# USING A.I AND MACHINE LEARNING EFFICIENTLY TO DECIDE ON VOYAGE FIXTURE OF TANKER SHIPS TO INCREASE TURNAROUNDS AND PROFITABILITY

*Research Paper in Progress*

Sathya Narayan Balaji, Synergy Marine Group (India), Swiss School of Business and Management Geneva, Switzerland, sathya@ssbm.ch

Mario Silic, Ph.D, Swiss School of Business and Management Geneva, Switzerland, mario@ssbm.ch

## Abstract

*This research paper brings insights on how Artificial Intelligence and Machine Learning principles can be leveraged to predict the shipping ports turnaround patterns with prime focus on the Tanker shipping markets and associated factors which will be used to analyze the market trends in order to improve the turnaround timings of the vessel and inturn result in the Profitability. Natural Language Processing (N.L.P), data processing to extract insights from the test data will also be explored as a part of this research.*

*Keywords: Artificial Intelligence, Machine Learning, Merchant Shipping, Oil tankers, Ship Chartering, N.L.P.*

## 1. Introduction

According to the UNCTAD (2018), 80% of global trade by volume and over 70% of global trade by value are carried by sea and are handled by ports worldwide.

The consequences of stoppages and delays in the maritime industry can disrupt the entire world as this was witnessed during blockage of the Suez Canal which handles 12% of global shipping by an Ultra Large Container Carrier (U.L.C.C) in March 2021 when the ship ran aground.

If we consider the case of COVID-19 the global maritime industry kept constantly moving the goods playing a vital role in the Covid 19 crisis. Maritime traffic data, collected via Automatic Identification System (AIS) receivers were analyzed to understand the effects that COVID-19 pandemic and the containment measures had on the shipping industry, which accounts alone for more than 80 % of the world trade (Millefiori et al., n.d.). As per the definition Automatic identification systems (AIS) transponders are designed to be capable of providing position, identification, and other information about the ship to other ships and to coastal authorities automatically (International Maritime Organization, n.d.).

AIS transponders provide several interesting data such as: Course over ground (C.O.G), Speed over ground (S.O.G), Heading, Navigation status (Vessel Underway, Moored or anchored etc.), Rate of turn and "Static" information such MMSI number, IMO number, Vessel Name and Call Sign, Length and Beam (Breadth of Ship), Type of ship (Shilavadra Bhattacharjee, 2021). "Voyage-related" information such as ships

draught, Hazardous cargo, Destination & ETA, route plan waypoints-at the discretion of the master (Ship's Captain).

This data shouldn't be completely relied upon for any decision making since this information can be changed or not disclosed due to security reasons (BigOceanData, n.d.). The quality of data is essential to make meangingul decisions. One of the challenges with the AIS data collection is the fact that important volume of data can be collected, which may impact the data quality and make it difficult to capitalize on the potential of using this data (Tsou, 2010).

According to German authority "Bundesamt fur Seeschifffahrt und Hydrograhie" (BSH), whenever irregularities with vessels AIS transmissions are observed the BSH forward an appropriate report to the German Ship Safety Division of the See-Berufsgenossenschaft(SBG). In many cases the SBG decide to pass the relevant information to the Flag State administration, instead of performing any additional Port State Control inspection on the concerned vessels. Authorities led to understand from some manufacturers that the malfunction of the internal GPS receiver and that the AIS unit synchronizes to the transmissions of other AIS stations which reduces the timing accuracy. Additionally, no position redundancy will be available.

If the external position sensor fails, the AIS unit cannot use the internal GPS receiver and no position will be transmitted (Isle of Man Register, 2009).

It is also important to understand shipping's role in the worldwide economy and how time relates to the cost and the pressure of the parties involved from the Shipowners, ship managers, crew onboard, charterers, brokers, receiver, and other involved stakeholders.

Other factors that impact the industry are related to the introduction of new maritime regulations, the increasing fuel prices and the research on developing a risk management tools to reduce unnecessary fuel cost risk, fuel price fluctuations and improving financial management and installation of equipment's such as Exhaust Gas Cleaning System (E.G.C.S) on the existing and new ships to purify the exhaust gas and choosing natural gas marine fuel (Han and Wang, 2021). It is important to take smart decisions to avoid downfall in the profits by decreasing operational costs.According to an article from McKinsey & Company commodity-related trends are likely to depress medium-term demand, but companies that can leverage deep market insights will have the opportunity to outperform in the post-crisis economy (Arjen Kersing et al., 2020). Leveraging Artificial intelligence (A.I) and Machine learning (M.L) in any company can led to exponential growth as data is the fuel driving today'sindustrial economy including shipping, and companies that invest in analytics can use data-led insights to seize opportunities in four main areas (Arjen Kersing et al., 2020).

According to (Arjen et al., 2020) application of AI and ML can be interesting in several ways:

1. Finding attractive subsectors and niches through insight into end customers,
2. Optimizing portfolios based on relative attractiveness and risk level of different vessel classes,
3. Improve commercial choices,
4. and operate vessels more effectively.

In this article we aim to discuss the application of Artificial Intelligence (A.I) and Machine Learning (M.L) in the commercial shipping industry in general with the primary focus on the tanker shipping industry. Adoption of Machine learning tools could have an impact on the efficiency, sustainability and operational cost of the Maritime Transportation (Akyuz et al., 2019). This study will try to better understand the current challenges and potentials which AI & M.L can unleash towards the turnaround periods by building better insight of market trends. Natural Language Processing (N.L.P) can be used to read through the data to extract relevant informationfrom existing data source & many other N.L.P models (i.e., GPT-3, BERT, ROBERTA, ELECTRA Etc.) can be used to summarize the data which will help Shipping companies, managers & owners to get more insight from the existing information which would rather be tough to go through manually.

## 2. Existing issue in the Tanker Shipping Industry.

A preliminary literature review shows that the past studies are primarily focused on advantages of using Machine learning in the maritime transportation and a broader

aspect on how this could help in solving various maritime business issues like Voyage optimization and economics, sustainability of transportation, controlling of freight rates, maintenance forecasting, etc. (Han and Wang, 2021). Sustainability in shipping can be enhanced by the application of "Machine learning" principles to increase ships efficiency by reducing fuel consumption (Pena et al., 2020). To make our research solutions more effective it is essential to understand the problem statement by understanding the existing issue in maritime industry.

## 2.1 Impact of Crude oil demand and supply imbalance & COVID 19.

The fluctuation in oil prices and the tanker markets associated risk of crude oil price fluctuations have been already highlighted as one of the challenges (Shi et al., 2013). The Crude oil prices are governed by the global supply and demand. Economic growth of the nation is one of the factors that increases in demand of energy and so in the demand of Petroleum products and in turn crude oil price (US Energy Information Administration (EIA), 2021). The Organization of the Petroleum Exporting Countries (OPEC) manages oil production of its member countries by setting crude oil production targets, or quotas, for its members hence it has a significant influence on oil prices. This includes countries with some of the world's largest oil reserves. As of the end of 2018, OPEC members controlled about 72% of total world proved oil reserves, and in 2018, they accounted for 41% of total world crude oil production (US Energy Information Administration (EIA), 2021).

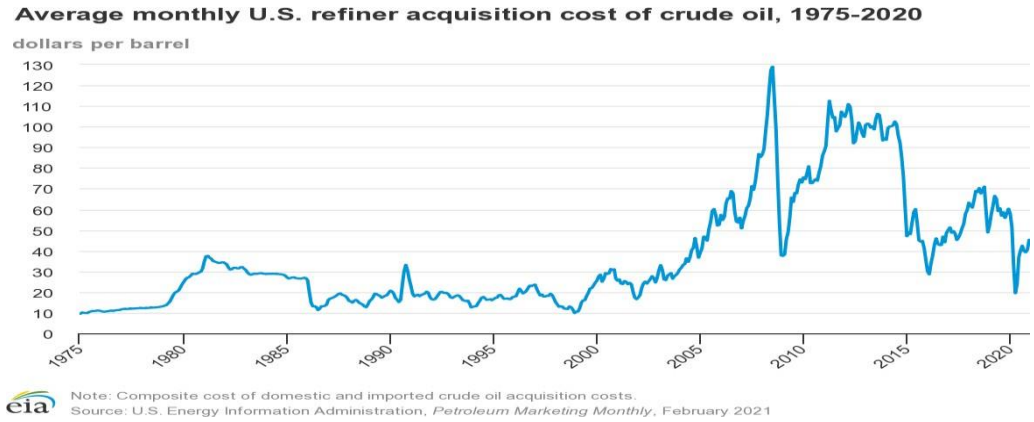


Figure 1. Average monthly U.S. refiner acquisition of Crude oil, 1975-2020 (US Energy Information Administration (EIA), 2021).

The Figure 1. shows the pattern of increase and decrease in demand of US refiner cost of Crude oil in USD per barrel from 1975 to 2020.

One consequence is, for example, that Iran is no longer accepting payments in USD currency. The payments would be accepted in local currencies, thereby reducing the risk of fluctuation. The above stated facts by Wenming Shi et al. statistics by the US Energy Information Administration (2021) clearly explain that the supply and demand of oil can affect the supply chain and indeed tanker shipping industry which can cause change in the time charter price (the price at which ship will be hired from ship owner). A good example of this would be if the oil price drops, the oil tanker ships charter price would increase due to the sudden surge of oil demand as to acquire more oil at less price especially during the pandemic (Baltic and International Maritime Council, 2020).

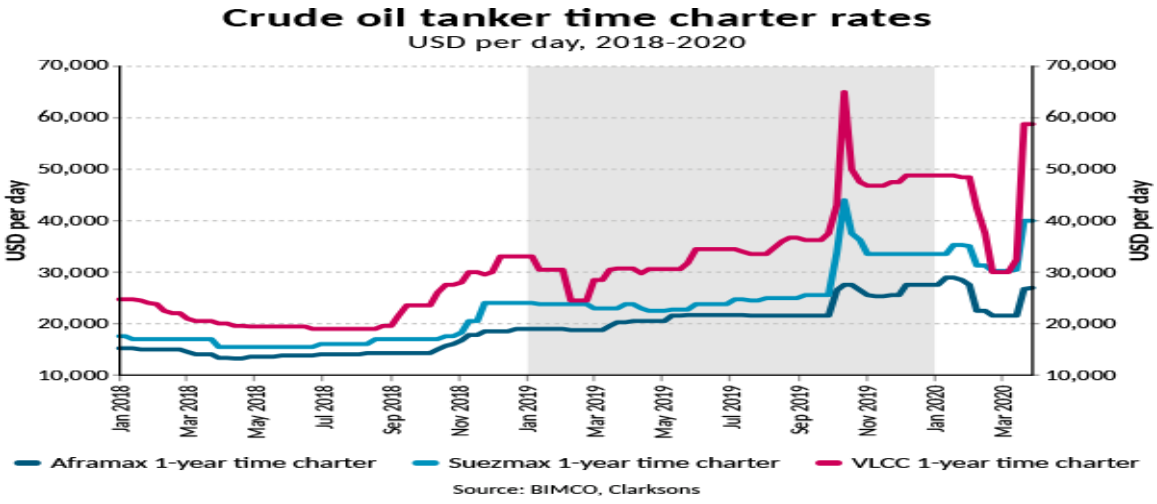


Figure 2. Crude oil tanker time charter rates (Baltic and International Maritime Council (BIMCO), 2020)

## 2.2 Impact of COVID-19

The Social and economic effect of COVID-19 has been devastating. According to World Health Organization (2020) tens of millions of people are at the risk of falling into extreme poverty. The entire industrial economy has also been badly impacted.

A global downturn in the shipping industry will put significant pressure on financial undertakings and this may adversely impact the shipping company's projected cash flows, such as a decrease in future charter rates, increase in off-hire days, increase in fuel prices, increase/decrease in operating expenses, increase in inflation, increase in a company's discount rate, etc. (PwC Greece, n.d.). On the other hand, the shipping industry is expected to benefit primarily by COVID 19's capacity to provide a better understanding of the causes of accidents and their prevention.

Therefore, the shipping industry would be able to reduce the number of accidents and incidents, thereby reducing the cost of insurance and the cost of ship ownership.

## 2.3 Impact of International Politics on Tanker market.

Major commercial routes of countries are dependent on oil, which means that if any of these region of those countries does political moves, commercial transportation may be negatively affected. The relation of tanker shipping industry with Iran has also led to significant political issues as in July 2020, the oil tanker ship “Gulf Sky” vanished from waters off the United Arab Emirates, along with its crew. Days later it turned up in Iran where it's now suspected to be working as a "ghost ship" – helping the regime ferry oil in breach of sanctions (BBC, 2020).

## 2.4 Overcapacity

Tanker shipping is facing another problem, which is overcapacity. It is an area in which there is an excess of ships supplying inadequate markets rather than moderating the demand. According to FORBES (2018) due to excess capacity, earnings were low, with an average of $6,001 per day for Very Large Crude Carriers (VLCCs) and the Suez-max tanker earning $10,908 per day. Compare that with $60,000 and $40,000 respectively in January of 2017. The underlying reasonis too many Very large crude carriers (VLCCs) in operation, owing to cuts in production by oil exporting nations, and lower U.S. import volumes, as local oil becomes more prevalent. Though tankers carrying capacities having increased by 50 percent in the last century. Two principal points to this overcapacity, one being overbuilt ships built for the utilization of the Chinese investment incentive program as Chinese quest for oil security to guarantee its oil supply during times of crisis (Oil & Gas Journal, 2006).

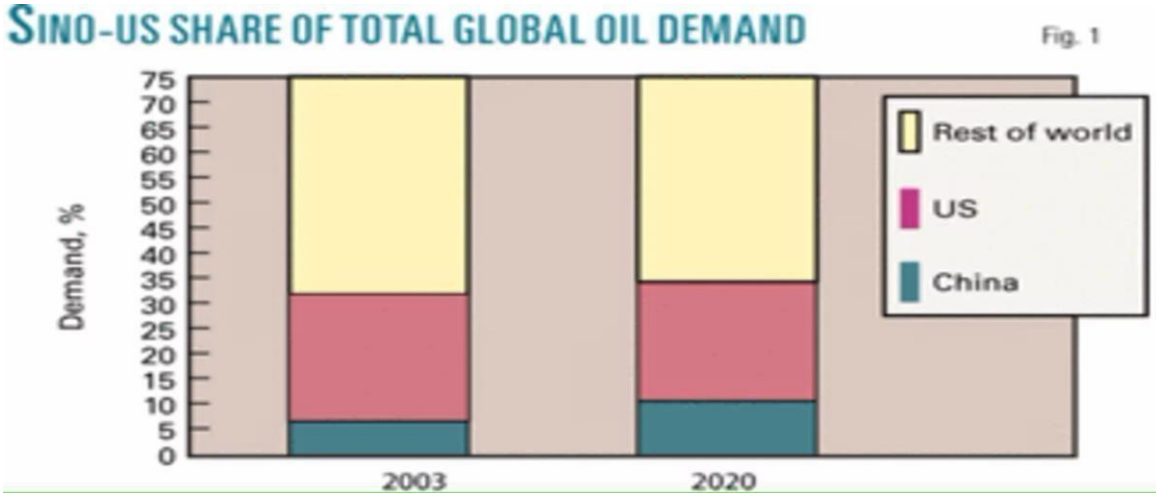


Figure 3. SINO-US share of total global oil demand 2003-2020 Source: (Oil & Gas Journal, 2006)

The other is that the shipping industry has increased their ship's grosstonnage due to there being little regard for what products are being carried or the market region or the reliability of buyer credit. In terms ofstatistical affordability, the undercutting rate is an amount of money equal to the total amount of money being sunk into the transportation divided by the amount of money earned from it. Indeed, companies gain more profit at a declining value. When the rates are low, tankers are deployed at more than full utilization and their operations are more efficient (Oil & Gas Journal, 2006). Turnaround timing of tankers Ships-Turnaround Management.

## 2.5 Turnaround timing of tankers ships- Turnaround Management

The tanker shipping industry has become highly competitive due to increasing demand of oil and associated products. Understanding “Turnaround timing” is quite essential as per the definition the time that is taken between the arrival of a vessel and its departure is referred to as the turnaround time. The vessel turnaround time isused to measure the efficiency of port operations (cogoport, n.d.). Turnaround time is one of the most significant port performance indicators, this is the total time,spent by the vessel in port, during a given call.

It is the sum of waiting time, plus berthing time, plus service time (i.e., ship's time at berth), plus sailing delay (Dayananda Shetty K, Vijayanand Gurudev, et al., 2021).

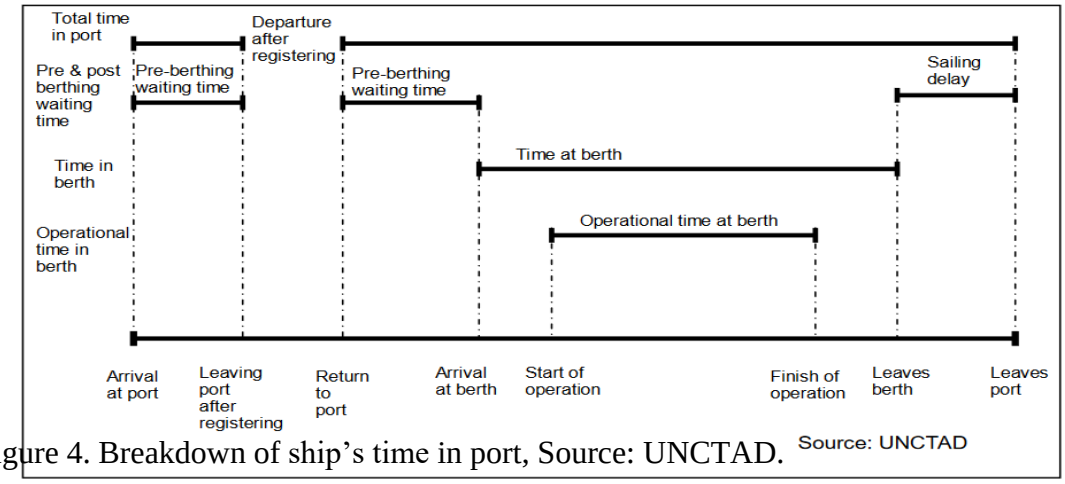


Figure 4. Breakdown of ship's time in port, Source: UNCTAD.

Timing of the tankers has also become longer. The average turnaround time of ships is a key parameter to measure a port's efficiency, this was reduced by 25 per cent to 64.4 hours in 2017-18 from 87.3 hours in 2015-16 in Indian ports. The higher efficiency and productivity had translated into the net profit of major ports increasing by nearly 75 % to ₹3,414 crore (455887709.65 USD) between financial years 2016-17 and 2017-18 (The Hindu BusinessLine, 2018a).

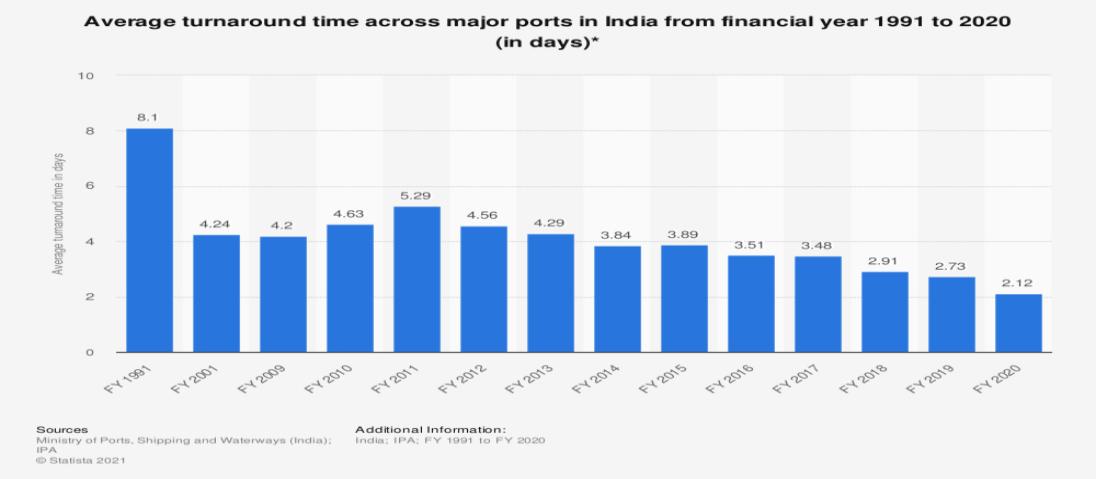


Figure 5. Average turnaround time across major ports in India 1991-2020, Source- Statista.

It is important to also understand the time and cost for bunkering (fueling of the ship) since this parameter is vital to determine the turnaround cost. Turnaround cost is proportional to the turnaround timing this means if the turnaround cost can be saved by minimizing cost and time in operation such as bunkering, we can reduce theturnaround timing, hence increasing the efficiency.

According to ISO (2021) cost savings for bunkering operations account for an estimated 66 % to 76 % of total savings, with the remainder attributed to reductions in the number of disputes that arose, as well as the time needed to resolve disputes when they do occur. Turnarounds can also be improved by improving the turnaround management which includes many management functions like ship selection, crew-training, planning, scheduling, and control etc. Turnovertime for each function must also be determined. Notwithstanding anything to the contrary contained by other authors with respect to turnaround parameters, all the turnaround parameters will be considered as training data to better visualize the impact of managing with the turnaround profitability from the tanker ship operations which means all the features that will lead to the

increase in efficiency at port and fast movement will be used as a training data for the machine learning model for this purpose. This will give a clear picture of which variable has a higher importance and also turnaround patterns for a particular port that can be predicted which will help ship owners and managers to fix their ships on a better route and at a better charter pricemaking smarter decisions.

## 2.6 Time Charter Price fluctuations.

According to the Moore Stephens Maritime index for a VLCC (Very Large Crude Carrier-class of Oil tanker ship) of deadweight (ships weight carrying capacity-Cargo+ Fuel+ Fresh water + Ballast water (for ship stability+ provisions+ passengers and crew) and excluding the weight of the empty ship ranging between 180,000 DWT to 319,999 DWT the Total OPEX (Operating Expense) per day would cost around $10,566 USD per day whereas the TCE-Time Charter Equivalent price at ship might be hired by charterer from the ship owner would range between $27316 to $43491 USD for the average age of VLCC- Oil tanker ship close to 10 years as mentioned in the below graph.


Figure 6. Moore Maritime Index 2020, Tankers – V.L.C.C KPI & Cost index

Worldscale is another factor considered for fixing the charter price for the given Oil tanker's cargo which is a unified system of establishing payment of freight rate (Clarkson's Research, n.d.).

As per the Clarkson's Research's Shipping Intelligence weekly publication for the year 2017 states the Floor rate and Cap rate for the VLCC ship charter hire. The charter hire under the contract is linked to one year time charter rates for 310,000 DWT and 150,000 DWT ships, the market rate shall be averaged out considering all weekly publications during the preceding year from January 1 to December 31 to arrive to base charter hire prices for the following year. Considering for the following year works out to be $18,601 per day and the agreed premium is 10 per cent, the charter-hire payable to owners during 2018 shall be 18,601 + 10% = $20,461 per day (Cap rate). Assuming it to be discount, the payable charter-hire during 2018 shall be 18,601-10% = $16,741 per day (Floor rate). If agreed premium works out to be less than the floor rate, the charter hire payable will be the floor rate & if the premium works out to be more than the cap rate, then the payable charter hire shall be the Cap rate (Clarkson's Research, 2017; The Hindu BusinessLine, 2018b). With such a stringent Cap and floor rates it would be tough for the ship owners to squeeze profits. This brings the question of the commercial aspect of the shipping industry whereas the operations are concerned when it comes to long delays at anchorage, ships waiting for a long time for the berthing prospects wherein after tendering N.O.R (Notice of Readiness) and ship is ready in all aspects to discharge its cargo, especially this happens in the case of tanker ships. There are lot of port across the globe which handles a huge volume of ships anchored at their anchorage waiting area for the berths during too heavy congestion. This delay leads to financial losses for interested parties concerned over the cargo being carried by a vessel which no owners indeed wouldever like to accept and

for unforeseen circumstances, these losses must be borne which interms of financial loss is very significant amount, and this especially effect the small shipping owners with less or even maybe older ships & when we look at this problem of financial lose and compare it with Moore Maritime index Total OPEX (Operating Expense) for the VLCC ship around $10566 USD a day (Moore Stephens SA, 2020), assuming the fact if the ship owners bare any lose in Charter hiring money, he would sometimes not even make any profits and what if as the ships grow old the operating price will also increase and again in turn the financial lose in any aspect can make ship- owners face the downfall. It's not only about the financial loses but delays also effect the entire supply chain & humanity. There are many issues modern shipping industry is

facing such as Decarbonization of shipping, new environmental regulations, global economic crisis, increase in fuel prices and the list goes on.

Leveraging "Machine learning" and "Artificial Intelligence" in the maritime industry can practically help any ship-owners analyze and better understand the current trends in the market and decide on where to fix their ship to get more profits, before fixing their ships on any charter contracts.

Based on the literature review and the identified gaps, we propose the following research questions:

RQ.1: How AI & ML can help ship owners and managers to fix their ships on charters at present day?

RQ.2: What are the associated problems they face and the barriers?

## 3. Conclusions

Through this research in progress paper, we aim at better understanding how AI and ML/NLP can impact the ship industry by giving better insight of the current market requirements by providing information to predict the turnaround factors and analyzing the port traffic data using M.L models. Whereby the Ship owners, ship managers can make better decisions to fix their ships on better voyage fixture to increase profitability. This will also lead to sustainability in shipping by betterplanning in advance to reduce CO2 emissions leading to Decarbonization.

In addition, with this research we want to help shipping fraternity such as ship- owners, ship managers to understand the market trends using Artificial Intelligence and Machine learning principles to make better decisions in fixing their vessel on voyage where in this period of Novel Coronavirus 2019 Pandemic, expensive fuel prices and stringent maritime regulations are concerned it is very important to make financial profits to comply with the new maritime regulations (i.e. installing equipment's like Scrubbers, B.W.T.S- Ballast water treatment system etc.) to make shipping more sustainable and to keep the Supply chain moving.

Through this research we can clearly understand economic value of Shipping and Maritime industry to the world & what if the shipping is affected so the supply chain and probably people somewhere might lose their jobs due to the stagnation of consumables and stoppage of productions across the globe. Nevertheless, as shipping is a global phenomenon, as a responsible citizen of the world and a responsible researcher understanding how the overall things also impacts the environment will be a point of concern.

Therefore, in this research we aim at understanding how ship owners fix their ships on charters in today's market and what are the barriers they face while fixing their vessels on a trade and how the application of AI or ML can help in better addressing these issues. Further, we aim at leveraging these areas to better understand the market's supply and demand using machine learning regression model to predict the turnarounds so that the ship owners can analyze these data and fix the voyage for their ships making smarter decisions.

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