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Container Vessel Fleet Expansion Decision-Making Under Certain Conditions

by

Xiao Wang

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At the completion time of this thesis, all the past memories came through my eyes like they just happened yesterday. What remains after all those sweets and bitters, ups and downs during this one year period are just three words: thank you, take care and good job.

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Time flees, I still remember how excited I was when I made my own decision to come to Rotterdam, the Netherlands and further develop myself at MEL. Before I really came here, I have always being thinking about a much more colorful and international life experience 9000 miles away from my hometown. However, I have to admit that I underestimated the difficulties I will encounter here. Culture difference, unsmooth communication as well as completely different education pattern all put a lot pressure on a Chinese student's shoulder. People may think Chinese students are shy or introverted, but in fact, they have so many things to adapt to after so many years completely different education and culture's influence. Life and study is rather tough and challenging at the very beginning of my academic year. Fortunately, I keep who I really am, find out what kind of person I want to be and improve myself consistently. So eventually, I would like to say good job to myself for graduating from such a strict and excellent program.

Abstract

Since the economy crisis in 2008, liner shipping industry went into depression thoroughly. Rapid increase of fuel price, sharp decrease of freight rate and severe overcapacity problem all contribute to an unstable and unpredictable shipping market. However, with the gradual recovery of freight rate and emergency of affordable fuel price, most liner operators are eager to grab the opportunity of further exploring their potential market in the touchable future. To begin with, how to use their limited budget wisely is the most frequent question facing by most liner operators.

Given the large capital investment of fleet expansion strategy, this study mainly concentrates on solving fleet expansion problems under different conditions with various investment approaches. The writer started the research with four diverse markets (new building, second hand purchasing, charter and global TEU capacity market) introductions and analysis aiming to provide latter decision process with proper market indications. In order to know current investment patterns regarding different TEU categories, the writer presented major liner companies' first-hand order book in 2015 as well. It not only revealed liner companies' fleet expansion strategy in the following five years but also showed us chartered and purchased capacity proportion on aggregation level. To further extent our study to a more accurate and comprehensive level, the writer employed case study of Maersk Line and depicted its order book structure as a whole, regarding each investment TEU capacity category, the writer deeply investigate and consider its alternative strategies' feasibilities and profitability. During comparing and selecting process, the writer constructed a mathematical model to compare different investment strategies' daily capital cost quantitatively as well, which makes the final conclusion of this research more convincible to the readers.

After taking both qualitative and quantitative analysis of Maersk Line case study into account, the research came to its conclusion about fleet expansion strategy under certain categories. In a nutshell, regarding 3000TEU to 3999TEU category fleet expansion, ordering new building vessels is more cost efficient, while chartering vessels under 7500TEU to 9999TEU category is much wiser. At the same time, regarding 13300TEU to 17999TEU super large container vessel expansion decision, it varies and depends on given completely different liner operators' backgrounds. Ultra large level fleet expansion decision is relatively fixed because of its large capital investment at the very beginning, which means only ordering new building ultra large container vessels is deemed to be sustainable and feasible according to your study. Additionally, the study also verified scale economy was applicable to container vessel daily capital cost.

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1. Introduction

As ocean transportation offers relatively cheaper rates, higher safety levels and less environmental impact compared to other transportation modes, it has played a larger role in nowadays international trade (Christiansen et al. 2007). Approximately, Shipping operation can be grouped in three categories: (a) liner shipping, (b) industrial shipping and (c) tramp shipping (Gelareh & Pisinger 2011). Competition among ocean carriers is known to be especially fierce in liner shipping (Ng 2015). Since global economic crisis in 2008, liner shipping went into depression deeply due to short of demand and low freight rate. Furthermore, sky rocketing bunker price and accumulated oversupply of shipping capacity also contributed to a more depressed and destroyed market. However, the global container vessel fleet capacity has been increasing constantly and significantly still during the past decade as a result of ship orders made both before and during crisis.

Given severe overcapacity problem and profit ambition condition, liner operators are in a certain dilemma. To tackle with overcapacity problem, it is vital for a liner company to maintain or appropriately cut down its current fleet size as it will largely remove the devastating impact of downward freight rates. However, to explore more profit of the shipping market, providing promising potential market with enough capacity supply and better shipping service is essential as a liner company. The later statement undoubtedly means expanding and improving existing fleet is necessary for those who desire to develop their business to a higher level. Meanwhile, recent adoption of slow-steaming strategy is also effective approach to expand margin space by minimising bunker cost, but it means deploying more vessels to keep regular service frequency as well (Wang & Meng 2015). Practical experience and current trend all indicate the necessity of fleet expanding. Hence, choosing expansion approach for a specific liner company carefully and cautiously is extremely important to overcome such dilemma.

Generally, problems involved in liner shipping can be classified into three levels: strategic, tactical and operational. Examples of strategic problems are alliance formation and fleet planning (Wang et al. 2015). Published researches on fleet planning and expanding topic are rather old and undetailed as the complexities involved in it, but we can never deny the value of conducting those researches. They provide a liner company the ability to supply effectively and operate efficiently. Without appropriate strategy support, rather small finance irrationality may lead to million even billion dollars loss. Concerning the importance of fleet expansion strategy, this thesis mainly concentrates on deciding most cost-efficient financing approach when a liner company expands its existing fleet given certain budget constraint and type of vessels. Qualitative and quantitative analysis are all included

to measure overall benefit comes from comparable financing approaches.

The writer believes that this research will definitely contribute to a much wiser fleet expansion decision-making process in the future and give the strategy decider insights when dealing with practical matters.

1.1 Research Objectives

This thesis deeply analyses the trend of current new building, second hand as well as charter market and investigate container fleet expansion strategy in order to help different liner companies adopt the most appropriate strategy under different conditions. Specifically, when a liner company decides its amount of TEU increase, number of vessels and categories of container vessels will be invested in, what this thesis will discuss makes sure the liner company has rational and detailed new or old, purchased or chartered vessel deployment plan to minimize the cost as well as the risks that incurred by investment approach. In other words, the main research question that this research aims to answer is listed as following:

"*Which expansion of the fleet of a liner company is most cost-efficient given certain conditions?*"

The dominant motivation behind this research is that most companies do want to expand their existing fleet to a higher degree for future development and potential profit, but they have no rules to follow except unbreakable rules like vessel volume constraint and forecasting trends supported by existing reports like what vessel tonnage would be most favourable in the future five to ten years. Develop certain measurable calculation method or selecting rule based on first-hand data figures is of great importance when dealing with practical expansion matters.

To better answer the main research question of this research, several sub-research questions should be answered primarily to provide the thesis with theoretical and empirical support. They are listed as follows:

"What are the current conditions and forecasting trends of new building, second hand purchasing and charter markets and what those figures indicate in a relatively long term?" (Purpose: To give the basis and background investment knowledge under different fleet expansion strategies and use it as our reliable and supportive data source to continue our further research)

"What are the current conditions and forecasting trends in liner operators' order book and what those figures indicate during fleet expansion decision making process?" (Purpose: To reveal changes as well as the majority choice currently when making fleet expansion decision and better help us analyse latter case study)

"How to analyse the pros and cons of different fleet expansion strategies both qualitatively and quantitatively and make the most appropriate choice?" (Purpose: To measure a liner company's overall benefit obtain from certain fleet expansion strategy on the basis of the answers and explanations of previous two questions and further extend to the conclusion of this research)

"What leads to the difference between calculated results and practical expansion strategies?" (Purpose: To combine quantitative calculation results with qualitative reasonable aspects in order to make the most appropriate possible fleet expansion decision and bring liner shipping companies most profits)

1.2 Research Methodology

This thesis will employ case study of Maersk Line as its main research methodology. All the data gathered from different resources are actually serving for knowing the empirical part much better and examine the validity of such strategy made by specific liner operator. According to analysis and reasonable explanation based on 2015 Maersk Line order book strategy, the writer will further extend the experience from Maersk line case study and data figures related to current trend to fleet expansion conclusion under various conditions.

This thesis will employ both qualitative and quantitative methods to answer in which way can a liner company with certain given background expand their existing fleet in a most cost-efficient way.

Regarding the qualitative analysis part, the writer will illustrate current trend in terms of various important aspects and existing valuable characters of four different markets: new building market, second-hand purchasing market, charter market and global capacity market in order to better understand current fleet expansion condition and forecasting trend. In addition, the writer will combine liner operators' individual background with specific fleet expansion decision terms under certain TEU capacity category to evaluate the feasibility and possibility of executing such fleet expansion strategy. Furthermore, even if all of those fleet expansion strategies are feasible, the writer will give his individual opinion based on knowledge introduced by this thesis with respect of the pros and cons when adopting those diversified strategies.

Regarding the quantitative part, the writer will make his own hypothesis and assumption to construct appropriate mathematical model calculating and comparing diverse daily capital costs come from three differentiate fleet expansion approaches. Quantitative part and qualitative part are not independent with each other, on the contrary, they have certain degree of mutual influence and eventually lead to final fleet expansion decision under certain TEU capacity category together. So, what is more important is to allocate certain degree of importance factor for both qualitative

part and quantitative part in order to help us make the tradeoff. The most appropriate and comprehensive fleet expansion decision for a liner operator is what remained after those tradeoffs.

1.3 Research Structure

Chapter 2 gives an overview of empirical important data related to fleet investment decision, it also introduces us certain methodology that would possibly applicable to our research question. Chapter 3 illustrates us container fleet expansion theory and important market and order book indications refined from various market figures, which will be valuable and applicable in latter case study qualitative analysis. Chapter 4 introduces us the methodology of this thesis as well as mathematical model that supports our quantitative measurements in later case study of Maersk Line. Chapter 5 uses case study of Maersk Line to further combine and extend our qualitative and quantitative knowledge to the thesis conclusion. Chapter 6 concludes by summarizing key findings achieved from the research, it reveals the limitation and further research suggestion of this research as well.

2. Literature Review

In order to better investigate in container fleet expansion strategy, getting relevant valuable experience from both past academic publications and current reports is very important. In this chapter, the writer will use sub-chapter 2.1 to 2.3 to illustrate different background knowledge that related to fleet expansion process and use sub-chapter 2.4 to further extend to articles and papers that have conducted researches on deciding optimal container fleet capacity. These experience and knowledge will certainly give the writer insights as well as inspirations to continue his research.

2.1 Literature Review on Liner Companies' Charter Policy and Order Policy

Regarding the time charter policy, in dry bulk market, one article has argued that expected energy efficiency savings are recovered largely by ship owners, especially effectively-operating ship owners (Agnolucci et al. 2014). This statement illustrates that the inefficiency of chartering vessel from a relatively new perspective. Since the time that ship owners start to understand the importance of energy efficiency, the charterers will surely bear more economical burden when chartering bulk vessels, which is also true and applicable to container ship chartering market.

Very much like the other industries, economies of scale came into existing in shipping industry for several decades, which to a large degree leads to larger and larger container ship size. Nowadays, with the arising of more severe overcapacity problem, whether to charter container ship or invest in new ones keeps disturbing liner companies. So, we listed current container vessels time charter rate under different TEU capacity categories as well as new building container vessel prices based on different resources in order to facilitate our further research in the latter chapters.

According to the latest Maersk Broker weekly report in 2015, it listed container vessel charter rates changes of main container vessel TEU categories over the last one year. Sales and purchase rates as well as new building rates were gathered too. Those figures are all used as empirical and helpful data in further study (Broker 2015).

Table 1 Average Container Vessel Time Charter Rates (in USD per day)

Size	2014	2015 YTD	4 Weeks MA	Trend (short term)
400-649	$4688	$4836	$4749	→

650-899	$5214	$5604	$6028	→
900-1299	$6915	$7649	$8601	↘
1300-1999	$7786	$9347	$11106	→
2000-2999	$7321	$9703	$12716	↘
3000-3949	$8180	$11136	$13550	→
3950-5199	$9228	$14389	$14528	→

Data Source: (Broker 2015)

To get better knowledge of relative large TEU capacity container vessel time charter rate, we found that according to reliable data source, Yang Ming ships had chartered 14000TEU super large container vessels at a price of 46500USD to 46800USD per day for 10 years, which considered to be very cheap time rater rate, while Evergreen had fixed ships of similar scale that are close to its delivery date for more than 49300USD per day (Industries 2015). For further data gathering and analysis in terms of diverse rates, they will be included in latter chapters.

With respect to second hand purchasing price, compared with 2014, almost all sizes of relatively small container ships' charter rates are increasing in 2015 on different levels, but whether this is still true with large or even super large container vessels purchase rates need more data to examine its correctness.

Table 2 Estimated Second Hand Prices - 10 years old (in USD million)

1100	1700	2700	4500
6-7	9-10	12-13	14-15
Price Development Since Last Week			
→	→	→	→

Data Source: (Broker 2015)

To purchase second hand container vessels is considered to be one of three important investment approaches. However, its pros and cons should be further investigated and compared with the other two investment approaches. The table below gives us an overview of estimated new building prices under different TEU capacity categories in Korean and Chinese shipyards.

Table 3 Estimated New Building Prices (in USD Million)

	1800	2800	4800	6600	9200	14000
Korean Shipyard	26-28	35-37	51-53	64-66	87-89	115-120
Chinese Shipyard	32-34	32-34	48-50	57-59	83-85	110-115

Source: (Broker 2015)

According to the data above, it is obvious that in general, Korean shipyard has more expensive new building prices compared with Chinese shipyard due to its advanced ship building technology and superior ship hull material technology. At the same time, it is well acknowledged that Korean ship builders as well as its manufactures are considered to be more superior and developed over the other main manufacture countries.

2.2 Literature Review on Overcapacity in Container Shipping

Overcapacity is a severe problem known to all players involved in liner shipping, however, major even small size liner operators still keep a higher capacity increase pace than real shipping demand increase pace on aggregation level. The expect overcapacity in container shipping will last until 2017 or at worst condition 2020 (Anon n.d.). If we assumed stable fuel prices, with the TEU capacity on aggregation level continuous forecasting growth, freight rates are expected to decline by 1.6 to 2.6 percent annually until 2019 (Anon n.d.), which indicates still depressed shipping market in the future. Nonetheless, with the sharp decrease of oil price globally since June 2014 (Anon n.d.), the whole shipping market as well as most liner operators are now gradually stepping back to its recovery and profitable pattern.

Extreme imbalance of supply and demand has been directly damaging all players for many years because of constant fierce freight rate competition in shipping market. This imbalance is expected to solve by continuously boosting demand between Asia and Europe shipping service routes in the near future, but it is still an uncertain expectation from most liner operators. “If we are to fix the industry, 50 percent of the current order book needs to disappear and that’s a massive amount” (Anon n.d.). However, to just give up and cancel the new purchased or chartered capacity is impossible and unfeasible as this kind of behavior will trigger even worse results that liner companies are not willing to see. As a result, to tackle with existing severe overcapacity problem, the liner operators at different levels need to find some other ways out like strategic alliance to cut the existing costs to a large extent and give more profit margin space as a result.

2.3 Literature Review on Growth of Ship Size and Fleet Expansion

When we look back to the development history of container ship, we can simply classify it into 5 main periods, trial era, sub-panamax era, Panamax era, Post-panamax era and Ultra-large container ship era (Tran & Haasis 2015). “The motivation for deploying mega vessels may stem from the basic rule in transportation, the bigger the transportation means, the cheaper the unit cost.” (Tran & Haasis 2015) Scale economy is applicable in liner shipping industry as well. Normally, there are three main major costs involved in liner shipping: capital cost, operating cost and bunker cost. Those three costs show decline trend separately with the ship size growing larger and larger according to Drewry consultancy data source.

The tables listed below describe daily capital cost per day, daily operating cost per day and daily fuel cost per day for different sizes of container ships.

Table 4 Daily capital costs (in USD)

Ship size (TEU)	2500	3500	6500	8000	10000	12000
Cost ($)	5384	6370	10110	12192	13793	15233
Unit cost ($)	2.15	1.82	1.56	1.52	1.40	1.27
Estimated regression model: cost=$22.89size^{-0.70}$				R^2=0.995		
Unit cost = $22.89size^{-0.30}$				R^2=0.975		

Data source: based on new building prices in 2011 published by Drewry and assumed operating life of ships of 20 years, operating time of 365 days per year.

Table 5 Daily operating cost (in USD)

Ship size (TEUs)					
Cost item ($)	2468	3752	5364	8200	10000
Manning	2306	2670	2855	3030	3235
Insurance	557	889	1007	1040	1474
Stores	400	466	511	514	560
Spares	471	663	795	826	1016
Lubricating oils	814	1689	1886	1899	2762
Repair and maintenance	451	546	587	596	662

Management and administration	508	551	578	710	767
Daily operating cost	5507	7474	8219	8615	10476
Unit operating cost	2.231	1.992	1.532	1.051	1.048
Estimated regression model: $cost=267size^{0.40}$				$R^2=0.911$	
Unit cost = $267size^{-0.60}$				$R^2=0.96$	

Data source: based on daily operating costs published by Drewry Consultancy Company.

Table 6 Daily Fuel Cost (in USD)

Ship size (TEUs)	4000	6000	8000	10000	12000	14000
Daily fuel consumption (tonne)	78.3	117.4	124.5	128.0	148.5	158.7
Cost ($)	54810	82180	87150	89600	103950	111090
Unit cost ($)	13.70	13.70	10.89	8.96	8.66	7.94
Estimated regression model: $cost=850size^{0.51}$				$R^2=0.920$		
Unit cost = $850size^{-0.49}$				$R^2=0.913$		

Data source: based on fuel consumption at 20 knots speed published by Drewry Consultancy and assumed fuel price of $700 per ton.

According to the empirical data processed by Drewry Consultancy, it is pretty obvious that unit cost (capital cost, operating cost and fuel cost) incurred by managing fleet has a negative relationship with the ship sizes. However, challenges of deploying large container ships cannot be simply ignored. High capital investment (new 18000TEU Maersk triple E class container ship worth more than 190 million dollars), high risk containing in long investment return period and negative, external influence on transshipment ports are all potential dangers to strategies of adopting ultra large vessels.

With continuous investment poured into new building ultra large container vessels order and charter deals, liner companies try to raise their profit margins by carrying

more traffic volume and filling more capacities. However, the fact is that “the throughput could not keep pace with shipping company’s capacity growth, which caused the downward trend of slot utilization” (Tran & Haasis 2015). CSL is a very appropriate example to demonstrate this phenomenon. In 2011, its total TEU capacity went from 2.5 million to 9.9 million, while its carrying traffic in practice only went from 31 million to 89 million TEUs, which leads to 5.2 billion loss in merely one year. As a result, based on the unexpected failure experience, fleet expansion and re-composition should be a long-term and gradual behavior, if liner operators push it too hard or adopt too ambitious expanding strategies, they will never achieve the goal as wished before because there are so many barriers and unpredictability involved in real fleet operation. None of those liner operators can simply put more capacity into the market and take up the market share over one night. What we also took from CSL failure case is that liner shipping industry indeed is a capital intensive industry. Most of its asset is tied up in container vessels, if the liner operators increase their fleets too aggressively, high level of fixed assets tied up in the market will inevitably make supply inelastic and raise the barrier of exiting the market (Tran & Haasis 2015). They cannot leave the market and reduce the capacity over one night under this condition, which means infinite competition in the market and no second opinion with even worse freight rate until final bankruptcy.

For another case, even if WanHai Line (Taiwan liner company) didn’t deploy mega container fleet capacity, it made its own way to be one of the three most profitable liner companies with Maersk Line and CMA-CGM. It has complete and perfect shipping service in intra-Asia trades, with which all the other companies cannot compare. Case of WanHai showed us equal importance of concentration on certain service scale and area, it also showed us profit involved not only in shipping routes with large demand but also regional short distance shipping routes.

2.4 Literature Review on Deciding Optimal Fleet Capacity

Existing research is constantly lack of model or method to measure a certain liner company’s optimal fleet capacity because of the complexity and difficulties involved in it. At the very beginning of solving this practical problem, Kjetil Fagerholt firstly designed a solution method consists of three phases to decide an optimal fleet (the type of ships and the number of each type). During phase 1, all feasible single routes are considered and generated for the largest ship available. However, in most cases, it leads to small utilization of those largest ships, which means most of those shipping routes can be performed by smaller ships at lower cost. This possibility is also calculated when considering the cost of each route. During phase 2, single routes generated in phase 1 are combined with multiple routes alternatives. In order to solve the partitioning problem, where the columns are routes generated during

phase 1 and phase 2, the writer eventually found both optimal fleet and coherent routes for the fleet (Fagerholt 1999). Latter, a research conducted by Wei-Ming Wu suggested that shipping lines with long distance deep-sea service routes is more likely to hold excess capacity compared with other liner operators. And, those excess capacities play a crucial role of deterring entry and maintaining market power for a liner shipping company. It somehow has influence on fleet scale decision of a liner company as well (Wu 2009). Apart from this qualitative conclusion, two German researchers went even further to analyze the impacts of fleet capacity and ship size on financial performance. They argued that although TEU capacity expansion and more efficient slot utilization brought higher total revenue, they made unit revenue much smaller than before (Tran & Haasis 2015). Meanwhile, “As carrying capacity increases, the growth rate of total revenue is smaller than that of total cost, which indicates total profit may go down albeit fleet scale becomes bigger”. (Tran & Haasis 2015) According to the research they have conducted, they also employed empirical liner companies (CSL, CMA CGM Group) cases to further illustrate their conclusion supported by quantitative calculation. A researcher from Norway also presented a model and algorithm to solve the problem of determining the optimal routing and deployment of a fleet of container vessels jointly (Álvarez 2009).

Chapter Conclusion:

1. Regardless of large number of advantages of scale economy, ordering and deploying more and more super or ultra large container vessel will postpone the ending time of overcapacity, which will lead to constant unhealthy market condition.
2. Meanwhile, specific expansion policies like chartering container vessels or ordering large amount of capacity has their own flaws proven by either academic report or failure case experience.
3. With respect to method of deciding optimal fleet capacity, past and existing research source is rather scarce. Research conducted by Tran and Haasis from Germany gave us direct and relevant indications among all articles.

3. Container Fleet Expansion Theory

To further continue our research, theoretical and empirical support from existing researches and data is essential. In this chapter, the writer provided latter case study with major shipping lines' fleet backgrounds, different markets' indications (new building, second-hand, charter), latest order books' indications, various strategies' advantages and disadvantages as well as important measurement criteria. All of these mentioned above constitute container fleet expansion theory to support the whole thesis.

3.1 Major Shipping Lines' Fleet Backgrounds

In order to make rational fleet expansion decision, knowing major shipping lines' fleet backgrounds is essential. Normally, we categorize a liner shipping company into a large shipping company mainly based on its existing fleet size and its profitability. In terms of TEU capacity, Maersk, MSC and CMA-CGM，as the members of P3 alliance in liner shipping, are on the top of the list:

Table 7 TEU Capacity and Share of Global Market (in TEU)

Operator	Rank	TEU	Share
APM-Maersk	1	3057781	15.4%
Mediteeranean Shg Co	2	2653092	13.4%
CMA CGM Group	3	1781686	9.0%
Hapag-Lloyd	4	958585	4.8%
Evergreen Line	5	948788	4.8%
COSCO Container L.	6	866260	4.4%
CSCL	7	699606	3.5%
Hanjin Shipping	8	623558	3.1%
Hamburg Sud Group	9	615902	3.1%
MOL	10	591064	3.0%
OOCL	11	589956	3.0%
APL	12	561150	2.8%

Yang Ming Marine Transport Corp.	13	530653	2.7%
NYK Line	14	502310	2.5%
UASC	15	441965	2.2%
K Line	16	389570	2.0%
PIL	17	384231	1.9%
Hyundai M.M.	18	382494	1.9%
ZIM	19	370750	1.9%
Wan Hai Lines	20	244411	1.2%

Data source: Alphaliner – TOP 100 Operated fleets as per 10 August 2015.

Shipping lines that have shares over 1% of world liner fleet in TEU terms should be considered as major shipping lines as those companies on aggregation level take up 86.6% in total out of world TEU capacity. Among them, the top 3 shipping lines account for almost 40% of world liner fleet capacity, which lays the foundation of today's liner shipping industry. Top three liner operators' extremely huge TEU capacities also reveal their unstoppable fleet expansion strategy in the past few decades to monopolize the liner shipping market. Those TEU capacities consist of mainly two parts: owned and chartered vessel capacity, the proportion between two categories is very important criteria when considering fleet expansion strategy.

Proportion between owned and chartered capacity of a liner company reflects largely its current fleet composition and intended developing strategy in the near future. It reflects a liner company's operational characteristics as well. The following table gives an overview of the proportion between owned and chartered existing capacity of major shipping lines.

Table 8 Proportion between owned and chartered capacity (in TEU and in percentage)

		Total		Owned		Chartered		
Operator	Rank	TEU	Ships	TEU	Ships	TEU	Ships	% Chart
APM-Maersk	1	3057781	610	1723846	259	1333935	351	43.6%
Mediteeranean Shg Co	2	2653092	506	1102321	198	1550771	308	58.5%

CMA CGM Group	3	1781686	474	583998	86	1197688	388	67.2%
Hapag-Lloyd	4	958585	180	523749	71	434836	109	45.4%
Evergreen Line	5	948788	201	542719	107	406069	94	42.8%
COSCO Container L.	6	866260	166	464412	85	401848	81	46.4%
CSCL	7	699606	138	479400	66	220206	72	31.5%
Hanjin Shipping	8	623558	103	278102	38	345456	65	55.4%
Hamburg Sud Group	9	615902	131	271011	42	344891	89	56.0%
MOL	10	591064	108	184384	28	406680	80	68.8%
OOCL	11	589956	109	348194	49	241762	60	41.0%
APL	12	561150	90	399895	51	161255	39	28.7%
Yang Ming Marine Transport Corp.	13	530653	102	196481	42	334172	60	63.0%
NYK Line	14	502310	106	284516	49	217794	57	43.4%
UASC	15	441965	54	278006	31	163959	23	37.1%
K Line	16	389570	70	80150	12	309420	58	79.4%
PIL	17	384231	157	288415	120	95816	37	24.9%
Hyundai M.M.	18	382494	59	159369	21	223125	38	58.3%
ZIM	19	370750	84	51223	12	319527	72	86.2%
Wan Hai Lines	20	244411	97	181345	74	63066	23	25.8%

Data source: Alphaliner – TOP 100 Operated fleets as per 10 August 2015.

According to table 8, the writer highlighted liner companies with charter rates both above 65% and below 35%. CMA CGM Group, MOL, K Line and ZIM all have extremely high charter percentage out of their total owned TEU capacity, which

means that they are less capital intensive compared to the other players and they have less risk to take when shipbuilding market is involved in crisis. It is also less difficult for them to leave the market in a relatively short time as a result of less tied up asset value. Meanwhile, this kind of charter strategy also gives them more flexibility and budget space to improve and extend their market strategy to a higher level.

On the contrary, CSCL, APL, PIL and Wan Hai Lines are liner companies with high percentage of self-owned fleet capacity. They prefer to be in fully charge of their owned capacity as purchased vessels will be at their disposal freely according to their deployment and development strategy and the liner operators won't be influenced too much by the fluctuation of charter rates unless they want to sell it to other second-hand buyers.

Except for those extreme cases from both sides mentioned above, the remained liner companies are more or less maintaining a proportion around 50% because both sides of the extreme situations are not beneficial to their business. Specifically, on one hand, if liner operators charter huge amount of vessels, they may incur huge chartering cost when the due date of previous contract is coming at the same time charter rates are experiencing its paramount value. On the other hand, if the operator orders and owns huge amount of vessels, they will have less circulating fund to finance other promising projects. More importantly, when facing with shrink of ship value, the later fleet capacity structure is going to experience extremely tough and difficult situation. Whether to leave or stay at the industry is rather painful.

3.2 Major Markets' Indications

Normally, there are three investment approaches when expanding fleet, they are related to three different markets separately. Current market conditions as well as trends determine largely a shipping line's financing policy. Hereby, the writer highlighted most valuable market indications and gave overviews of pros and cons of different financing approaches.

3.2.1 New Building Market Indications

To efficiently invest money in expanding fleet size, ordering new building container vessels is considered as the most risky financing approach because of its money intensiveness character. In order to benefit from this rather risky behavior, since the very beginning, liner operators has to consider lots of aspects which consist of future profitability of such vessels at expected delivery date, fluctuation of new building rate as well as technology and reliability of such container vessels etc. Driven by pursuing much wiser and more reasonable new building investment, analyzing current trend and market indication of new building market is both meaningful and useful.

According to new building market data from Clarksons research database, the writer found that fixed patterns were included in this investment approach. The writer primarily gathered all new building container vessel orders in 2015 aiming to observe nowadays' new building trend and situation. Questions like what types of container ship are perceived to be the most favorable, promising and profitable ones will be answered after this sub-chapter's study. Table 9 below shows the general overview of different categories of newly ordered container ships in 2015.

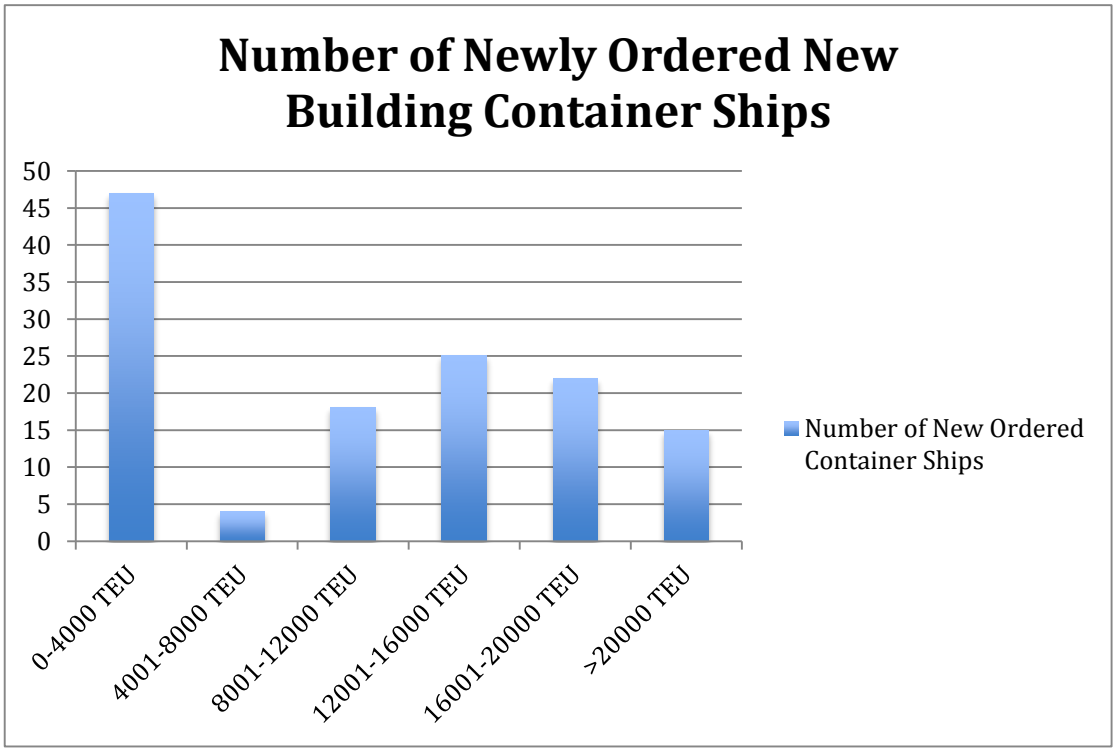
Table 9 Number of New building Container Vessels under Different Categories

TEU Capacity	Number of Container Ship Ordered
0-2000	9
2000-4000	38
4000-6000	4
6000-8000	0
8000-10000	6
10000-12000	12
12000-14000	25
14000-16000	0
16000-18000	11
18000-20000	11
20000-22000	15
Total	131

Data Source: Clarksons Research Database (Shipping Intelligence Network 2010)

To show the distribution of new building container vessels ordered in 2015 more clearly, the writer transferred primary data into recognizable figure as below:

Figure 1: Number of Newly Ordered New building Container Ships



Data Source: Clarksons Research Database (Shipping Intelligence Network 2010)

Driven by recently sharp decrease of fuel price and gradual rise in freight rates, number of new building container vessels keeps a rather stable increasing amount. According to figure 1, in total, 131 new building container vessels are either under construction in shipyards or prepared to start. It also shows us clearly that new building container ship orders concentrate mainly on two levels: container vessels with capacity below 5000TEU and container vessels with capacity over 10000TEU. This phenomenon directly give us two possible explanations: rather small and super large container vessels are perceived to be the most profitable and admirable vessel types, new building financing approach in terms of those two TEU categories is much more economical compared to other investment measures.

Specifically, huge amount of super large container ships' orders reflected not only the advantage of scale economy but also promising future of Asia – Europe service routes from liner operators' perspectives. They firmly believe super large, even ultra large container vessels will become future's majority in liner shipping due to its unprecedented merits. Another important reason for increase on ultra large level is that existing capacity of large vessels is rather small and stable, if the liner operators would like to deploy more vessels on its trading routes, they have to construct new economical vessels to expanding its fleet. It is even more important for especially

leading and ambitious liner companies which desire to operate on Asia-Europe trade routes to improve themselves as soon as possible because the sooner they finish their fleet transitional period, the sooner they will take full advantage of scale economy and seize more opportunities. Much clearer division of vessel types will bring them more benefits over their competitors as well.

On the other hand, large order quantity of container ships below 5000 TEU reminds us of the equal importance of regional trade. Currently, regional trade with relatively short distance is expected to stimulate the depressed market largely since people are more willing to trade with their neighbors to enjoy the differentiation brought by similar product nowadays. Even though according to new building market details under 5000TEU category, Evergreen Line from Taiwan takes up almost 40% of total small tonnage container vessels ordered in 2015 order book. There are still 27 new orders of small tonnage container vessels left proving that other liner companies have equal confidence in digging profit from such market.

In terms of prices of new building vessels, they are various among different shipyards. The writer listed different container vessel building prices collected from Korea and China shipyards in table 8 to provide later case analysis with data support.

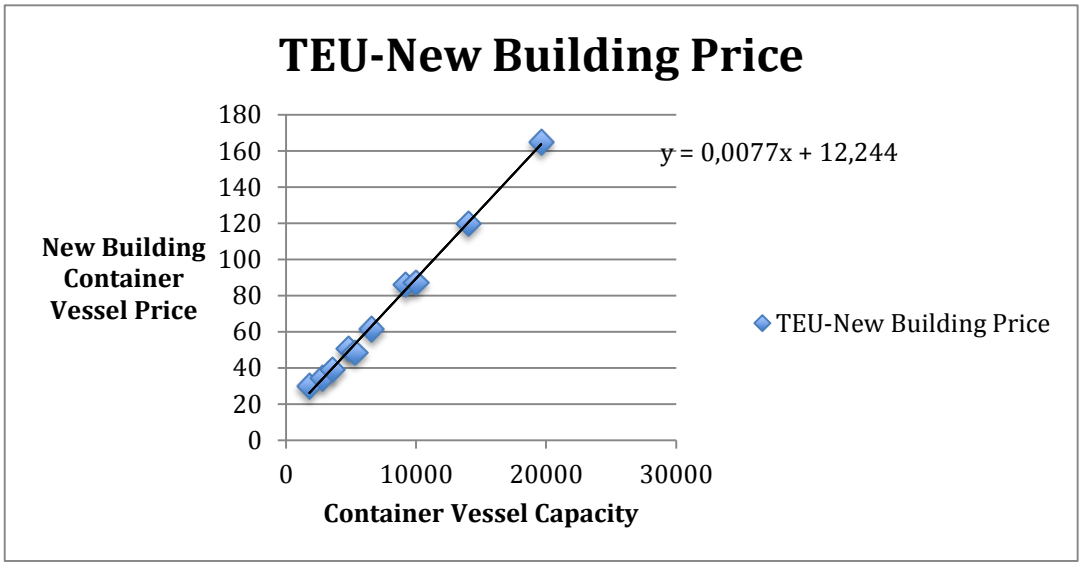
Table 10 New Building Container Vessel Prices (in million USD)

TEU Capacity	1800	2800	3600	4800	5300	6600	9200	10000	14000	19630
New building price	29 to 31	33 to 36	38 to 40	49 to 52	47 to 50	58 to 65	84 to 88	85 to 90	115 to 125	160 to 170

Data Source: Clarksons Research Database (Shipping Intelligence Network 2010)

To see if there is liner relationship between TEU capacity and its new building price, the writer conducted linear regression calculation and showed its trend line in the figure below:

Figure 2: linear Relationship between TEU capacity and New building Price in Ship Yards



Date source: Summarize from Clarksons Research Database (Shipping Intelligence Network 2010)

The figure above demonstrated that there is an approximate liner relationship between TEU capacity and new building price. The calculated equation of this liner relationship is expressed as:

$$New\ Building\ Container\ Vessel\ Price\ (in\ Million\ USD) = 0.0077 TEU\ Capacity + 12.244 \qquad (Equation\ 1)$$

Regardless of fuel cost and daily operation cost, new building unit cost stays the same according to our calculation.

Current New Building Market Indications: container vessels around 2000TEU to 4000TEU and container vessels above 10000TEU are ordered most frequently. Hence, in general, regardless of companies' backgrounds, ordering new building those vessels is deemed to be more economical than other two financing approaches.

Pros of ordering new building vessels (compared to purchasing second-hand vessel and chartering vessel): longer economic lifespan of vessels, more advanced and reliable ship building technologies employed on vessels, lower daily capital cost based on calculation method mentioned in chapter 5, more operational patterns to choose (operate vessels itself, charter vessels to other operators, charter vessels to others after certain operating time etc.).

Cons of ordering new building vessels (compared to purchasing second-hand

vessel and chartering vessel): larger capital investment in the beginning, more uncertainty and risk to take, more pressure from other alternative larger vessels etc.

Applicable condition of ordering new building vessels: vessels with large and promising potential market, vessels with unprecedented superiorities, liner companies with sufficient and abundant budget.

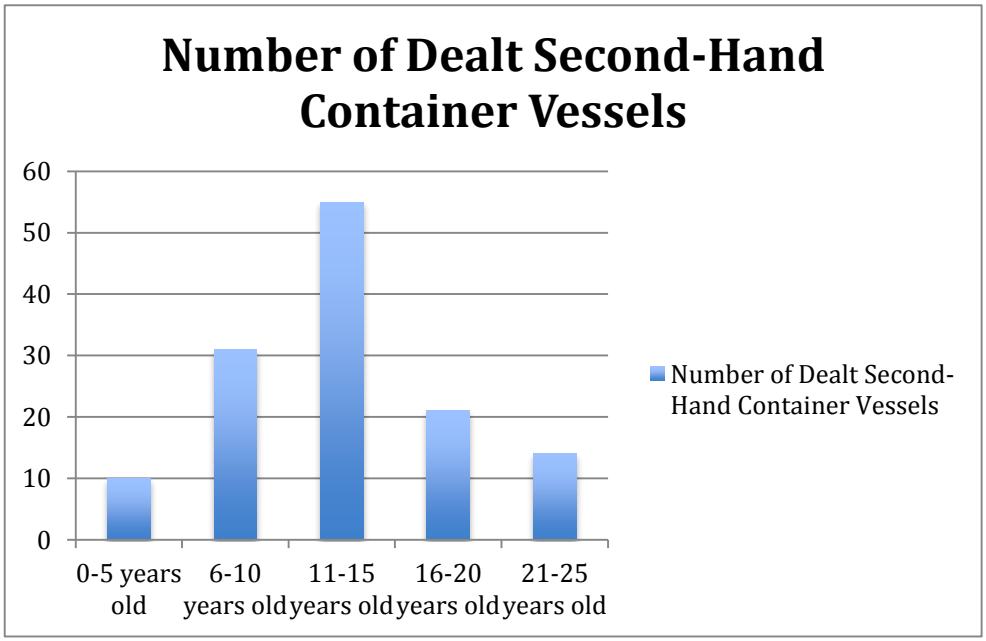
3.2.2 Second Hand Market Indications

Apart from investing in new building container vessels, purchasing second-hand container ships with certain age makes another essential element of fleet expansion strategy as a result of its flexibility and more affordable price. It is undoubtedly feasible and wise option that can bring a liner company ownership of a fully cellular container ship.

To get a better knowledge of current condition of second hand container vessel dealing market, the writer have had a look at the containership sales figures and its details from up to date report in 2015 and analyzed preference situation regarding second hand container vessel market.

With respect to valuable details of container ship sales records, the writer insisted that vessel age distribution, vessel capacity distribution and second-hand price trend should take the leading positions among all the other aspects. The figure below shows firstly the age distribution of dealt container vessels.

Figure 3: Dealt Second Hand Container Vessels Age Distribution



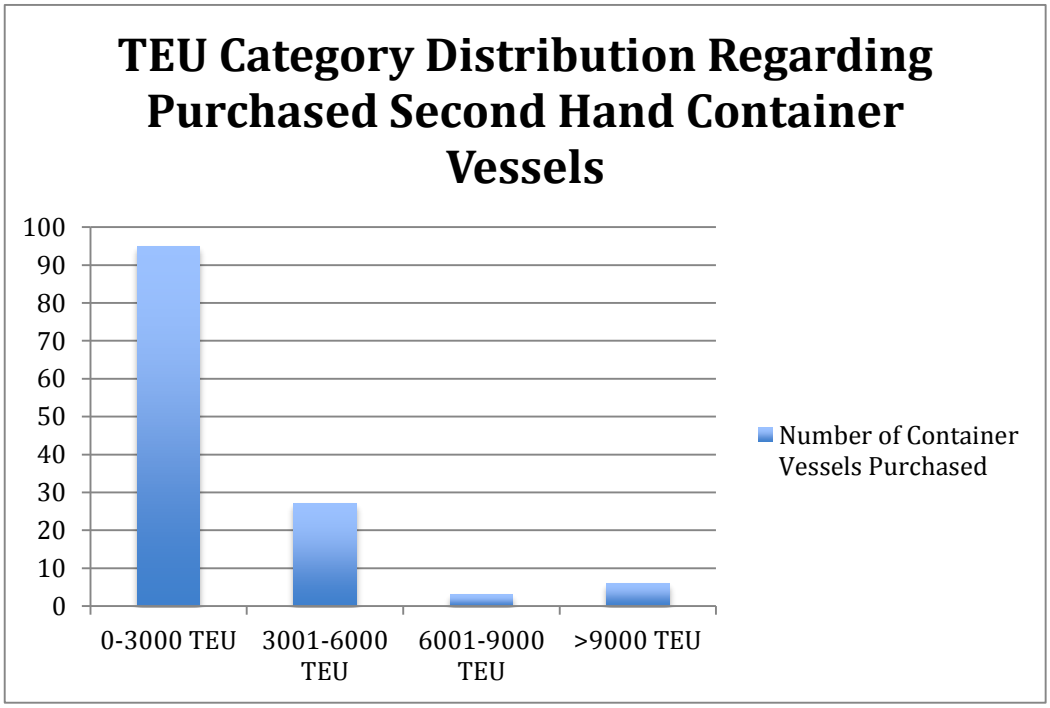
Date source: Clarksons Research Database (Shipping Intelligence Network 2010)

The age distribution of second-hand container vessel purchasing in 2015 illustrated that vessels with an average age around 10 to 15 years are the best sellers. Normally, economic life of a container vessel varies from 25 to 30 years, 10 to 15 years is approximately half of a container vessel's life. Purchasing vessels at this time is regarded as wise investment as a result of relatively advanced technology employed on container vessels, reasonable price offered by sellers and potential margin space brought by left lifetime of a vessel. Hence, among all 131 purchased second-hand container ships in 2015, this category represents 41.9% out of total dealt quantity.

Regarding the other two majorities, buyers who chose to purchase very old container vessels focus more on extremely cheap prices and remained value of such vessels, while buyers who chose to purchase very young container vessels lay more emphasis on the advanced characters and potential market of those purchased container vessels.

What's more, purchased second hand vessel capacity distribution is another important aspect that should be taken into consideration. It indicates current shipping market preference and future promising shipping market. The figure below displayed the TEU capacity category distribution thoroughly.

Figure 4: TEU Category Distribution Regarding Purchased Second Hand Container Vessels



Date source: Clarksons Research Database (Shipping Intelligence Network 2010)

Out of 131 purchased second-hand vessels, 72.5% are container vessels below 3000 TEU, 93.1% are container vessels below 6000 TEU. Those figures reveal that relatively small container vessel is considered as the most cost-efficient container ship size by nowadays second hand ship buyers. Although number of new building small container ships is already large enough (51 out of 131) compared to other categories, purchases of second-hand small container vessel is even larger (122 out of 131). The reasons are: firstly, most relatively small liner companies put more efforts on regional trade than deep-sea international trade, meanwhile, they have less money compared to large companies but still desire to be involved in the competitive market, so they choose to charter container vessels to achieve similar result. Secondly, for small shipping lines, they are unstable and easy to be influenced by freight rate fluctuation and other unpredictable issues, which forces them to think about the strategy with least risk. Then, to purchase second hand vessels satisfies their need entirely. Thirdly, because of limited fleet size of small liner shipping companies, they want their vessels in profit-making pattern as soon as possible. They prefer to employ second hand container vessels or chartered vessels to form their fleet as a result.

To further determine whether to charter a container vessel or purchase a second hand vessel, second-hand vessel price as well as its price trend should be taken into account definitely as it is the primary standard measured by liner operators when deciding their individual expansion strategy.

As mentioned previously, second hand vessels with 10 years age are the most commonly traded type. Hence, when liner companies are making decisions, second-hand prices for 10 year-old container vessels are used most frequently. The table below describes different container ship types with 10 years age except for last two classes as larger ships just came into effect in the past decade. Most of those relatively large vessels are either owned by shipping lines or third-party ship owners.

Table 11 Price Trend of Second hand Container Vessels (in million USD)

	2014 Quarter 3	2014 Quarter 4	2015 Quarter 1	2015 Quarter 2
1000-1100 TEU (10 years old)	3.75	3.25	3.75	5
1650-1750 TEU (10 years old)	8.5	8	8	9.25
2500 TEU	11.75	10.5	12.25	13.75

(10 years old)				
3200-3600 TEU (10 years old)	10.5	10	11.5	13.75
4500 TEU (10 years old)	13.25	14.5	15.5	15.5
5100 TEU (10 years old)	14.75	15.5	17	17
6600-6800 TEU (5 years old)	50	44	44	44
8500-9100 TEU (5 years old)	65	60	60	60

Date source: Clarksons Research Database (Shipping Intelligence Network 2010)

Throughout the table, it is obvious that price of second hand vessels below 5000 TEU is experiencing rises during the past year from July, 2014 to August, 2015, among them, 3200-3600TEU classification has the most highest rise of 30.95%. This phenomenon should be attributed mainly to popularity of small TEU container vessels, especially 3000-3999TEU feeder vessels. On the other hand, price of vessels between 6000 TEU and 10000 TEU is rather stable or even declining. Those seemingly little changes and clues are leading to future strategy changes largely.

Current Second Hand Market Indications: Second-hand container vessel with approximate 10 years age is the best option for most liner companies; small capacity (below 6000TEU) second-hand container vessels are purchased most frequently; small capacity second-hand vessels are experiencing rapid growth in price rate, among them, 3000TEU to 3999TEU category has the highest rise of 30.95% during merely one year.

Pros of purchasing second-hand vessels: much cheaper and more affordable price rate compared to ordering new building vessels, longer manageable time compared to chartering vessels and less risk to take compare to new building investments.

Cons of purchasing second-hand vessels: unreliability of second-hand vessels compared to new building vessels, larger initial capital investment compared to chartering vessels.

Applicable condition of purchasing second-hand vessels: vessels with relatively stable market demand, vessels with relatively new and advanced technology support, liner companies with normal level budget.

3.2.3 Charter Market Indications

Chartering vessels is possibly the most complicated approach of expanding existing fleet due to its relationship with time periods. Regardless of the complexity of this investment approach, it makes an important part of expanding world container vessel fleet. Currently, the global cellular fleet counts 5078 ships for 19.03 Million TEU – of which 49.6% are chartered from non-operating owners, details has been shown in the table below.

Table 12 Existing TEU Capacity under each Category aggregation level (in TEU)

CELLULAR	01 June 2015 - Existing				
Size ranges	All		Of which chartered from NOO		
TEU	Ships	TEU	Ships	TEU	% Cht
18000-20000	26	482268	2	38448	8.0%
13300-17999	93	1326060	27	383772	28.9%
10000-13299	175	2082356	78	931942	44.8%
7500-9999	423	3700856	182	1573726	42.5%
5100-7499	508	3129621	251	1540872	49.2%
4000-5099	745	3380110	405	1836659	54.3%
3000-3999	263	910699	151	527123	57.9%
2000-2999	641	1626395	484	1229449	75.6%
1500-1999	572	976733	311	533385	54.6%
1000-1499	685	795836	415	486418	61.1%
500-999	757	560427	446	339393	60.6%
100-499	190	60891	39	12938	21.2%
TOTAL	5078	19032252	2791	9434125	49.6%

Data source: Alphaliner Monthly Report

The table above showed us existing global fleet composition and chartered ratio

under each type of container vessel. Number of ultra large container vessel (large than 13300TEU) is fair small because of its rather short history. And, for those existing ultra large container vessels, most of them belong to shipping lines or third-party ship owners instead of being chartered to operators as a result of young age and extremely high charter rate. Meanwhile, according to table 12, the writer observed that with the container vessel size increasing, the chartered ratio showed opposite decreasing trend. However, this trend is composed by past figures which are rather fixed and outdated. Hence, to better analyze the trend and character of chartered vessels, up-to-date order book structure is more useful and valuable. The order book before 01 June 2015 in practice counts 458 ships for 3.82 Million TEU representing 20.1% of the existing fleet (firm orders only). At the same time, it includes 274 ships for 2.36 M TEU with charter status representing 61.8% of the total order book.

Table 13 2015 Order Book Details and Structure on Aggregation Level (in TEU and in percentage)

CELLULAR	01 June 2015 – Order book				
Size ranges	All		Of which chartered from NOO		
TEU	Ships	TEU	Ships	TEU	% Cht
18000-20000	62	1199330	31	583720	48.7%
13300-17999	56	816128	42	603233	73.9%
10000-13299	52	568240	27	279190	49.1%
7500-9999	82	752777	71	652337	86.7%
5100-7499	4	27794	4	27794	100.0%
4000-5099	14	62658	8	37958	60.6%
3000-3999	22	80043	2	6842	8.5%
2000-2999	73	175899	34	81563	46.4%
1500-1999	55	96476	38	67132	69.6%
1000-1499	32	36592	14	17977	49.1%
500-999	6	4346	3	2325	53.5%
100-499	0	0	0	0	
TOTAL	458	3820283	274	2360071	61.8%

Data source: Alphaliner Monthly Report

Different from existing fleet composition, current chartered vessel order book has revealed that medium size (4000TEU to 9999TEU) and large size (10000TEU to 17999 TEU) container ships can be and should be chartered and are currently chartered more frequently than before. At the same time, small size (500TEU to 2999TEU) container ship deals constitute another necessary component of chartering market. Among those categories, 3000TEU to 3999TEU category showed extremely low charter ratio in latest order book, which means most liner companies have faith in operating such vessels successfully in a long term.

In terms of charter rates fluctuation, the majority is making use of fixed period time charter as their measurement unit, for instance, 6-12 months time charter rate, 3 years time charter rate, 10 years time charter rate etc. Table 12 below showed us charter rate changes in the past four years.

Table 14 Time Charter Rates (in USD per day)

	6 – 12 months time charter					3 years time charter			
	FCC	FCC	FCC	FCC	FCC	FCC	FCC	FCC	FCC
Average	1000TEU	1700TEU	2750TEU	3500TEU	4400TEU	1700TEU	2500TEU	6600TEU	9000TEU
2011	7729	10142	13388	14871	19854	12625	15417		
2012	5358	6292	6742	7179	9942	9821	11175	29857	37357
2013	6321	7096	6829	7021	8696	8279	9467	27542	37625
2014	6396	7313	7425	7746	8771	8550	9292	24667	39125

Data source: Clarksons Research Database (Shipping Intelligence Network 2010)

The table above displayed different container vessel charter rates as well as fluctuation of charter rates for the past 4 years. If we combine those figures with order book changes, they are somehow consistent with each other.

For instance, chartered 4099TEU to 5000TEU container vessel took up 60.6% of total order book. The reasons why chartered capacity took the lead under this category are explained as: primarily, existing number of 4000TEU to 5000TEU container ships is extremely high, wise liner companies are not willing to add more capacity to the market and make it suffer more from overcapacity, secondly, time charter rate of 4099TEU to 5000TEU container vessels has experienced sharp decrease and reached its valley point for the past few years according to table 14, it is more affordable and quite reasonable for an operator to charter such vessels at

very cheap price instead of purchasing it, thirdly, according to the figures of 2013 and 2014, we noticed that there were very little rises of charter rates, those rises may indicate later continuous growth of charter rates, hence, the operators would like to charter the vessels at least now as soon as possible in order to minimize their potential cost in the near future.

Current Charter Market Indications: Medium size (4000TEU to 9999TEU), large size (10000TEU to 13299TEU) and super large size (13300TEU to 17999TEU) container vessels are chartered most frequently among all capacity categories; 3000TEU to 3999TEU and 18000TEU to 20000TEU container vessels are mostly ordered by shipping lines; charter rates are recovering currently, among them, vessels between 3000TEU and 3999TEU has the most rapid growth of charter rates.

Pros of chartering vessels (compared to ordering new building vessels and purchasing second-hand vessels): lower initial investment, has more flexibility to leave or stay the market, lower risk level due to less tied up assets.

Cons of chartering vessels (compared to ordering new building vessels and purchasing second-hand vessels): higher daily capital cost, influenced more by fluctuation of freight rates, longer adaptive and preparation time before service.

Applicable condition of chartering vessels: vessels with unstable and fluctuated market demand, liner companies with limited budget constraint, liner companies which are at their fleet transitional and improving period.

The writer summarized pros of different expansion strategies in the table below to show the general picture of various strategies clearly.

Table 15 Summarized Pros of Different Expansion Strategies

Pros Compared to	Order New Building Vessels	Purchase Second-hand Vessels	Charter Vessels
Order New Building Vessels	/	Longer economic lifespan of vessels, more advanced and reliable ship building technologies, more operational patterns to choose, lower daily capital cost	Longer economic lifespan of vessels, more advanced and reliable ship building technologies, more operational patterns to choose, lower daily capital cost

Purchase Second-hand Vessels	Cheaper and more affordable price, less risk to take	/	Longer manageable time
Charter Vessels	Lower initial investment, has more flexibility to leave or stay the market, lower risk level due to less tied up assets.	Lower initial investment, has more flexibility to leave or stay the market, lower risk level due to less tied up assets.	/

Data source: Summarized by author

3.2.4 Global Market Indications

To choose the best fleet expansion structure, getting to know the future global container vessel fleet changes is necessary. Those changes have influence on fleet expansion decision details to a large degree. For example, if existing orders of new buildings will be delivered at very close dates, for latter orders, it is much wiser for them to postpone their delivery dates in order to avoid possible price competition and sudden capacity boosting. From other perspectives, if a liner operator sees small percentage of fleet increase, they may have the sense that there is still space left for more capacity in the future. Hence, from both sides, getting to know the future better is rather rational behavior before drafting fleet expansion strategy.

The table below provided forecast of the cellular fleet growth based on order book as at 01 June 2015 and assuming no ships are deleted after that date (other than those planed).

Table 16 Fleet Capacity Changes on Aggregation level in the coming 4 years

Fleet as at:	31 Dec 2014		31 Dec 2015		31 Dec 2016		31 Dec 2017		31 Dec 2018		Rise p.a (3 years)
TEU nomina	Ships	TEU	Ships	TEU	Ships	TEU	Ships	TEU	Ships	TEU	TEU

l											terms
18000-21000	15	276380	36	670972	48	900814	73	1405078	83	1591598	71.9%
13300-17999	81	1147483	111	1602973	135	1944338	140	2015338	149	2142188	20.7%
10000-13299	169	2021012	181	2143846	202	2361956	227	2650536	227	2650536	9.5%
7500-9999	404	3527503	476	4186473	503	4434751	505	4453551	505	4453551	8.1%
5100-7499	501	3086765	509	3137460	511	3151490	511	3151490	511	3151490	0.7%
4000-5099	745	3378484	749	3398562	752	3411519	757	3432519	760	3447519	0.5%
3000-3999	255	883731	269	935613	272	946331	279	971531	281	978731	3.2%
2000-2999	649	1650462	672	1700657	704	1777891	717	1811199	718	1813899	3.1%
1500-1999	575	981943	590	1008029	621	1062837	627	1073357	627	1073357	3.0%
1000-1499	679	789299	698	809919	710	822928	716	830488	716	830488	1.7%
500-999	766	568141	762	563880	764	565295	764	565295	764	565295	-0.2%
100-499	197	63076	190	60835	190	60835	190	60835	190	60835	-1.2%
TOTAL	5036	18374279	5243	20219219	5412	21440985	5506	22421217	5531	22759487	6.9%
TOTAL after Exp. Scrap/	5036	18374279	5174	19994634	5246	21016400	5240	21746632	5165	21834902	5.8%

Slip											
Rise 12 months	2013 >	6.3%	2014 >	8.8%	2015 >	5.1%	2016 >	3.5%	2017 >	0.4%	

Data source: Alphaliner

The global container fleet has a rise of 6.3% in 2014 and is going to rise 8.8%, 5.1%, 3.5% and 0.4% separately in 2015, 2016, 2017 and 2018. This trend illustrated much slower growing pace of global fleet size as a result of overcapacity. However, number as well as capacity of ultra large container vessels showed an opposite trend, it will experience a enormous growth (from 15 to 83) in the coming 5 years, constantly maintaining an average of 71.9% growth rate. Although large container vessels (10000TEU to 13299TEU) and medium size vessels (7500TEU to 9999TEU) will encounter similar rising rates around 9%, they are under completely different situation. Large container vessels' growth comes mainly from the upcoming years, while most growth of medium size vessels comes from order made before 2013 or 2014, which means current orders of medium size container vessels are rather small regardless of 8% average growth rate.

Because of the character of chartering behavior, it will not change the total TEU capacity of the global fleet in aggregation level. When to charter a vessel only relies on future forecasting trend of charter rate and relative price comparison with purchasing new building or second hand vessels. Only if huge amount of new tonnages are put into or out of the market can lead to intensive fluctuation of existing charter rates. As a result, charter rates are relatively stable when facing with slight growth of world total TEU capacity. On the contrary, purchasing container vessels is far more complicated when facing steady growth of specific container vessel types, the writer will further extend it in the case study of Maersk Line.

Current global market indications: In the following 3 years, container vessels with TEU capacity above 10000TEU will experience rapid increase in terms of capacity on aggregation level, among them, ultra large container ships (18000TEU to 20000TEU) will have incredible growth of 475% compared to 2014 until 2018; relatively small container ships (1500TEU to 3999TEU) will have steady growth (around 10%) on aggregation level.

3.3 Order Books' Indications

For the past almost 10 years, the world container vessel fleet kept at least 5% to 8% TEU capacity growth annually. The table below shows both container ship charter owner order book and operator owner order book, these 2 separate components

form the annual order book of liner shipping industry on aggregation level.

Table 17 Global Order Book Overview (in 1000TEU)

Date	Containership Charter Owner Order Book (,000 TEU)	Containership Operator Owner Order Book (,000 TEU)	Containership Charter Owner Order Book Number	Containership Operator Owner Order Book Number	Total TEU Growth From Order Book (,000 TEU)
2008	3577.89	2998.14	936	487	6576.03
2009	3379.96	2801.31	762	428	6181.27
2010	2542.59	2389.39	503	330	4931.98
2011	1606.44	2242.16	305	311	3848.6
2012	1603.93	2751.65	307	336	4355.58
2013	1437.55	1992.11	250	231	3429.66
2014	2314.18	1701.43	316	214	4015.61
2015	2365.45	1088.80	297	161	3454.25

Data Source: Clarksons Research Database (Shipping Intelligence Network 2010)

According to the table, since 2008 global order of containership has decreased sharply from over 6 million TEU to around 3.5 million TEU. It revealed that economic crisis brought severe effect to shipping as well. Chartering vessels, as an important investment approach, has always been the majority of total order book all the time except 2011 and 2012. What happened then in 2011 and 2012? After study on this phenomenon, the writer found that charter rate at that time reached its first paramount peak after long time price depression, which forced the people to consider new buildings as more attractive opinion. However, not long after, charter rate went into depression again and chartering vessel became the leading way of investing due to cheaper cost and more flexible character as before crisis. Until recently, we see 3-year gradual and constant increase from order book on aggregation level instead of fluctuated situation. Decrease in bunker price and recovery in freight rate contributed largely to a more stable and gradually recovery market.

To further study on the investment behavior of major shipping lines, the table below showed top 20 liner operators' order books and its fleet expansion scale in 2015.

Table 18 Top 20 Liner operators' order books (in TEU and in percentage)

		Order Book		
Operator	Rank	TEU	Ships	% Existing
APM-Maersk	1	475130	38	15.5%
Mediteeranean Shg Co	2	713112	56	26.9%
CMA CGM Group	3	367264	33	20.6%
Hapag-Lloyd	4	52500	5	5.5%
Evergreen Line	5	374508	32	39.5%
COSCO Container L.	6	327501	22	37.8%
CSCL	7	108000	8	15.4%
Hanjin Shipping	8	36120	4	5.8%
Hamburg Sud Group	9	54260	8	8.8%
MOL	10	144376	8	24.5%
OOCL	11	140920	8	24.1%
APL	12			
Yang Ming Marine Transport Corp.	13	112640	8	21.2%
NYK Line	14	140000	10	27.9%
UASC	15	204301	12	46.2%
K Line	16	97090	7	24.9%

PIL	17	50467	7	13.1%
Hyundai M.M.	18	60000	6	15.7%
ZIM	19			
Wan Hai Lines	20			

Data source: Alphaliner – TOP 100 Operated fleets as per 10 August 2015.

Throughout the table, it is obvious that APL, ZIM and Wan Hai Lines have no ambition to expand their fleet in the coming few years due to their own strategic or budget reasons. They choose to maintain or slightly scale their existing fleet size down in order to optimize the use of their fleet or have more money put into operational parts.

For the other leading players involved in liner shipping industry, they more or less planned to enlarge their container fleet by either chartering or ordering new or second-hand vessels. In terms of the expansion level, it is technically dominated by 3 factors according to our knowledge. A liner company's budget constraint (which is related to its previous year net profit result and amount of circulating fund, its function is to give a liner company possibilities of investing continuously and precisely), its main operating shipping routes' profitability (which determines whether to put more vessels and reconsider a tighter shipping schedule to further exploit potential benefit contained in specific trade lanes), its forecasting report about the future profitable shipping market under certain TEU category as well as trend of container ship charter and order rate (the former aspect determines what type of vessels should be invested in and the later aspect determines which type of financing approach should the operators employ to invest in those type of vessels). If the answers to all the 3 aspects mentioned above are positive, then the board of a liner company will normally make expansion decisions depend on their current financial situation and long-term strategy.

On the top of order book list, we saw 4 companies with over 350000TEU growth, Maersk, MSC, CMA CGM and Evergreen. As 4 largest liner shipping companies, they have been taking advantage of their monopoly power and scale economy for a long time. They constantly consolidate and develop their market position by improving and expanding their fleet. In return, they benefit more from gradually increased market share and lower unit cost. Large capital accumulation and continuous structure revolution over the past decades gave them more opportunities to develop themselves on a totally different level, which is relatively small and new companies cannot achieve in such a short time. Even if those new and small companies have sufficient money to invest in large vessels, other supporting

conditions cannot be built and developed in such a short period to maintain huge fleet's daily operation. It is qualified functional departments' mutual cooperation plus fully utilization of usable capacity that make those liner companies survive and thrive eventually during past decades. Regarding the other liner companies that have TEU growth over 100000, they are either optimistic with their operation future or sufficient with their budget. Yang Ming, COSCO and UASC are representatives of those companies.

Order books' indications: Decrease in bunker price and slow increase in freight rate contributed largely to a gradually recovering shipping market; leading shipping lines keep at least 15% annual capacity increase in general to maintain its market position; shipping lines with sufficient budget urge to invest in more capacity in order to grab more market share.

3.4 Daily Capital Cost

Daily Capital Cost, defined as capital cost per day, is a very important measurement criteria when deciding fleet expansion strategy. It successfully made initial large amount of capital investment and unit capital cost (for example, charter rate) on comparable level. For instance, in our case, ordering new building container vessels and purchasing second-hand container vessels only have one full payment which represents the whole value of a vessel. Only if we divide it into daily amount can we compare it with charter rate because the latter term measures charter price in unit time period.

Apart from dividing total initial investment by its designed or remained economic life to achieve unit time period capital cost. During this procedure, it is also essential to think about second-hand rate and charter rate fluctuations between delivery date and current date since only second-hand rate and charter rate at new building's delivery time can be compared with daily capital cost under same time condition. Furthermore, annual global inflation rate should also be taken into consideration to eliminate the influence from inflation and make the price changes more accurate. The general formula of estimating daily capital cost is shown as below:

$$Daily\ Capital\ Cost\ (New\ Building) = \frac{Current\ Rate\ of\ Contaienr\ Vessel * (1 + inflation\ rate)^n}{Economic\ life * Operating\ days\ per\ year}$$

$$Daily\ Capital\ Cost\ (Secondhand\ or\ Chartered) = \frac{Current\ Rate\ of\ Container\ Vessel * (1 + annual\ rate\ change)^n}{Economic\ life * Operating\ days\ per\ year * (1 + inflation\ rate)^n}$$

Overview conclusion:

In the following 3 years, container vessels with TEU capacity above 10000TEU will experience rapid increase in terms of capacity on aggregation level, among them, ultra large container ships (18000TEU to 20000TEU) will have incredible growth of 475% compared to 2014 until 2018; relatively small container ships (1500TEU to 3999TEU) will have steady growth (around 10%) on aggregation level. Decrease in bunker price and slow increase in freight rate will constantly contribute to a gradually recovering shipping market; largest shipping lines keep at least 15% annual capacity increase on average to maintain its market position; shipping lines with sufficient budget urge to invest in more capacity in order to grab more market share.

Chapter Conclusion (Overall Theoretical Conclusion):

Qualitative part:

1. Container vessels with large and promising potential market, container vessels with unprecedented superiorities, liner companies with sufficient and abundant budget are three situations in which a liner company should use ordering new building container vessels as its fleet expansion strategy. (3000TEU to 3999TEU container vessel and container vessel with TEU capacity above 10000TEU are ordered most frequently under current trend)

2. Container vessels with relatively stable market demand, container vessels with relatively new and advanced technology support, liner companies with normal level budget are three situations in which a liner company should use purchasing second-hand container vessels as its fleet expansion strategy. (Currently, second-hand container vessel with approximate 10 years age is the best option for most liner companies, small capacity second-hand vessels are purchased most frequently, among them, 3000TEU to 3999TEU category has the highest rise of 30.95% during merely one year.

3. Container vessels with unstable and fluctuated market demand, liner companies with limited budget constraint, liner companies that are at their fleet transitional period are three situations in which a liner company should use chartering vessels as its fleet expansion strategy. (Currently, Medium size (4000TEU to 9999TEU), large size (10000TEU to 13299TEU) and super large size (13300TEU to 17999TEU) container vessels are chartered most frequently among all capacity categories)

Quantitative part:

4. Daily capital cost is important measurable criteria when conducting quantitative analysis to decide certain fleet expansion strategy. After certain calculation method, when we are given various daily capital costs under same time condition, they can be compared and lead to quantitative recommendation. The formulas are shown below:

$$Daily\ Capital\ Cost\ (New\ Building) = \frac{Current\ Rate\ of\ Containenr\ Vessel * (1 + inflation\ rate)^n}{Economic\ life * Operating\ days\ per\ year}$$

$$Daily\ Capital\ Cost\ (Secondhand\ or\ Chartered) = \frac{Current\ Rate\ of\ Container\ Vessel * (1 + annual\ rate\ change)^n}{Economic\ life * Operating\ days\ per\ year * (1 + inflation\ rate)^n}$$

4. Research Methodology

Case study of Maersk Line is the methodology of this thesis because under different conditions, the fleet expansion strategies could be completely different. There isn't a methodology or model applicable to all situations and cases. Hence, Case study is the most appropriate research form on this issue regarding specific TEU capacity category.

The writer will mainly focus on TEU categories mentioned in the case study of Maersk Line and give a general conclusion to the main research question. This process requires both quantitative analysis and qualitative measurement. For qualitative part, it will apply current different market indications as well as container fleet expansion theory which is illustrated in chapter three, for quantitative part, it relies on mathematical model constructed by the writer to estimate the differences of daily capital costs between various financing approaches. In this chapter, the writer will illustrate the quantitative model thoroughly.

4.1 Model Description

In order to make initial capital investment and charter rate on comparable level, we must divide total initial investment by its designed or remained economic life to achieve unit time period capital cost. During this procedure, it is essential to consider the second-hand rate and charter rate changes between delivery date and current date as well since it makes all three approaches' calculated daily capital costs under same time condition. Only the costs are under same time condition can they be compared with each other and give us valuable results. Furthermore, annual global inflation rate should also be taken into consideration to eliminate the influence from inflation and make the price changes more accurate. Based on those, the writer constructed model equations to estimate different expansion strategy's daily capital cost as follows:

$$\boldsymbol{Daily\ Capital\ Cost\ of\ Ordering\ New\ Building\ \ Vessel\ (in\ USD\ per\ day)}$$

$$= \frac{New\ Building\ Cost\ of\ Container\ Vessel * (1 + Inflation\ Rate)^n}{Economic\ Life\ (in\ years) * Operating\ Days\ per\ Year} \qquad (Equation\ 2)$$

$$\boldsymbol{Daily\ Capital\ Cost\ of\ Purchasing\ Certain\ age\ Container\ Vessel\ (in\ USD\ per\ day)} \quad (Equation\ 3)$$

$$= \frac{Forecasting\ Price\ of\ Certain\ age\ Container\ Vessel\ at\ Same\ Delivery\ Date}{The\ Rest\ Economic\ Life\ (in\ years) * Operating\ Days\ per\ Year\ (in\ days) * (1 + Inflation\ Rate)^n}$$

$$= \frac{Current\ Certain\ Age\ Container\ Vessel\ Price * (1 + Forecasting\ annual\ rate\ change)^n}{(Economic\ life - Age\ )(in\ years) * Operating\ Days\ per\ Year\ (in\ days) * (1 + Inflation\ Rate)^n}$$

$$\textbf{Daily Capital Cost of Chartering Container Vessel (in USD per day)} \quad (Equation\ 4)$$

$$= \frac{Forecasting\ Charter\ Rate\ of\ Container\ Vessel\ at\ Same\ Delivery\ Date\ (in\ USD)}{(1 + Inflation\ Rate)^n\ (in\ \%)}$$

$$= \frac{Current\ Charter\ Rate\ of\ Container\ Vessel * (1 + Forecasting\ annual\ rate\ change)^n}{(1 + Inflation\ Rate)^n}$$

Forecasting annual rate change – refers to rate changes based on existing figures

Age – refers to specific container vessel age

N – refers to time difference between delivery date and current date

4.2 Data Gathering

Indicators of the model:

3.8% Global average inflation rate in the coming 30 years annual.

Economic lifespan for new building container vessels is 25 years, 1 year consists of 365 operating days.

Data of the model:

New building cost of container vessel: based on figures collected from Clarksons Research database and figures from shipyards in China and Korea.

Certain age container vessel price: based on figures collected from Clarksons Research database mentioned in chapter 3.

Forecasting annual rate change: based on figures collected from Clarksons Research database mentioned in chapter 3.

Current charter rate of container vessel: based on published news, charter deals in Clarksons Research database and market indications mentioned in chapter 3.

For all the data that will be used in case study of Maersk Line, they will be further illustrated and analyzed in chapter 5.

Chapter conclusion:

Case study will be used as our methodology to answer our main research question. During the research process, qualitative analysis based on theoretical conclusion and quantitative measurement based on mathematical model will be employed on individual fleet expansion background from case study of Maersk Line to achieve our fleet expansion conclusion.

5. Case Study of Maersk Line

When dealing with specific liner company fleet expansion case, it is usually difficult to determine their needs for various types of container vessels as they may focus on different perspectives. Also, their budget space and individual forecast about the future profitable market may not be the same, either. Hence, in order to analyze the possibility of improving the order book structure, we have to know a liner company's personalized order book as well as its financial and fleet background because those are the fundamental things a decider needs to acknowledge before making decisions.

In this chapter, the writer provided a case study of Maersk Line with its company's comprehensive background that related to ship finance and well acknowledged latest order book structure. Based on those, the writer calculated, tested and analyzed the other feasible alternative options using the theory and model mentioned in the previous sub chapter and compared them with its existing latest order book.

5.1 General Picture of Maersk Line

As the undoubted world's largest container shipping company in liner shipping industry, Maersk Line is the global container division and the largest operating unit of the A. P. Moller – Maersk Group. Over the past nearly a hundred years consistent development, it now has the most advanced and sufficient container vessel fleet size, profitable and diversified shipping service routes, constant and positive margin space. Those are all considered to be the premise for enormous and continuous investment in fleet expansion behavior.

Specifically, 610 vessels with 3.05 million TEU capacity constructed the world largest container fleet. Out of those 610 container ships, 259 vessels are owned or partly owned by Maersk Group, which gives the company initiatives to operate under different water conditions and shipping routes. When berthing at various kinds of terminals, well-constructed owned or partly owned port facilities also make it much easier to load and unload its containers at landside. Every connection dot contained in Maersk Line transportation network is effective and tailor-made, which in return contributes to a more integrated and effective system.

With respect to existing service routes, even though Maersk Line has its own most profitable routes as the other liner companies, it still tried its best to cover almost all the possible trading routes on the map to be responsive and well-rounded to every possible customer in every corner of the world. Among all the service routes, East West Maersk Line Network is Maersk Line's dominant service network because of its large transportation demand. However, Maersk Line has also been involved in feeder

business for a long time, which enables itself to establish feeder network in order to satisfy relatively small requests in specific region as well.

Dry cargo, reefer cargo and special cargo will be transported by characterized containers to safely arrive its destination, so shippers don't have to worry about the security of its delivered cargo, either.

With respect to profit performance, in the past consecutive years after economy crisis, Maersk Line has experienced a tough re-rise journey.

Table 19 Maersk Line Profit Overview

Year	Profit or Loss in Million USD	
2011	(602)	Loss
2012	461	Profit
2013	1500	Profit
2014	2300	Profit

Data source: Maersk Line Official Website

In 2011, as a result of sharply lower freight rates especially on the Asia – Europe route and nearly 35% increase in fuel costs, even Maersk line cannot escape from the price and cost double disaster. However, this disaster didn't last long and Maersk Line strived to find its way out just one year after with the help of slowly recovering freight rate of Asia – Europe route and success in cost reduction strategy. Combined with consistent fuel price decrease, Maersk line gradually returned to its normal profit track until 2014. For the just past 2014, Maersk line, as the leading player in liner shipping industry, proved itself its remained dominant position with 2.3 billion USD profit.

5.2 2015 Maersk Line Order book Analysis

Normally, a liner company's order book consists of 3 parts, ordered new building vessels for delivery in near future, purchased second hand vessels for delivery in recent period and chartered vessels for delivery recently. Different combination of three parts will bring a liner company completely different cost sheets and budget conditions. The table below shows the order book detail of Maersk Line in 2015. It approximately corresponds to 0.47 million TEU or approximate 15.5% of Maersk Line's current fleet capacity.

Table 20 Structure of Maersk Line Order Book

	Order Book	
Maersk Line	Ordered Vessels	Chartered Vessels
	9 x 14K vessels (126k TEU) for delivery from 2017 onwards 7 x 3.6KBaltic Feeder vessels (25k TEU) for delivery in 2017 11 x 19K vessels (221k TEU) for delivery in 2017-18	11 x 9.5-10K chartered vessels (108k TEU) 2015-16

Data source: Maersk Line Official Website

In terms of delivery times, all the container vessels in Maersk order book are expected to be delivered after 2017 excepts 11 chartered relatively large container vessels as new orders are not able to be finished in at least 2 years. According to this order book structure, it not only shows Maersk line's proactive strategy but also reflects its determination in steadily expanding its ultra large container vessel fleet. What is also worth mentioning is that all the recently ordered vessels in Maersk Line order book are new building vessels. This phenomenon reflects the liner company's large amount of available money as well as its confidence in the future of all those container vessels' profitability. However, we cannot simply ignore possibility of effectiveness of other alternative strategies merely because the largest liner company made those decisions as such. In depth analysis will be needed to further examine this structure's validity. However, first of all, to explore the advantages of Maersk Line order book structure is very meaningful as there must be some convincible reasons forcing such huge liner companies to make those decisions.

To start with, having a look at each category of Maersk ordered container vessels' forecasting market changes is rather necessary.

Table 21 Forecasting Capacity Changes related to Categories included in Maersk line's Fleet Expansion

Ordered Vessels	Delivery Date	Total Capacity Rise 12 Months at Delivery Date	Total Capacity Rise Compared with 31 Dec 2014
7*3.6k feeder	2017	2.66% (7 out of 7)	9.94% (7 out of 24)

vessels			
9*14k vessels	2018	6.29% (9 out of 9)	86.7% (9 out of 68)
11*19k vessels	2017	55.9% (11 out of 25)	476% (11 out of 68)

Data source: Alphaliner

For the 3600 TEU feeder vessels, it is forecasting that until delivery date, there will only be in total 9.94% increase (from 883731TEU to 971531TEU) as a result of relatively large existing TEU capacity under 3000TEU to 3999TEU category. Unpredictable market changes in this TEU category also let the liner operators wonder whether to put more capacity in the existing shipping market. So, if we think about the problem normally, even though ordering new vessels at small percentage won't have much influence on chartered vessel market as well as freight rates, this behavior should also be classified into rather bold behavior classification compared to purchasing second hand feeder vessels or chartering feeder vessels. Nonetheless, we cannot ignore an important fact that with the regional trade becoming more popular, both charter rate and second-hand container vessel rate under this category are showing rapid increasing trends, with an increase rate of 8.73% and 30.95% separately. Following this trend, it is reasonable to estimate that in the near future, both charter rate and second hand price will continue to increase at unforeseeable level. So, what Maersk line has done on 3600 TEU feeder vessel actually considers more about future constant growth of regional short distance trade and future price trend at the vessels' delivery date. What's more, ordering new vessels can also let the liner operator benefit from much longer lifespan and more advanced and reliable technology of the vessel. Considering all the measurable and important aspects, we calculated the daily capital cost of all 3 investing methods regarding 3000TEU to 3999TEU vessel category.

The writer assumed:

The price of second hand 3600 TEU container vessel will have an increase rate of 30.95% until 2017 (based on empirical figures from Clarksons).

The charter rate will have an increase rate of 10.33% until 2017 (based on empirical figures from Clarksons).

$$Daily\ Capital\ Cost\ of\ Ordering\ New\ Building\ 3600TEU\ Feeder\ Vessel$$

$$= \frac{39\ Million\ USD * (1 + 3.8\%)^2}{25\ years * 365\ days} = 4604.97\ USD/day$$

$$Daily\ Capital\ Cost\ of\ Purchasing\ Second\ Hand\ 10\ years\ old\ 3600TEU\ Feeder\ Vessel$$
$$= \frac{13.75\ Million\ USD * (1 + 30.95\%)^2}{15\ years * 365\ days * (1 + 3.8\%)^2} = 3997.01 USD/day$$

$$Daily\ Capital\ Cost\ of\ Chartering\ 3600TEU\ Feeder\ Vessel\ in\ 2017 = \frac{7746 * (1 + 10.33\%)^2}{(1 + 3.8\%)^2}$$
$$= 8751.25 USD/day$$

Among all those three different daily capital costs, chartering feeder vessels has the highest daily capital cost, which seems unbelievable given the million dollars purchasing cost condition. However, if we think the charter terms through, its flexibility to extent its contract or leave the market is obviously superior to the other two financing approaches. Also, its short time period and less risky character make the investment more stable than the other two options. Hence, it is reasonable that vessel owners will charter at a relatively higher price than other two approaches.

We now recall the order book of percentage of chartered capacity under each TEU category on aggregation level, it is easily observed that based on the 01 June 2015 order book, only 2 out of total 22 vessels were chartered by liner operators. 3000TEU to 3999TEU is simultaneous the TEU category with the lowest chartered capacity percentage (8.5%) in the order book. This phenomenon verifies our calculation results above, liner operators mostly prefer to choose a much lower daily capital cost investment way.

When further comparing new building strategy and purchasing second-hand container vessel strategy, we found rather similar daily capital costs which are 4605 USD and 3997 USD per day separately (608 USD difference per day). As a result, in one year, the resulting difference will save purchasing second hand strategy around 200000 USD compared with new building. However, we have to admit that even if the spending is costly, most liner companies will still go for new building strategy. With new building feeder vessel at hand, the liner operators definitely grasp several very significant advantages which purchasing second hand strategy doesn't have: 1. Newly constructed hull structure and first-tier technology employed on vessel equipment 2. Main engines with high energy-efficiency to save daily fuel cost enormously 3. Possibilities of trading and chartering their new buildings at whatever time they want to 4. Tailor-made vessels constructed according to specific liner company's requirement to adapt to certain shipping route's condition.

Conclusion: with sufficient budget space, to order new building 3600TEU feeder vessel is rather sensible than purchasing second hand feeder vessel or chartering feeder vessel. Maersk Line's expansion decision regarding 3600 TEU feeder is reasonable and successful.

For the 14000 TEU container vessels, it is forecasting that until delivery date, there will be striking 86.7% capacity growth (from 1147483TEU to 2142188TEU) under this category (13300TEU to 17999TEU), which possibly indicates fierce competition in this super large container vessel market during 2015 to the end of 2018. Nonetheless, when the expansion strategy comes to super large container vessel classification, the situation is slightly different because currently, there are only 81 super large container vessels under this category representing merely 1147483TEU capacity in total. It is still a relatively new but advanced (lower unit cost, lower pollutant and green house gas emission, higher energy efficiency) classification in global fleet composition. There is no doubt that future Asia – Europe routes' transportation demand relies largely on this fleet category. However, boosting of super large vessel fleet also comes from strong desire of improving existing fleet of leading liner operators.

For those players with strong market power in liner shipping industry, they have already had sufficient capacity to operate on Asia – Europe routes, the only problem they are facing with is to transfer their existing operation pattern into a more profitable and reasonable pattern. A more profitable pattern nowadays means to put much more appropriate vessels into operation in order to lower the cost under each category. Chartering those super large container vessels is also different from chartering small TEU capacity vessels. Because of their short invented time, most of the super large chartered vessels cases are chartering new building super large container vessels from third-party ship owners. In nature, this kind of charter behavior is to operate the fleet with new building vessels but in time charter form. To further calculate the daily capital cost, we employ our calculation model with such assumptions:

14000TEU class container vessel is rather new to second hand market and the dealt number of those vessels is extremely small, so we neglect the option of purchasing second hand 14000TEU container vessel here in this section

The charter rate in 2015 for 14000TEU container vessel is 50000USD per day.

The charter rate will have an increase rate of 5% until 2018

$$Daily\ Capital\ Cost\ of\ Ordering\ New\ Building\ 14000TEU\ Container\ Vessel$$
$$= \frac{122\ Million\ USD * (1 + 3.8\%)^3}{25\ years * 365\ days} = 14952.68\ USD/day$$

$$Daily\ Capital\ Cost\ of\ Chartering\ 14000TEU\ Container\ Vessel$$
$$= \frac{50000\ USD/day * 1.05^3}{1.038^3} = 51754.23\ USD/day$$

To analyze the superiorities of those two investment strategies more comprehensively, the writer had a quick look at the current trend in 01 June 2015 order book. What surprised us is that the chartered capacity under this TEU category accounts for almost 75% out of total TEU capacity, which means most liner operators are willing to charter 14000TEU container vessel instead of purchasing 14000TEU super large container vessel. Given the calculated results of completely different daily capital cost, why would so many liner operators still insist to choose chartering 14000TEU container vessel? According to the writer's analysis, the reasons are as follows: 1. If we go one step further to the highest TEU capacity category (18000TEU to 20000TEU), we found that it would have amazing growth (476%) in the following 3 years, which would be potential threat to super large (13300TEU to 17999TEU) market as those two kinds of vessels basically serve similar shipping routes. Under this condition, given the foreseeable future, the liner operators prefer to charter 14000TEU container vessels during the transition period of the shipping market and wait for their ultra large new buildings to be delivered. 2. Even though daily capital cost difference between those two strategies is rather enormous, we cannot simply ignore the fact that 122 million USD is extremely huge amount of money to be invested at the beginning, let alone 9 times 122 million USD given the situation that most liner companies just came back to their profit patterns. Although compared to 14405.28USD per day, 51754.23USD per day is three times much more expensive, we have to admit that an annual cost of 18.89 Million USD is rather affordable compared with 122 million USD. 3. Most liner operators want to get some profit from super large container vessel operation, however, not all of them have sufficient money to invest in new building vessels. The flexibility and possibility that charter policy can offer is exactly what liner operators need to achieve their ambition and minimize the impact of unpredictability of shipping market.

Nonetheless, when considering Maersk Line case, the latter two reasons are not applicable because of its strong risk-taking ability and powerful financial background. The only thing that matters is whether Maersk Line will make full use of those 14000TEU super large container vessels during their economic life since their delivery date given the situation that more and more ultra large (18000TEU to 20000TEU) container vessels will come into service. If we have a look at the order book of Maersk Line carefully, it can be easily observed that Maersk line also ordered eleven 19630TEU ultra large container vessels to further extend its market power on Asia – Europe routes. Until 2018, there will be 20 super large container vessels (9*14000TEU + 11*19630TEU) come from Maersk Line represents 16.97% increase out of those two categories' total increase (2015458TEU). Will the market share of Maersk Line on Asia – Europe routes increase by 341930 TEU at least or will the demand on Asia – Europe routes shared by Maersk Line grow by 341930

TEU? According to the forecasting report about future demand conducted by Drewry Consultancy Company, it is impossible for Maersk Line to fully utilize its new delivered vessels at their delivery date in 2017 and 2018. However, in a longer term, it may be feasible and possible.

Conclusion: With sufficient budget and foreseeable constant high utilization of the new ordered capacity, purchasing new building 14000TEU super large container vessels is more cost-efficient than chartering 14000TEU super large container vessels. However, among all the liner shipping companies, only Maersk Line is relatively applicable to this strategy because of its characters mentioned before. For the other large and medium size shipping companies, chartering those 14000TEU container vessels until their ultra large container vessels' delivery date gives them more freedom and makes more sense.

For the 19630TEU ultra large container vessels, although they are the newest members of global container fleet, they are experiencing the fastest capacity growth among all the TEU categories. Currently, before 01 June 2015, there are only 26 ultra large container vessels existing, represents in total 482268TEU capacity, but until the end of 2017, there will be 73 ultra large container vessels, represents 191% capacity growth under this category. Driven by scale economy, trend of larger vessel is unstoppable in the touchable future.

When we look at the latest order book under 18000TEU to 20000TEU category, chartered capacity takes up 48.7% (583720TEU out of 1199330TEU) of the total capacity, while at the same time only 8% (38448TEU out of 482268TEU) of total existing capacity under this TEU category is chartered by charter owner, which means more liner companies are willing to charter new building ultra large container vessels from third-party ship owners. However, considering the ultra large container vessels' extremely high charter rates, the writer deems that without strong financial background or large and stable market demand, chartering behavior is rather bold and risky. Normally, only large shipping companies with strong financial background can be involved in this classification's competition as even employing charter policy will cost a liner company around 20 million USD annually without yearly fuel and operation cost. Hence, regarding this ultra large class container vessel, the writer only calculate the daily new building investment capital cost as follows:

$$Daily\ Capital\ Cost\ of\ Ordering\ New\ Building\ 19630TEU\ Container\ Vessel$$
$$= \frac{163.63\ Million\ USD * (1 + 3.8\%)^2}{25\ years * 365\ days} = 19320.78\ USD/day$$

Even with such low daily capital cost, operating those ultra large container vessels in practice still have severe problems to solve. Among all the problems, updating port

facilities should be given the first priority because all the quay cranes and loading, unloading equipment need to be improved to serve those vessels. Other, the whole ocean transportation network will never be integrated and effective.

Conclusion: In terms of ultra large container vessels' investment, largest liner operators (Maersk Line, MSC, CMA CGM) as well as liner operators with abundant money (UASC) will be better off if they choose to sign contract with ship yards to order new building vessels. Large or medium size liner companies that also want to be part of the ultra large level competition should try charter policy to attain the opportunity and reduce their initial investment amount, but the risk contained in this behavior is rather huge.

For the 7500TEU – 9999TEU container vessels, they are now in a very awkward position because of their medium capacity level. If we look at the existing fleet under this category, 57.5% (1573726TEU) of its total existing capacity (3700856TEU) is owned capacity. However, in the 2015 new order book, 86.7% of total ordered capacity is chartered capacity, which reveals that most liner operators didn't have much confidence in running such container vessels for a long time period. It is also proven by slow capacity increasing pattern which is forecasted by Alphaliner. From 2014 to the end of 2018, there will only be 26.25% capacity growth under this category, from which most of them are chartered.

In short, the emergence of more and more substituted and economical vessel classifications lead to unpromising market under this category, lead to uncertainty and distrust from liner operators, lead to slow capacity increase rate, lead to high percentage of chartered capacity under this category. The fair stable time charter rate and second-hand price under this category also indicates its undynamic market character in the following at least 5 years. What's more, the emergence of young age (5 years old) second-hand 9000TEU container vessel also points to the fact that ship owner shows less faith in this market profitability. To quantify the problem and make those investment strategies on comparable level, the writer still employ the calculation model but different assumptions:

Expected delivery date for a new building 9800TEU container vessel is 3 years after current date.

The price of second-hand 9800TEU container vessel will have an increase rate of 0% until 2018 (based on empirical figures).

The charter rate in 2015 for 9800TEU container vessel is 42000USD per day (based on empirical figures).

The charter rate will have an increase rate of 4% until 2018

$$Daily\ Capital\ Cost\ of\ Ordering\ New\ Building\ 9800TEU\ Container\ Vessel$$
$$= \frac{88\ Million\ USD * (1 + 3.8\%)^3}{25\ years * 365\ days} = 10785.54\ USD/day$$

$$Daily\ Capital\ Cost\ of\ Purchasing\ Second\ Hand\ 5\ years\ old\ 9800TEU\ Container\ Vessel$$
$$= \frac{65\ Million\ USD}{20\ years * 365\ days * (1 + 3.8\%)^3}$$
$$= 7961.56\ USD/day$$

$$Daily\ Capital\ Cost\ of\ Chartering\ 9800TEU\ Container\ Vessel = \frac{42000USD * (1 + 4\%)^3}{(1 + 3.8\%)^3}$$
$$= 42243.24USD/day$$

Even though purchasing new building and second hand container vessels have lower daily capital cost compared with charter policy according to our calculation, whether the former two investment ways will have such long operational life as assumed is a big problem. Super large liner company like Maersk Line even is reluctant to order a new vessel or purchase a second hand vessel. When the same situation comes to the other liner company, what decision they will make is pretty clear.

Conclusion: Considering the 7500TEU to 9999TEU investment decision-making, even if daily capital cost of charter policy is still a lot higher than the other two investment ways, given the potential market in depression, chartering container vessels under this category is considered much more sensible fleet expansion behavior than purchasing either new or second hand vessels.

5.3 Budget Decision and Scale Economy

By using the current figure of time charter rates and known prices of those new building or second hand vessels from shipyards, we calculated the total cost of Maersk Line order book of 2015 as follows (the writer assumed that those chartered vessels have time charter contracts of 1 year period):

$$Total\ Order\ Book\ Cost\ (in\ Billion\ USD)$$
$$= Ordered\ Vessel\ Cost\ (in\ Million\ USD) + Chartered\ Vessel\ Cost(in\ USD)$$
$$= (9 * 122\ Miliion + 7 * 39\ Million + 11 * 163.63\ Million)$$
$$+ (11 * 42000 * 365\ ) = 3.339\ Billion\ USD$$

According to the annual report from Maersk Line, its profit in 2014 in total was 2.3 billion USD, however, the total budget of its order book in 2015 costs more than its last year profit. If we have a careful look at the order book, we will find that different orders were made at different timings in 2015, for instance, 14000TEU orders were

made at 08, July, 2015, 19630TEU orders were made at 08, May, 2015. There is certainly some buffer space considered by Maersk Line both for differentiating delivery dates and for consistent investing.

Meanwhile, according to calculated total order book cost, the investment pattern of Maersk Line is rather stable. 4.93% of its total budget is allocated to chartering investment, 8.18% is allocated to small TEU container vessel investment and the rest 86.89% of total investment is directly arranged to super large or ultra large container vessel investment. The percentages below revealed that Maersk Line is very ambitious about Asia – Europe service routes and routes that have large transportation demands in the future.

Furthermore, new building container vessels' budget in Maersk Line order book account for almost 95.0% of its total budgets. This on one hand reflects Maersk Line's preference on new building container vessels due to its advantages, on the other hand, it reflects Maersk Line's determination and confidence in successfully operating those vessels. It employed a fleet expansion strategy that for long term promising and certain market, constructing its own fleet to take initiatives, for short term stable and average level market, chartering vessels to maintain its market position.

Scale economy is always mentioned by employing super large and ultra large container vessels, however, to examine its correctness, we conducted calculations in terms of daily capital cost per day per TEU unit using data from Maersk Line case, which is shown below:

$$Daily\ Capital\ Cost\ per\ unit\ of\ Ordering\ New\ Building\ 3600TEU\ Feeder\ Vessel$$
$$= \frac{New\ Building\ Cost\ of\ 3600TEU\ Feeder\ Vessel\ (in\ million\ USD)}{Economic\ Life\ (in\ years) * Operating\ Days\ per\ Year\ (in\ days) * TEU\ Capacity\ (in\ TEU)}$$
$$= \frac{39\ Million\ USD * (1 + inflation\ rate)^2}{25\ years * 365\ days * 3600TEU} = 1.279 USD/TEU * day$$

$$Daily\ Capital\ Cost\ per\ unit\ of\ Ordering\ New\ Building\ 9800TEU\ Container\ Vessel$$
$$= \frac{New\ Building\ Cost\ of\ 9800TEU\ Feeder\ Vessel\ (in\ Million\ USD)}{Economic\ Life\ (in\ years) * Operating\ Days\ per\ Year\ (in\ days) * TEU\ Capacity\ (in\ TEU)}$$
$$= \frac{88\ Million\ USD * (1 + 3.8\%)^3}{25\ years * 365\ days * 9800TEU} = 1.101\ USD/TEU * day$$

$$Daily\ Capital\ Cost\ per\ unit\ of\ Ordering\ New\ Building\ 14000TEU\ Container\ Vessel$$
$$= \frac{New\ Building\ Cost\ of\ 14000TEU\ Feeder\ Vessel\ (in\ Million\ USD)}{Economic\ Life\ (in\ years) * Operating\ Days\ per\ Year\ (in\ days) * TEU\ Capacity\ (in\ TEU)}$$
$$= \frac{122\ Million\ USD * (1 + 3.8\%)^3}{25\ years * 365\ days * 14000TEU} = 1.068\ USD/TEU * day$$

$$Daily\ Capital\ Cost\ per\ unit\ of\ Ordering\ New\ Building\ 19630TEU\ Container\ Vessel$$
$$= \frac{New\ Building\ Cost\ of\ 19630TEU\ Feeder\ Vessel\ (in\ Million\ USD)}{Economic\ Life\ (in\ years) * operating\ Days\ per\ Year\ (in\ days) * TEU\ Capacity\ (in\ TEU)}$$
$$= \frac{163.63\ Million\ USD * (1 + 3.8\%)^2}{25\ years * 365\ days * 19630TEU} = 0.984\ USD/TEU * day$$

The writer summarized different daily capital cost per TEU in the table below:

Table 22 Daily Capital Cost per TEU per day

	3600TEU	9800TEU	14000TEU	19630TEU
Unit Capital Cost	1.279	1.101	1.068	0.984

Data source: Summarized by author

According to the calculation the writer conducted, it showed us with the TEU capacity increasing, the unit daily capital cost shows negative relationship with it, which proves the scale economy principle is at least applicable to daily capital cost. Regarding fuel cost and operational cost, this research will not demonstrate further as they are related to many other aspects which cannot be measured quantitatively. However, in literature review part, the empirical figures used by Drewry Consultancy Company showed us negative relationship between them too.

Chapter conclusion:

1. With enough budget space, to order new building 3600TEU feeder vessel is more sensible than purchasing second hand feeder vessel or chartering feeder vessel.
2. Considering the 7500TEU to 9999TEU investment decision-making, chartering container vessels under this category is considered more sensible fleet expansion behavior than purchasing either new or second hand vessels.
3. With sufficient budget and foreseeable constant high utilization of the new ordered capacity, purchasing new building 14000TEU super large container vessels is more cost-efficient than chartering 14000TEU super large container vessels. However, among all the liner shipping companies, only Maersk Line is relatively applicable to this strategy because of its characters mentioned before. For the other large and medium size shipping companies, chartering those 14000TEU container vessels until their ultra large container vessels' delivery date gives them more freedom and makes more sense.
4. In terms of ultra large container vessels' investment, ordering new building vessels is considered more sensible investment approach.
5. With the ship size growing larger, new buildings' daily capital costs get lower and lower.

6. Conclusions

6.1 Key Findings

In order to find out *"Which expansion of the fleet of a liner company is most cost-efficient given certain conditions"*, the writer used case study of Maersk Line and further extended it to certain TEU categories expansion strategy under different scenarios. The answer to the thesis' main research question can be briefly divided into five parts:

Regarding the 3000TEU to 3999TEU fleet expansion decision-making process, our conclusion is as follows: given the rather promising 3000TEU to 3999TEU market profitability, rapid increase of both second-hand price and charter rate under this category in the touchable future, relatively low amount of total investment and daily capital cost difference between three various strategies, it is much more sensible to order new building 3000TEU to 3999TEU container vessels for most key players involved in liner shipping industry, even medium and relatively small liner operators.

Regarding the 7500TEU to 9999TEU fleet expansion decision-making process, our conclusion is as follows: given the condition of forecasting depressed 7500TEU to 9999TEU market in the following 5, even 10 years, high pressure derived from emergence of more and more economical and larger container vessels and relatively low freight rate of this category, it is much more reasonable to charter 7500TEU to 9999TEU container vessels for most liner operators involved in liner shipping industry in order to satisfy their customers' needs and pass the transition time during their fleet expanding period.

Regarding the 13300TEU to 17999TEU fleet expansion decision-making process, our conclusion is different based on 3 different scenarios. Scenario 1: for super large liner operators with extremely strong financial background and constant, boosting large demand from service routes that need ultra large container vessels; Scenario 2: for large liner operators with strong financial background, relatively stable demand and new building ultra large orders to be delivered in the near future. Scenario 3: for medium or rapidly developing liner operators without sufficient capacity but with sufficient money support. Under scenario 1, employing new building investment strategy is more sensible, but in reality, no more than 5 liner operators are applicable to this strategy because most super large liner operators are facing with the same situation that vessels under this category are already in their fleet or about to deliver, at the same time, ultra large 18000TEU to 20000TEU container vessels were just being ordered recently. Under scenario 2, the most common scenario, there is no doubt that chartering 13300TEU to 17999TEU container vessels makes more sense as a result of its flexibility, relatively short period and lower capital investment

characters. Under scenario 3, the companies described above have to get into super large level competition step by step, which means ordering new building ultra large container vessels is too ambitious. Hence, ordering new building 13300TEU to 17999TEU container vessels is regarded as the most appropriate and primary fleet expansion strategy to those liner operators.

Regarding the ultra large 18000TEU to 20000TEU fleet expansion decision-making process, ordering new building ultra large container vessels is the only feasible and sensible investment approach compared to the other very expensive charter approach.

6.2 Limitation of The Research

Although the research conducted gave several TEU capacity categories' most appropriate fleet expansion strategy choice under current situation, however, it is based on various kinds of first-hand data gathered by the writer. The forecasting trend 20 years later maybe is completely different with in the coming 5 to 10 years, which means this kind of research has great relationship with time and current market trend. It is changing and moving all the time.

Meanwhile, regarding fleet expansion strategy, every liner company has its personalized financial, fleet, operational background. We cannot simply generalize the problem without considering each liner operator's own characteristics. Only when we are given the number and TEU categories the liner operators would like to expand and invest in, can we decide its individual most appropriate fleet expansion strategy.

For every market, there is some unpredictability involved in it, so is liner shipping industry. Hence, we should not deny the possibility of sudden changing of the current trend. For those unpredictable events that will have profound influence on shipping market, the writer didn't take them into consideration.

6.3 Suggestions for Further Research

For further research, there are in total 2 suggestions which will make the conducted research go one step further and more comprehensive.

1. Summarize all the important and measurable characters a liner company may have related to its background information and decide several main categories of different background combination. Then, categorize all the liner companies at list into those main classifications. (This approach will make the most appropriate fleet expansion decision more applicable to each kind of liner operators, at the same time, it will make the research more clarified.)

2. Try to quantify all the measurable background characters and give them certain importance factor in order to evaluate a liner company's power. (This approach will make it much easier to construct a quantitative calculation model in the future study)

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