Towards utilizing autonomous ships: A viable advance in industry 4.0
Humayun Rashid Askari and Mohammad Nazir Hossain

*Department of Port & Shipping Management, Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh; †Department of Genetic Engineering & Biotechnology, BSRMU

ABSTRACT
The maritime world is rapidly evolving, and the impact of new technologies on the reduction of manning onboard vessels, leading eventually to unmanned large ships, has taken huge steps forward. Autonomous cargo ships, also known as autonomous container ships or maritime autonomous surface ships, are ocean-going vessels that carry containers or bulk cargo with little or no human interaction. This paper seeks to explore the impact of autonomous ships on the shipping industry by comparing and finding feasibility with the industry 4.0. The primary and most useful features of autonomous ships have been identified. Moreover, the advantages of autonomous ships have been shown and explained with their impacts. Some upcoming challenges are also pointed out. Extreme situation scenario (like the COVID-19 scenario) has been briefly discussed. Finally, an overall SWOT analysis is conducted.

Introduction
Autonomous cargo ships, or autonomous container ships or maritime autonomous surface ships, are ocean-going vessels which are used for transporting containers or bulk cargo in navigable waters without recourse to any human interactions (Redsseth 2017). In other words, mainly, it independently controls its own actions. [Jbid] The term “shipping” means to transport and merchandise goods and cargo from one place to another. So, the main idea of autonomous shipping is shipping or transporting with none or minimum human interactions (Munir 2019).

Industry 4.0, also known as 4IR (Fourth Industrial Revolution) concerns industry in general. Autonomy and AI (Artificial Intelligence) bear enormous relation to it. AI is mainly the intelligence illustrated by machines, opposed to natural intelligence displayed by humans (Primi and Toselli 2020). The industry which grows according to shipping purposes is known as the shipping industry.

The ongoing new era of the industry is focusing on and evolving towards Industry 4.0 (Primi and Toselli 2020). The use of automated technology is very much related here. To keep pace with it and make it possible, autonomous ships are a must, and it has a great prospect. Because the sea is the world’s transportation route, and shipping accounts for around 80% of international trade and about 70% of its value (Ahn et al. 2019) and to completely embrace the concept of industry 4.0, the usage of autonomy here becomes imperative (Reza, Mohsen, and Shahbakhsh 2020). The present paper tries to seek this prospect through the autonomous shipping sector because autonomous ships have a significant future impact (Benson, Sumanth, and Colling).

In the current years, the maritime world is fast changing and growing interest in procuring benefits of unmanned marine vessels for freight transportation services. This has yielded several exploratory projects along with the AAWA autonomous shipping concept (Rolls Royce Marine 2016). The International Maritime Organization (IMO) is also looking into how safe, secure, and environment-friendly Maritime Autonomous Surface Ships (MASS) services could be. In addition, IMO has identified four degrees of autonomy (IMO 2018).

The COVID-19 pandemic has, until recently, spread in about 220 countries and regions (WHO: Coronavirus disease (COVID-19) pandemic[18 May 2021]) of the mother planet, considerably affecting the world economy. The Asian Development Bank (ADB) forecasted that the world might lose from 0.089% to 0.40% of its GDP due to spillover impacts of COVID-19 (ADB BRIEFS-2020). The COVID-19 pandemic has reached dangerous proportions everywhere on the planet and brought considerable difficulties in its train. The prolonged scenario is taking its toll on human lives and additionally on the economy. The shipping sector is also getting very much affected, due to the pandemic. As the coronavirus is very much contagious and mainly spreads through human interactions (Adebowale, Fagbamigbe, and Akinyemi et al. 2021), autonomous ships can be a safe alternative and feasible solution.
As of March 2021, Ever Given MV, one of the world’s largest container ships got jammed in the Suez Canal in high winds and remained grounded for six days blocking traffic in all directions. This has made the Japanese-owned ship incur the total trade loss worth roughly $54 billion (Das 2021). Technical or manmade errors are responsible for the grounding of the gigantic container ship in the murky waterway, said Admiral Osama Rabie, the Chairman of Suez Canal Authority. (“Suez Canal: Ship blockage may be due to ‘human errors’”) A lot of maritime accidents are caused by human errors. Autonomous ships can also be a viable alternative here.

Thus, this study reviews some potential research in the Autonomous Shipping sector and identifies the economic impacts. It shows its importance in industry 4.0, briefly explains the concept of shipping 4.0 (Reza, Mohsen, and Shahbakhsh 2020), and suggests innovative applications in the shipping industry and for the extreme and challenging situations as well.

Literature review

The concept of autonomous ships, autonomous ship development projects, and other related things are clearly discussed and pointed out in Ziaul Haque Munim’s paper (Munim 2019). While writing the concept of autonomous ships, the researcher has also made some remarks about the economic and operational benefits of autonomous ships and the potential role of autonomous ships in the supply chain. [Ibid].

Ahn et al. (2019) also showed the changes in the container shipping industry and demonstrated the application of autonomous ships. The study suggested a viable strategy for the prospect of container shipping in the near future. The study also explains that an effective response to the Fourth Industrial Revolution and the full compliance with the environmental regulations will develop container shipping into a smart industry beyond the capital- and labor-intensive businesses. Finally, the study proposed autonomous shipping as a suitable strategy for container shipping in days to come.

C L Benson, et al. conducted a quantitative analysis of the probable future of autonomous transport (Benson, Sumanth, and Colling). From the paper, we see the future economic impact of autonomous transport and cost analysis of autonomous transport according to different variables.

Yewen Gu, Julio Cesar Goez, et al. presented a brief account of literature review on autonomous marine vessels in general (Yewen et al. 2020). The paper defined ten thematic categories by way of pinpointing the main research interests in the field. They conducted a comparative study between the existing literature on autonomous vessels and autonomous vehicles and identifies that in both cases, there has been done quite a considerable work on navigation control and safety. [Ibid]

The possible threats and related development areas of autonomous shipping have been discussed together in the papers of Ahn et al. (2019), Komianos (2018), Felski and Zwolak (2020). We can see the author’s experience from the first unmanned transit across the English Channel Andrzej Felski and Karolina Zwolak’s paper. [Ibid]

Moreover, IMO has identified four levels of autonomy (IMO 2018), Lloyd’s Register (2017) six levels (Lloyd’s Register 2017), and Rolls-Royce (2016) eleven levels (Rolls Royce Marine 2016).

In addition, Rolls-Royce has developed a complete design and model of an autonomous ship of theirs (Rolls Royce Marine 2016; Rolls-Royce -Sauli Elo ranta). We see the technology demonstrated on the paper, and the paper also showed some key issues about why we should go for remote & autonomous shipping (Rolls-Royce -Sauli Elo ranta). They have also shown their next steps till 2035 (Rolls Royce Marine 2016).

In a paper of 21st Marine Industries Conference (MIC2019), named “Shipping 4.0 and Training Seafarers for the Future Autonomous and Unmanned Ships” (Reza, Mohsen, and Shahbakhsh 2020), autonomous ships and their relation with industry 4.0 is discussed. The concept of shipping 4.0 and how to embrace it is also explained. In addition, Gholam Reza et al. also showed the technological concept and the next steps in autonomous ship development here. [Ibid]

However, much study has not been carried out on the future economic impacts of autonomous ships.

Transportation and logistics sectors are booming. It is found that substantial work has been done on navigation control and safety of autonomous ships, and we are reaching a level of maturity that may persuade researchers to begin work on practical applications of autonomous technologies (Yewen et al. 2020). However, the impact of autonomous vessels on the current logistic models still remains an open question, and review shows that further research on this category is very rare. [Ibid]

Moreover, there is not much specific study conducted on shipping technological changes in pandemic scenarios (like the COVID-19 scenario). That is the approach which has been adopted, and this study also tries to explore the prospects of autonomous ships in the shipping industry by comparing and finding feasibility with Industry 4.0 and also forecasts the future of the shipping industry. And here lies the importance of this study.

Methodology

A precise literature review approach has been adopted in this study to map the major impacts and to summarize the potential economic benefits of autonomous ships in the industry and the world economy as well.
This study is a qualitative research, mainly based on the analysis of secondary information. By qualitative research we mean collecting and analyzing non-numerical data to deal with concepts, opinions, or experiences, gather in-depth insights into a problem and generate new ideas for further research (Hossain 2011). Different policy documents and scholarly articles, websites, conference papers and news reports were reviewed with a view to collecting secondary data. This study has also applied descriptive statistics and graphical charts to present the impact of autonomous shipping on industrial sectors. Graphical inspection is a common and helpful technique to observe the trend and behavior of any variable.

For secondary data analysis, the content analysis method was used. Qualitative content analysis is conducted for analyzing qualitative data which helps to understand the inner meaning (Elo et al. 2014). It is a research tool for interpreting and understanding the inner meaning of the textual material, articles and graphics (Shamsuzzaman and Islam 2018).

Through the articles reviewed in this research, we pointed out six essential features of an autonomous ship and its major impacts on the world economy. Then through secondary data analysis, we compared its feasibility with industry 4.0.

Finally, we indicated the strengths, weaknesses, opportunities, and threats of autonomous shipping by way of the strategic planning technique called SWOT matrix. SWOT Analysis approach allows analysts to identify the status of systems by categorizing the internal (strengths and weaknesses) and external (opportunities and threats) factors. In addition to that, SWOT analysis method can be applied for the purpose of defining future trends. The most prominent aspect of the method is analyzing internal and external factors to obtain systematic approaches and support for unique strategy formulation. Figure 1 indicates the procedure of this study.

Industry 4.0 & the concept of shipping 4.0

The industry has evolved through four technological revolutions within the last few centuries. These consecutive revolutions have tremendously modified the ways and means of business, marketplace, and overall economy. The first revolution, the industry 1.0, also known as the age of steam started at the end of the 18th century in England. In the early 20th century, the USA started industrial revolution 2.0, the age of electricity. The mid-20th century witnessed business 3.0, also known as the knowledge age. This revolution lead

![Figure 1. Schematic procedure of the study.](image-url)
was led by the usage of computers and information communication technology (ICT). The current revolution, the industry 4.0, belongs to the age of cyber-physical systems (CPS). Here lies the usage of advanced technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and Cloud Computing to build and control intelligent unmanned and autonomous systems. (Turan et al. 2016; Vagia et al. 2016; Wahlström et al. 2015) The era of industry 4.0 is understood for its paradigm shift from ancient central production into suburbanized, smart, autonomous systems and now it is integrating into all industries and transforming their nature of work along with it (Reza, Mohsen, and Shahbakhsh 2020). The Industry 4.0 brings the idea of machines capable of autonomously communicate information and being able to control each other (Tjahjono et al. 2017). Through the CPS technology, we can combine the physical and the digital world by sensing, processing, and analyzing data produced in realtime. In this way, it allows the operation of an autonomous system. Here lie enormous application possibilities for various industries. Through this process, we can achieve cost-time effectiveness and efficiency along with improvements in the quality of the work (Albers et al. 2016). It is also predicted by UNIDO that industry 4.0 is going to make a powerful effect on societies and their economies (Industry 4.0 Opportunities and Challenges of the New Industrial Revolution for Developing Countries and Economies in Transition, Panel discussion 2017)

Shipping is at the edge of stepping into its fourth technical revolution also known as the cyber shipping or commonly referred as shipping 4.0 (Reza, Mohsen, and Shahbakhsh 2020). Shipping 4.0 means the utilization of CPS, IoT and Internet of Service (IOS) in the shipping sector. This has already started and is gradually beginning to transform some aspects of ships, such as, design, building, operation, maintenance and manning. All these changes reshaped the way of work in the maritime industry. It means new job opportunities which require different skills to cope up with it. [Ibid]

Features and levels of autonomous ships

Autonomous or unmanned ships are provided with code & hardware replacing human interference. These ships are mainly run through the usage of some technologies (Research in maritime autonomous systems project Results and technology potentials). They are:

- Sensors
- Automated navigation
- Propulsion & auxiliary systems
- GPS huntsman
- Integrated radio detection and ranging systems
- Live pursuit navigation assembly
- IoT
- Artificial intelligence (AI)

To represent different levels of autonomy, the IMO selected four levels of autonomy as its taxonomy (IMO 2018). Moreover, Lloyd’s Register (2017) has defined six levels of autonomy (Lloyd’s Register 2017), and we see eleven levels of autonomy level definition by Rolls-Royce (2016). (Rolls Royce Marine 2016) Table 1 indicates the different levels of autonomy.

Key reasons for utilizing autonomous ships as a viable advance

Industry 4.0 has already made an impact on the shipping industry. According to The United Nations Conference on Trade and Development, in 2015, the total seaborne trade volume has surpassed 10 billion tons (Walker 2019). It is evident from this that the global economy is highly dependable on maritime transportation. So, it is a must to prepare this sector to go hand in hand with Industry 4.0. In order to prepare for and understand the opportunities and threat that it may bring to the maritime industry,

Table 1. Different levels of autonomy by IMO (IMO 2018), Lloyd’s Register (Lloyd’s Register 2017) & Rolls-Royce (Rolls Royce Marine 2016).

| Levels by IMO | Levels by Lloyd’s Register (2017) | Levels by Rolls-Royce (2016) |
|---------------|-----------------------------------|-------------------------------|
| L 1 – Ship with automated processes and decision support. | L 0 – Manual steering. | L 1 – The computer provides no assistance, human in charge of all decisions and actions. |
| L 2 – Remotely controlled ship with seafarers on board. | L 1 – On-board decision support. | L 2 – The computer provides a complete set of decision alternatives. |
| L 3 – Remotely controlled ship without seafarers on board. | L 2 – On and off-board decision support. | L 3 – Computer narrows alternatives down to a few. |
| L 4 – Fully autonomous ship. | L 3 – “Active” human in the loop. | L 4 – Computer suggests single alternative. |
|               | L 4 – Human in the loop. | L 5 – The computer executes the suggested action if human approves. |
|               | L 5 – Autonomous. | L 6 – The computer provides human beings limited time to veto before automatic execution. |
|               | L 6 – Fully autonomous. | L 7 – The computer operates automatically, when necessary, informing human. |
|               |                    | L 8 – The computer informs human only if asked. |
|               |                    | L 9 – The computer informs humans only if it decides so. |
|               |                    | L 10 – The computer does everything autonomously ignoring humans. |
there is a need to study the reasons for thinking autonomous ships as a viable alternative (Reza, Mohsen, and Shabakhsh 2020). Attractive advantages of autonomous and unmanned ships are being familiar and oft-quoted among maritime businesses. As discussed before, some notable research work has also been done on these particular criteria. Among them, there are some key factors about why we should bring autonomous ships to practical usage and why it should be feasible for economic growth and stability according to industry 4.0. They are as follows:

Reduction of human errors

The current maritime system is a human-based system (Rothblum). A large number of marine accidents are caused by human beings directly and partially. According to Allianz, about 75–96% of marine casualties result from some forms of human errors (Rothblum; Allianz Global Corporate & Specialty, Safety & Shipping 1912-2012). Moreover, AGCS of from 2011 to 2016 almost 15,000 marine liability insurance claims show human error to be a primary factor and it is equivalent to over $1.6bn of losses (Shipping safety – Human error comes in many forms).

Grounding of the TORREY CANYON and spilling 100,000 tons of oil (Rothblum), collision of the M/V SANTA CRUZ II and the USCGC CUYAHOGA (Perrow 1984) all are causes of human errors.

Moreover, in March 2021, Ever Given MV, one of the world’s largest container ships got jammed in the Suez Canal in high winds and remained grounded for six days blocking traffic in all directions. This has made the Japanese-owned ship incur the total trade loss worth roughly $54 billion. (Das 2021). Technical or manmade errors are responsible for the grounding of the gigantic container ship in the murky waterway, said Admiral Osama Rabie, the Chairman of Suez Canal Authority (“Suez Canal: Ship blockage may be due to ‘human errors’”).

In Figure 2 we can see that shipping is immensely affected by human error. Human errors are reasons for 96 out of 100 maritime accidents (Rothblum). Autonomous ships hold the promise of reducing human errors (Research in maritime autonomous systems project Results and technology potentials) and therefore bringing down costs related to accidents and insurance (Walker 2019). Autonomous shipping allows improved optimization of operations and processes (Rolls Royce Marine 2016). So autonomous ships will be a feasible alternative.

Achieving efficiencies without crew: headcount savings, raised wares capability

If the necessity of having people on board is done away with, the entire vessel can be redesigned to improve efficiency in many ways. Systems which are required to make the vessel livable for the crew can be taken away entirely (Walker 2019). The deckhouse that is placed above the deck of ships will no longer be required for the crew to steer the vessel. This can open up more space for cargo. [Ibid] The deletion of the accommodation structure may result in 6% reduction in fuel consumption and a 5% reduction in the cost of construction (Mishra 2020).

Typically, crew-related expenses account for 30% of the budget of a whole voyage (Massive Cargo Ships Are Going Autonomous 2018). MUNIN (Maritime
Unmanned Navigation through Intelligence in Networks) anticipated a saving of over $7 m over 25 years per autonomous vessel in fuel consumption, crew supplies and salaries (Research in maritime autonomous systems project Results and technology potentials). According to another research, while cheaper labor cut costs by 60%, automation could cut labor costs by 90% (Mishra 2020). Figure 3 shows an overall percentage of cago annual costs.

Autonomous ships can offer the advantage of eliminating the expense of salaries and benefits for crew members (Rolls-Royce -Sauli Eloranta; Walker 2019). This is more important for smaller vessels because crew costs make up a significant share of total costs (Walker 2019). According to Rolls-Royce, autonomous ships can save almost 20% of total general cargo annual costs (Rolls-Royce -Sauli Eloranta).

**Reduction of fuel consumption and Increasing time and energy efficiency**

Autonomous shipping can be the ultimate solution to the improvement of productivity, reduction of fuel consumption and increase in time efficiency (Mishra 2020). As predicted by MUNIN, a saving of over $7 m over 25 years per autonomous vessel in fuel consumption, crew supplies and salaries (Research in maritime autonomous systems project Results and technology potentials). Autonomous ships will surely maximize fuel utilization (Mishra 2020).

The Yara Birkeland, is likely to be the first fully-electric, and zero-emission vessel (Massive Cargo Ships Are Going Autonomous 2018). As shipping vessels are the cause of 3% of global carbon-dioxide emissions, the adoption of zero-emission ships could substantially reduce pollution around the globe. [Ibid]

**Reduction of piracy risks and increasing monitoring activity**

In east Africa, the economic expense of Somali piracy was around $1.7 billion in 2017 and it was as high as $7 billion in 2010 (The state of maritime piracy). The economic cost of somali piracy from 2010 to 2017 is shown in Figure 4. Pirate attacks on Sulu and Celebes Seas have prompted some merchants to change their routes which can take longer delivery times (Walker 2019). In west Africa, the economic cost of piracy was $818.1 million in 2017. (The state of maritime piracy) In Asia, the value of stolen ship stores, crew belongings, and cargo has been estimated to be worth around $6.3 million, up from $4.5 million in 2016. [Ibid]

The issue of piracy along certain trade routes will be reduced or mostly eliminated because on autonomous ships, no human crews will be there to threaten or hold hostage. Kidnapping crew members for money is a main driving force behind modern piracy.

Autonomous ships ensure more effective cargo and machinery performance monitoring activity. Moreover, the global trade supply chain is becoming increasingly combined, digitalized, and data-driven (Massive Cargo Ships Are Going Autonomous 2018). Autonomous ships will be well-equipped to further promote supply chain visibility by collecting voyage-related data through their autonomous systems. [Ibid]

**Prescribing a feasible alternative to pandemic situation (COVID-19 scenario)**

The COVID-19 pandemic has, until recently, spread in about 220 countries and regions [WHO; Coronavirus disease (COVID-19) pandemic](18 May 2021) on the mother planet, considerably affecting the world.
Economic Cost of Somali Piracy (2010-2017)

![Economic Cost of Somali Piracy (2010–2017)](image)

Figure 4. Economic Cost of Somali Piracy (2010–2017); Source: Oceans Beyond Piracy website (“The state of maritime piracy”).

economy. The Asian Development Bank (ADB) forecasted that the world might lose from 0.089% to 0.40% of its GDP due to spillover impacts of COVID-19 (ADB BRIEFS-2020). The COVID-19 pandemic has reached dangerous proportions everywhere on the planet and brought considerable difficulties in its train (Askari 2020). The prolonged scenario is having a very bad effect on human lives and additionally on the economy. [Ibid] The shipping sector is also getting seriously affected by the pandemic. As the coronavirus is very contagious and mainly spreads through human interactions (Adebowale, Fagbamigbe, and Akinyemi et al. 2021), autonomous ships where the human interactions are less than other vessels, can be viable solution.

For keeping the economy going forward globalization must be kept alive. In order to do that, some steps must be taken according to the Europe situation as it has become new the epicenter of COVID-19 outbreak. Moreover, all the countries or companies will not be interested in focusing on one thing or side or sector and the people will also look for diversified supply chain (Hawkins 2020). In accordance with the International Chamber of Shipping (ICS), maritime vessels comprise around 90% of all global trade and they are the essence of world economy (International Chamber of Shipping (ICS) website). So, it is very important to keep the ports open in a contained manner to maintain the flow of goods. It is a must to keep the shipping sector economy going. Domestic ports and terminals should also be kept open in order to maintain the flow of food and goods.

As the COVID-19 pandemic situation is deteriorating day by day, it has become imperative to take some steps. Among them a major step is investment in the freight technologies and also in companies providing data analysis, artificial intelligence software and overall end-to-end supply chain management. It will work as a key factor in the shipping sector. Dr. Jean-Paul Rodrigue et. al; drew correlations between transportation and pandemics, with specific reference to the Spanish Flu. They highlighted the transportation sector as one of the key reasons 100 million people died and 30% of the global population became ill (Rodrigue, Luke, and Osterholm 2020). Moreover, cargo and passenger ships around the world have been turned away (Jankowicz 2020) from ports by local authorities, with as many as 300,000 merchant sailors stuck at sea for months, far beyond their contractual agreements (Sawers 2020).

In order to give a sustainable solution to these problems and accompany by growth investment, it is a must to look forward into the autonomous transportation sector like autonomous shipping (Sawers 2020). Because, the COVID-19 incident will highly disrupt not only the industries but also the supply chain and the transportation sector. To overcome this problem robotics, autonomous transportation sector can be an effective solution.

Gaining efficiency in other shipping activities

Autonomies ships can ensure effectiveness and efficiency in the realm of shipping activities. They are: sailing over sea/river/port, passing locks and bridges, docking or departing, loading and unloading, preparing for next sail (Dijk et al. 2018). Unmanned ships can operate more efficiently with more advanced automatic energy management systems and improved routing and navigation (Research in maritime autonomous systems project Results and technology potentials).
Embracing shipping 4.0 and the future market

The maritime sector started to embrace industry 4.0 by integrating advanced technology into daily shipping operations. For example, Maersk line is already using IoT technology to keep watch on their containers (Reza, Mohsen, and Shahbakhsh 2020). Shipping companies are also familiar with the integration of technology into different aspects of shipping. Nowadays, almost all ships are automated in some ways. (Ibid) However, the shipping 4.0 revolution introduced unmanned and autonomous ships operated by AI-based intelligent machines (Cross and Meadow 2017). So, there are several steps for shipping companies to embrace autonomous shipping. Removing seafarers from onboard will be a major incentive (Reza, Mohsen, and Shahbakhsh 2020). The integration of autonomy into the onboard and ashore side of shipping will not be instant, but the change would be evolutionary. (Ibid)

Major competitors in the autonomous shipping market are: Rolls-Royce Holding PLC, Kongsberg Gruppen AS, NYK Line, Mitsui E&S Holdings Co Ltd, Vigor Industrial LLC and Praxis Automation Technology B.V. General Electric and DNV GL (Report by The Business Research Company 2021)

The global market for autonomous ships is likely to grow from $5.68 billion in 2020 to $6.46 billion in 2021 at a combined annual growth rate (CAGR) of 13.7%. This is because the companies resume their operations and adapt to the new normal as they recover from the COVID-19 onslaught. The market is expected to reach $9.24 billion in 2025 at a CAGR of 9%. (Ibid) Moreover, the demand for autonomous ships has been increasing because of the rise in automation, increased tourism activities, and rising demand to promote safe and efficient operations in the maritime sector. According to official statistics, Artificial Intelligence can improve the transportation and logistics industry performance by almost 90% by way of increasing the industry’s annual revenue up to EUR 0.45 trillion (Mishra 2020). These will also likely boost the demand for autonomous ships in times to come (“Autonomous Ships Market – Global Industry Analysis, Size, Share, Growth, Trends, and Forecast, 2020–2030”). The COVID-19 issue will also make a profound impact, as discussed before.

This drive will bring a fundamental transformation in the industry. In the long term, the implications extend well beyond the shipping industry. Lessening the cost of transportation would reduce operating expenses for the whole range of industries and create a variety of new market possibilities. Low-value items that were not worth shipping before could become profitable (Walker 2019).

Job factors & human replacement threats

Though the implementation of industry & shipping 4.0 was welcomed, it however raised some issues. One of that is the job market, because it is assumed that automation can replace humans (Reza, Mohsen, and Shahbakhsh 2020). However, people won’t be out of work, new sectors are discovered. In reality these ships are still in need of some human controls to operate which can be clearly understood from Figure 5.(ICS (International Chamber of Shipping)- Press release 2018; Johns 2018) The workers and seafarers simply have to take coaching and gain experience in this sector (Johns 2018). Besides, introduction of any technology could replace some jobs at an equivalent time, however, it creates new set of jobs (Industry 4.0 Opportunities and Challenges of the New Industrial Revolution for Developing Countries and Economies in Transition, Panel discussion 2017).

Regarding the probable effects of autonomous ships on the activities of the seamen and the international shipping industry, ICS published a new study, carried out by the Hamburg School of Business

![Figure 5](Image Courtesy: Rolls-Royce).
Administration (HSBA) and the study indicates that, in the following couple of decades, there will be no dearth of jobs for the seamen, particularly officers (Johns 2018). However, the size of crews may reduce due to technological changes on board, but there may also be considerable additional jobs ashore that require seafaring experience. [Ibid] The study also conducts an assessment of risks and opportunities of digitalization in international logistics chains and in the automation of ship operations. [Ibid] According to the study, the role of the employees on board and ashore needs to be reconsidered both operationally and legally.

As Guy Platten, the Secretary General of ICS, noted, automation will affect a number of areas under IMO’s purview. It will also offer new opportunities that do not exist today, but there is much work to be done, especially regulatory-wise, in order to address concerns about the impact of MASS on seafarers employed worldwide (ICS(International Chamber of Shipping)-Press release 2018). So there will be a need for reskilling of the manpower.

**Conclusion & Recommendations**

This study proposed a feasible and sustainable strategy for container shipping and suggested innovative applications of autonomous shipping in the shipping industry and for the extreme and challenging situations as well. Out of the argument, overall discussion and related literature review about impacts, opportunities and some threats of autonomous shipping, a SWOT analysis can be formulated, which is shown in Table 2.

The transport volume of global seaborne trade has steadily risen over the last decade and today, approximately 90% of world trade is transported by vessels (International Chamber of Shipping (ICS) website). The maritime world is in a state of flux. To keep pace with the industry 4.0, autonomous ships are a must. Based on this study, some recommendations can be summarized as follows:

(i) Autonomous ships have some potential features and because of those it can be considered as a feasible alternative in the shipping industry to keep pace with the 4IR (Fourth Industrial Revolution).

(ii) It also can be a solution to pandemic crisis problems like the COVID-19 scenario.

(iii) New constitutive strategies can be developed based on strengths, elimination of weaknesses, exploiting the opportunities and counteracting the threats.

Mikael Makinen, President of Rolls-Royce Marine, announced that the future of the maritime industry lies in autonomous shipping. As the smartphones have revolutionized personalized services, the smart ship will revolutionize the landscape of ship design and operations (Press Release 2016). So, automation and AI will give birth to the future that we cannot avoid. However, the integration of digitization into on board and ashore side of shipping is not going to be instant and revolutionary. This change would rather be gradual and evolutionary. And while experiencing this evolutionary period, the societal role of training institutions is to help smooth the transition. So, the future of shipping industry is highly dependent on the autonomous shipping which has enormous prospects provided that the challenges are dealt with properly.

**Disclosure statement**

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**ORCID**

Humayun Rashid Askari (http://orcid.org/0000-0002-8943-9743)

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**Table 2. SWOT analysis of Autonomous Shipping.**

| SWOT analysis of Autonomous Shipping | Weaknesses | Threats |
|-------------------------------------|------------|---------|
| Strengths                           |            |         |
| ● Reduces Human Interactions:       | High software reliability | Job replacement factors |
| (Headcount savings, raises wages   | ● High capital cost | Encounter with manned ship |
| capability, reduces labor cost)     | ● High maintenance schedule | Remote control network risk and cyber attacks |
| ● Reduces fuel consumption          | ● Lack of local infrastructure or skilled manpower | Legal implications & adoption of marine regulations |
| ● Increases time and energy         | ● Change in ship design | Uncertainty of maritime insurance |
| efficiency                           |            | Energy-supply risk |
| ● Increases monitoring activity     |            |         |
| ● Gaining efficiency in other      |            |         |
| shipping activities (sailing over   |            |         |
| sea/river/ port, passing locks and |            |         |
| bridges, docking or departing,     |            |         |
| loading and unloading, preparing   |            |         |
| for next sail)                      |            |         |
| ● Reduces port expenses and        |            |         |
| management cost                     |            |         |
| Opportunities                       |            |         |
| ● Reduces piracy risks             |            |         |
| ● Reduces human errors & maritime  |            |         |
| accidents                           |            |         |
| ● Feasible Alternative to pandemic  |            |         |
| situation (Covid 19 Scenario)       |            |         |
| ● Increases loading and discarding |            |         |
| rate                                |            |         |
| ● Eco friendly                      |            |         |
| ● Creates new job sector            |            |         |
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