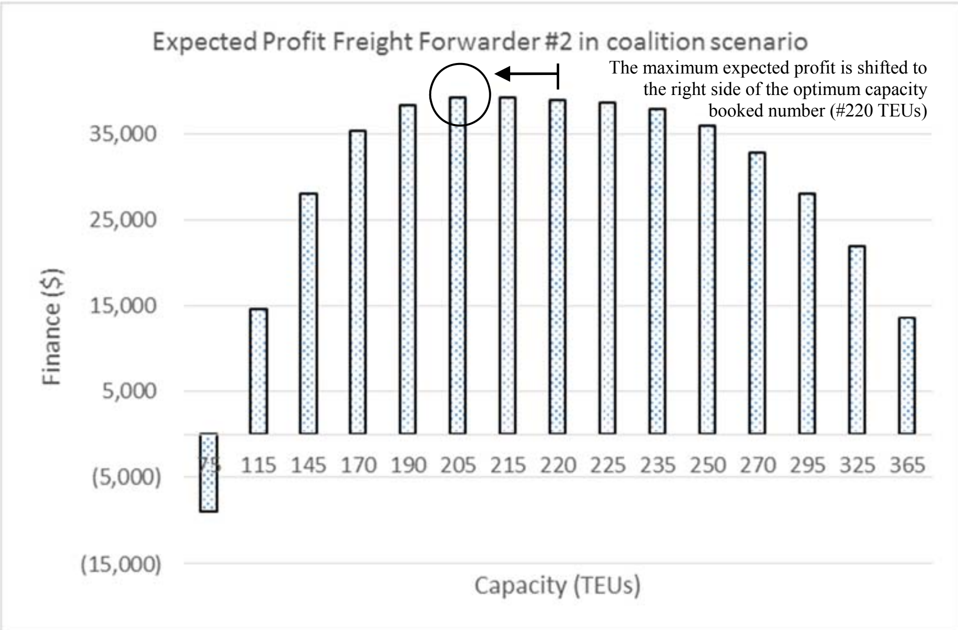

Figure 6. Average expected profit freight forwarder #2 in a coalition scenario

5. Conclusion

The proposed model has shown that coalition is giving a better result. The benefit of coalition occurs at the end of the period where total demand number already declared. Experiments demonstrated that coalition yielded more profits for the freight forwarder. Yet, the coalition may reduce the purchasing cost because it can reduce the number of capacity booked. Therefore, implementing coalition can improve profitability and it is an extended application of newsvendor concept in the shipping industry.

Comparing with previous studies, this study proposed a non-discrimination rate among freight forwarder. It may be a novel approach to manage the capacity booking effectively. For the small-medium freight forwarder, this scenario is more feasible to apply.

Future work can expand the proposed model to find the optimal number of capacity booking under a coalition scenario. The model can also develop with considering a competition environment in freight forwarder business.

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