

# The concept of sustainable development and safety in maritime transport

## Keywords

safety, transportation, environmental risks, sustainable development

## Abstract

The chapter presents opportunities of implementing the concept of sustainable development in sea transportation. The most important areas in which the concept is introduced are discussed. This revolves around the three important pillars of sustainable development: economic, social and environmental. Economic pillar is especially important in view of shipping's role in the movement of about 90% of trade in goods, energy and raw materials. Social sustainability is based on improvement of maritime safety by development of safety regulations. Because operations at sea involve a high degree of physical risk, the shipping industry is committed to the continuous improvement of its environmental performance. The development and implementation of global standards for sustainable shipping cover safety, environmental protection, security and facilitation. The chapter also presents key advantages of implementing the concept of sustainable development in sea transportation.

## 1. Introduction

The international shipping industry directly facilitates growth of the world trade, economic development and the improvement of global living standards. About 90% of world trade is carried by sea to people and communities all over the world. Shipping is the most efficient method of transporting goods globally and helping to create prosperity among nations. Global economic expansion is the main driver of the world shipping demand. The volume of maritime trade is therefore expected to increase significantly as world economy and population continue to expand. 2017 was the year when the world economy and global shipping experienced a cyclic recovery from the lows in 2016 and after the 2008–2009 global financial crisis. With GDP expanding by 3.1% in 2017 (up from 2.5% in 2016), the global economy experienced a broad upswing generating positive impact on seaborne trade.

The latest economic downturn and subsequent recovery show new trends that are reshaping the landscape of the international maritime transport and trade. These include:

- global new design,
- energy security, oil prices and transport cost,

- cutting carbon emissions from international shipping and adapting to climate change impacts,
- environmental sustainability and Corporate Social Responsibility,
- maritime piracy and related costs.

Due to the fact that reorientation in the global production and trade continues, the developing countries are contributing large share to the world output and trade. Historically, developing countries have been the main suppliers of high-volume, low-value raw materials; this has changed over the years [27].

In 2017, international trade volume expanded by 4.7%. Merchandise trade volumes increased in line with positive trends in the world economy, an upturn in investment and the rise in commodity prices.

Global port activity and cargo handling expanded rapidly in 2017, following two years of weak performance. According to 2017 estimates, the top 20 global ports handled 9.3 billion tons of goods.

International seaborne trade gathered momentum with volumes expanding by 4% and the fastest growth in five years. Reflecting the world's economic recovery and improved global merchandise trade, the world seaborne trade volume

was estimated at 10.7 billion tons in 2017. Dry bulk cargoes have powered nearly half of the volume's increase (Figure 1). The continuous increase in the number of vessels and their exploitation result in reduced natural resources, and pollution from the combustion of fossil fuels which contributes to the destruction of the ecosystem and threatens human health on a global and local level. Global concerns about climate change, energy use, environmental impacts, and limits to financial resources for shipping industry require new and different approaches to planning, designing, constructing, operating and maintaining transportation solutions.

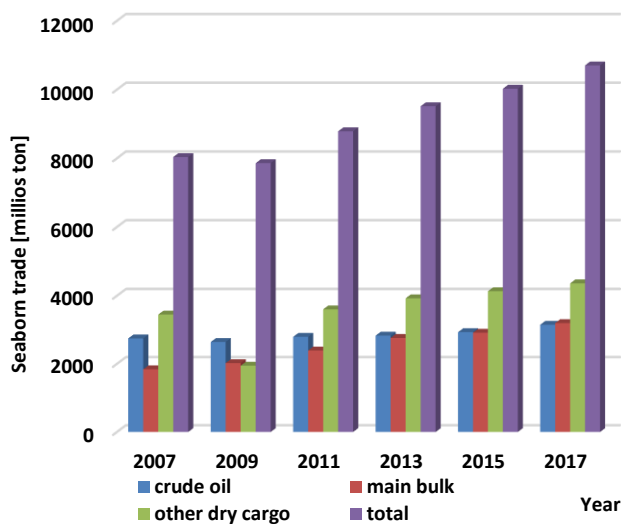


Figure 1. International seaborne trade, selected years [5]

Maritime transport (shipping industry) contributes significantly to the three pillars of sustainable development – social, environmental and economic [2], [17].

Reducing greenhouse gas emissions is a key challenge to avoiding the most catastrophic impact of climate change. Countries have committed to reducing their GHG emissions under the Paris agreement, which aims to limit global warming to well below 2°C above the pre-industrial levels [20]. International shipping, like all other sectors of human activity, must take urgent action to contribute to achievement of the objectives of the Paris Agreement for the future of the planet and of humanity.

The paper discusses the main areas that should be considered if maritime sustainable development is to be achieved. It presents activities focused on environmentally friendly solutions as a form of IMO support for realization of the strategy of sustainable development.

## 2. Sustainable maritime strategy

The most commonly accepted definition of sustainable development is that adopted by the Brundtland Commission in the report entitled "Our Common Future from 1987: Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs".

The report contains within it two key concepts:

- The concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given;
- The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

Sustainable development promotes the idea that social, environmental and economic progress are all attainable within the limits of Earth's natural resources [29].

World trade and maritime transport are fundamental to sustaining economic growth and spreading of prosperity throughout the world. The role will continue to grow with the anticipated increase in world trade. Furthermore, maritime transport is the most environmentally sound mode of transport, both in terms of energy efficiency and prevention of the pollution.

The International Maritime Organization (IMO) coordinates maritime policy worldwide as the UN Specialized Agency in charge of setting the global standards for safe and efficient maritime transport. IMO develops and provides a comprehensive framework focused on environmentally friendly solutions and implementation of the concept of sustainable development [15].

Fundamental assumption of the marine sustainable development was formulated as follows:

*"International regulations concerning maritime transport focus primarily on the application of the principle of freedom to provide services and to ensure the correct application of the competition rules, while ensuring a high level of safety, decent working conditions and high environmental standards"* [8].

Sustainable transport is a system that optimizes transportation of goods and passengers, minimizes consumption of energy, generates low emissions of greenhouse gases and minimizes the adverse social impacts arising from transport operations.

The main objectives of Sustainable Maritime Development are to build a strategy that is safe, convenient, highly efficient, economical, equitable, environmentally friendly, and in line with socio-economic development (Figure 2). The transport

system development should contribute to the economic development needs. It should meet the demands for transport arising from rapid industrialization and urbanization, and from economic globalization. The transport system should contribute to social development. It should be equitable and provide transport mode choices to all consignors, achieving the objectives of safety, reliability, convenience and cost-effectiveness.

The transport system should develop in harmony with the natural environment. It should be based on the circular economic concept, realizing efficient and circular resource use, controlling pollutants and greenhouse gas emissions to prevent serious damage to the natural environment.

### 2.1. Economic pillar

Seaborne trade continues to expand bringing benefits for the consumers across the world through competitive freight costs. Thanks to the growing efficiency of shipping as a mode of transport and increased economic liberalization, the prospects for

the industry's further growth continue to be strong. The United Nations Conference on Trade and Development estimates that the operation of merchant ships contributes about 5% of the total world trade [25]. It facilitates global commerce and the creation of wealth and prosperity among nations. In the era of globalization, access to overseas markets is a key element for economies to create economic growth. About 90% of the world trade is carried by sea. The volume of sea transportation is expected to increase significantly as the world economy and population continue to grow. Without sea transportation, transport of goods between the continents and movement of raw materials in bulks or oils would simply not be possible.

The prosperity of any nation is linked to its possibilities to import and export its surplus. Due to low cost and efficiency of sea transportation, a major shift towards industrial production in Asia and other emerging economies was possible. This process has in large part been responsible for improvement in the global living standards.

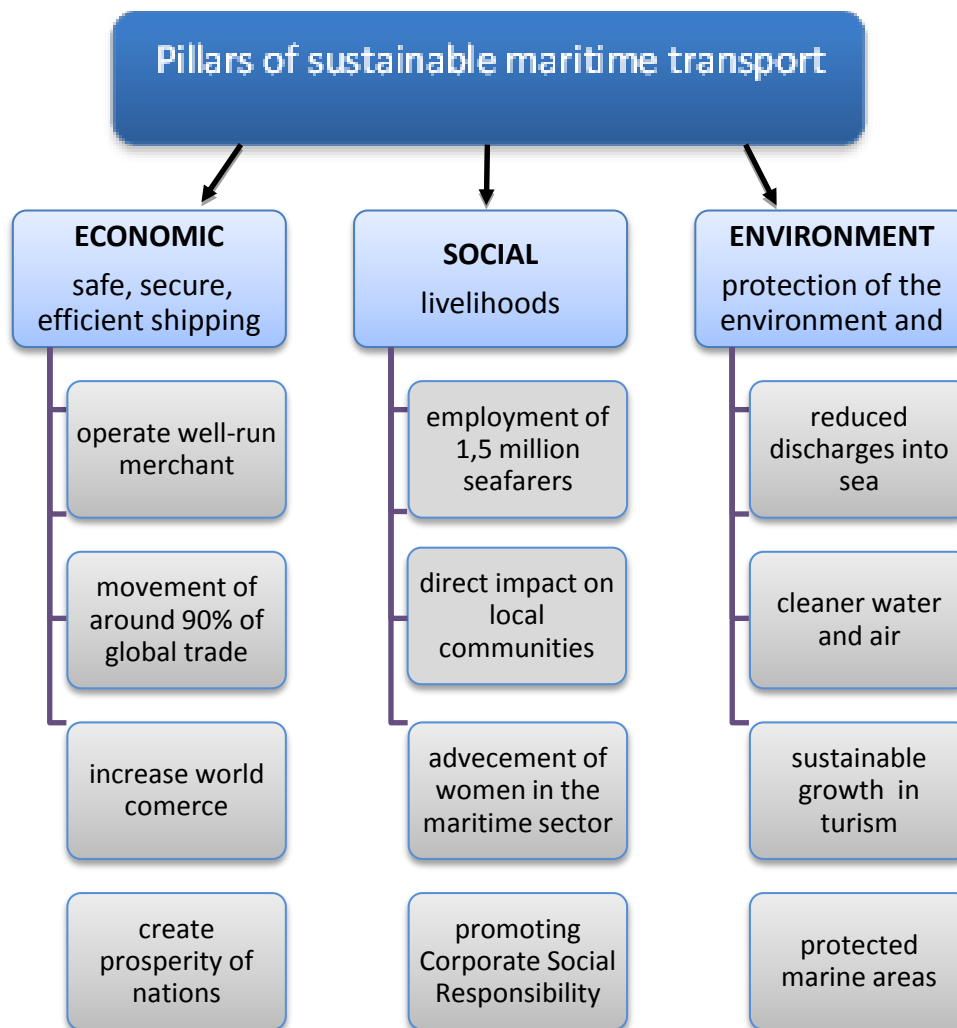


Figure 2. Pillars of sustainable maritime transport

Maritime transport exists in conjunction with many shore-side infrastructures, services and personnel for cargo handling and delivery.

It is a vital link in the international logistics chain, moving cargo across the world at the service of global trade, and economic development. Currently, national and international organizations pay special attention to the development and modernization of sea transportation in order to play a more effective role in implementing the framework of sustainable development.

## 2.2. Environmental pillar

During transport of one tonne of freight, the highest emissions of carbon dioxide come from air transportation, and the lowest from operation of the largest ships [22].

In spite of being economically cheap and environmentally friendly (when measured in tonnes of transported goods), shipping also has other negative effects on the environment, including emissions into the atmosphere, illegal and accidental discharges of oil, hazardous substances or other waste [13].

Total fuel consumption increased from 291 to 298 million tonnes from 2013 to 2015, compared to a 7% increase in demand for shipping supply. Emissions are increasing despite improvements in operational efficiency for many classes of ships. Increasing emissions are being driven by rising demand for shipping and the associated consumption of fossil fuels.

In 2015, total shipping emissions were responsible for 2,6% of the global CO<sub>2</sub> emissions from fossil fuel use and industrial processes. If shipping was treated as a country it would have been the sixth largest emitter of energy-related CO<sub>2</sub> [19].

Forecast scenarios for the medium term suggest that carbon emissions from international shipping could increase by 50–250% by 2050, depending on the expected long-term growth of the world economy, population and global energy demand [26]. Container ships, bulk carriers and oil tankers accounted for 55% of shipping’s CO<sub>2</sub> emissions (Figure 3).

Another product of fuel combustion is black carbon – small very dark particles, which might warm the atmosphere about one third as much as CO<sub>2</sub> [14]. After CO<sub>2</sub>, black carbon is a major contributor to shipping’s climate impact. It has effects on cloud processes, solar radiation, and alters the melting of snow and ice cover.

IMO is responsible for regulation of the global shipping sector. There exist only one IMO regulation

mandating improvements in ships’ energy efficiency – the Energy Efficiency Design Index.

IMO continues to contribute to the global fight against climate change, in support of the UN Sustainable Development Goal 13. Complementing international efforts to address greenhouse gas emissions, an important achievement was made at the International Maritime Organization related to the determination of international shipping’s fair share of greenhouse gas emissions reduction.

In 2018, IMO adopted the Initial IMO Strategy on Reduction of GHG emissions from international shipping [12]. The strategy includes: reduction of CO<sub>2</sub> emissions, as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008. The total annual GHG emissions from international shipping should be reduced by at least 50 % by 2050 compared to 2008.

IMO is also executing global technical cooperation projects to support the capacity of states to implement and support energy efficiency in the shipping sector. Support for implementation of energy-efficiency measures is provided through major global projects executed by IMO, which include:

- The Global Maritime Technology Cooperation Centers network project which was funded by the European Union and has established a network of five Maritime Technology Cooperation Centers. Through collaboration and activities at regional level, Centres have been focusing their efforts on helping countries develop national maritime energy efficiency policies and promote the uptake of low-carbon technologies in maritime transport.
- Global Maritime Energy Efficiency Partnerships: project supporting the uptake and implementation of energy-efficient measures for shipping.

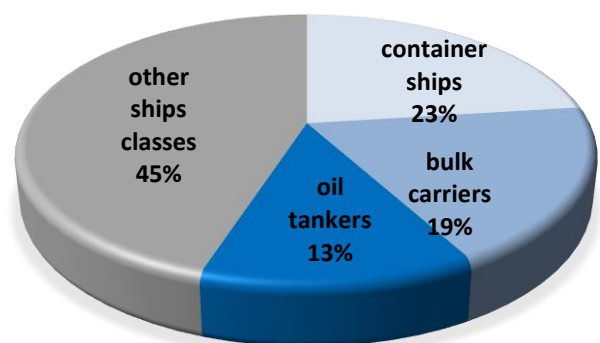


Figure 3. Share of CO<sub>2</sub> emissions by ship class [14]

- The Global Industry Alliance to Support Low Carbon Shipping: project identifying and developing solutions that can help overcome barriers to the uptake of energy-efficient technology in the shipping sectors.
- Green Voyage 2050 project: project launched in 2019, which will initiate and promote global efforts to demonstrate and test technical solutions for reduction of emissions.
- Multi-donor trust fund on GHG: project to provide a dedicated source of financial support for technical cooperation and implementation of the Initial IMO Strategy on reduction of the GHG emissions from ships.

### 2.3. Social pillar

Sea transportation must be considered as a very important source of not only economic but also social development of countries [23].

New technologies and geopolitical trends are creating new opportunities for cities and countries to participate in the global economy.

The international shipping industry employs more than 1.5 million seafarers and many other port and logistics workers who are responsible for the safe delivery of food, raw materials and consumer goods and is essential component of world's economy [18]. Millions more are employed as shore staff across the world in various supporting activities. The specific aim is to promote seafaring as an attractive option for young people, one which can provide

them with rewarding, stimulating and long-term prospects, not only at sea but also in the broader maritime industry. Shipping provides job opportunity to people in developing countries.

The quality of life for seafarers at sea is important in order to maintain and develop the maritime transport industry as an attractive career option for talented professionals.

IMO started to promote the Programme on the Integration of Women in the Maritime Sector for the inclusion of women in the maritime sector. Its primary objective is to encourage governments to open doors of the maritime institutes to enable women to train alongside men.

Shipping introduces ever more sophisticated equipment for enhancing the safety of ships and cargo, route planning and navigation, cargo handling, energy efficiency monitoring, plus vessel-source pollution control and prevention. Retrofitted and new equipment bundled together with evolving shipboard procedures will lead to ship crews performing new functions. Furthermore, it will require training and education of the maritime professionals including engineers, lawyers, port personnel, ship managers and policy administrators.

### 3. Goals and actions developed by IMO

To realize the concept of sustainable development in the maritime transport, IMO has formulated main goals, which should be completed in the near future (*Figure 4*).

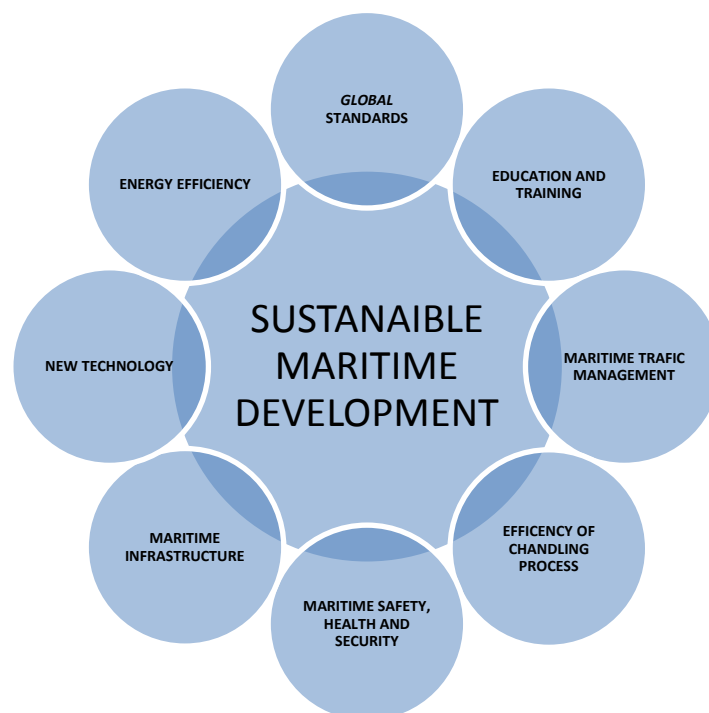


Figure 4. The key objectives of sustainable development in the maritime transport



The challenge for Governments and IMO is to frame a transport strategy that supports sustaining a strong economy, quality of life and protection of environment. IMO aims to regulate all technical aspects of international shipping, introducing more than 50 conventions, supplemented by 800 codes, guidelines, circulars, and recommendations.

IMO's regulatory framework covers all kinds of technical matters pertaining to the safety of ships and of life at sea, efficiency of navigation, and prevention and control of marine and air pollution from ships.

Harmonizing interpretation and implementation of the safety codes, standards and regulations has a positive effect on the safety of sea transport. Some goods transported by sea can be hazardous during shipping due to their chemical nature.

The International Convention for the Safety of Life at Sea (SOLAS Convention) is the most important international convention dealing with maritime safety [10]. SOLAS in its present version was adopted in 1974 and entered into force in 1980.

It is estimated that more than half of packed goods and bulk cargoes transported by sea today can be regarded as dangerous, hazardous or harmful to the environment.

Dangerous goods are transported on a regular basis by sea and include many widely-used commodities such as: oils, fertilizers, paints, fuels, alcohols, perfume products, pesticides, aerosols and refrigerated gases [7].

Transport of dangerous goods is generally associated with significant levels of risk which may depend on a variety of factors. Safety is the one of the main concerns in all activities related to the transport of dangerous goods. Catastrophic consequences of a possible accident include: fatalities, injuries, emergency evacuations, property damage and environmental damage [16].

Maritime safety during transport of dangerous goods depends on the factors associated with technology and the organization of the transport and crew preparation for the task resulting from the specific working conditions.

The most significant situations during the sea transportation of dangerous goods which have impact on the environment are uncontrolled releases of liquids into the water, gas emissions and waste generation.

Shipping accidents, many involving spills of mineral oils, have been a catalyst for environmental protection regulations over the past 40 years. Environmental risk is linked to the type and amount of oil and hazardous substances and the sensitivity of the marine area where an accident happens.

A clear link can be made between environmental protection and shipping safety, with shipping accidents provoking a strong response from civil society and politicians. Even small-scale accidents in very sensitive environments can have profound environmental consequences. History has shown that large-scale accidents serve as key drivers of change which is often manifested in new or amended safety regulation [4].

To minimize the risk of negligent or incidental release of marine pollutants transported by sea, The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) was adopted and entered into force on 2 October 1983 [11].

Shipping is also the only industrial sector to have a comprehensive international framework in place to address employment standards following the entry into force on 20 August 2013.

The maritime transport industry should take advantage of new technology in order to maximize its environmental performance as well as to enhance safety, and be prepared for new cargo types and new trades. The application of new technology will be critical in enabling transport to achieve any future pathway for CO<sub>2</sub> reduction.

High fuel costs and rising environmental regulations create demand for more fuel-efficient and eco-friendly maritime transport that is set to intensify. In this context shipping industry introduced term "Eco-shipping". Eco-shipping can be described as an evolution of ships, through the process of hull and engine design, and new technologies making significant savings on costs with the main saving being on the engine fuel consumption [21].

Many experimental designs and concepts for eco-friendly ships (for example wind and solar power) are being reported but their application in the near future remains doubtful. However, eco-ships are expected to be almost 30% more fuel efficient than current generation of ships.

Pressure to reduce carbon emissions from ships has also directed shipping companies to implement the slow steaming [28]. IMO has an important role in setting the frameworks and incentives that will foster promotion of lower-carbon fuels and energy efficiency. Shipping has traditionally used heavy fuel oil but the global society now expects and requires progressively cleaner solutions.

Port facilities that provide fuel to ships should be arranged based on the proper assessment of future fuel demand. Maritime transport will need to have access to an ample amount of cleaner energy such as LNG and low-sulphur fuel oils.

Sustainable energy fuels for maritime transportation have for the last 40 years received attention from politicians and researchers. There are many options

available such as bioethanol, biodiesel, biogas, or solid biomass such as wood. In recent years, one of the main focus areas for economic development and policy has been centred on maritime policy which has strengthened cooperation on several issues related to sustainable of energy, mainly focusing on the potential use of LNG as a maritime fuel. In the future, this topic will attract more attention due to an expected growth in maritime transport, related environmental challenges and regulations on sulphur and NOx emissions.

In 2000, the share of renewable energy was less than 3%. It nearly doubled within three years and should reach 20% by 2020 [24].

Methanol is readily available worldwide and every year over 70 million tonnes are produced globally. Methanol could be 100% renewable as it can be produced from variety of renewable feed-stocks. This makes it an ideal pathway fuel to sustainable future in which shipping is powered by 100% renewable fuels. The potential of methanol as marine fuel remains unrecognized outside of the specialist circles. Marine methanol fuel produces no sulphur emissions and very low levels of nitrogen oxide emissions [1].

Biofuels could be one of the options to realize a lower carbon intensity in the propulsion of ships and also possibly reduce the effect of ship emissions on local air quality. Biofuels are currently globally available, they can be produced from many abundant types of biomass, and they can be optimized to match the existing distribution channels and applications of fuels in all forms of transport. Most commonly used and produced biofuels are biodiesel (from oil containing agricultural crops) and bio-ethanol (from sugar or starch containing agricultural crops) [6].

Various agricultural products previously used only for consumption are now being used to produce fuel. An increase in the production of bio-energy from agriculture sounds like a promising concept to cope with global climate change. However, there is a tight correlation between economic growth and energy demand, as there is between population growth and food demand. The competition between food and fuel production based on energy crops will only grow with the expansion of their cultivation on arable land. Efficiency must extend beyond the ship, addressing the ship-shore interface through standardization of the documentation for both the delivery and the reception of cargo, improving coordination and promoting the use of electronic systems. As ships do not operate independently, sustainable maritime transport needs efficient port facilities to keep the operational efficiency of ships at the highest level.

Although all types of vessels are considered vulnerable to incidents and accidents, the ones who for obvious reasons cause the most concern are those carrying pollutants and loads with great potential to cause an environmental disaster [3]. Governments should ensure minimal environmental impact during the construction and maintenance of port infrastructure developments.

The use of oceans is becoming more intensive as a result of the increase in the maritime transport and other uses, such as offshore exploration and the exploitation of traditional and renewable energy sources. Maritime transport requires co-operation and harmonization in the development of optimal systems for navigation including pilotage.

There has always been strong focus in sea transport on reducing risks of transport accidents to transport users, workers and third parties. Maritime safety depends to a large extent on the competencies and knowledge of the seafarers.

For more than two decades, IMO has offered both the developing and developed countries the possibility to attain high-level maritime education through the establishment of a training institution. Training and education for maritime transport should be based on The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention) [9]. Improving education and training systems for seafarers allows to improve their competence, motivation and the attractiveness of the profession.

#### **4. Conclusion**

Transport can affect people's lives both in a positive way (by supporting the global economy), and a negative way (by contributing to climate change and through pollution and accidents). A shift towards sustainability and safety requires policies, strategies, investments and technological development in maritime transport. Citizens will also have to adapt to new conditions and change their user behaviour.

Implementation of the main objectives of sustainable maritime transport needs close collaboration by governments, academics, investors, and users. The environmental, social and economic dimensions of maritime transport are equally important and should be fully recognized in any strategy, policy and regulatory framework and action.

Reduction in ship emissions will require concerned actions to improve the energy efficiency of shipping and development of alternative fuel and propulsion concepts.

In order to succeed with necessary transformation, information and education is mandatory together

with participation in the shaping of new practices related to energy efficiency.

It is assumed that a number of institutional and technological barriers may appear. Technological barriers include the specific designs of vessels that are incompatible with certain technologies and the potential risks associated with new technologies. There may also be financial barriers such as very short-time amortization investments in new technologies.

The main role of the International Maritime Organization is to create a regulatory framework for shipping industry that is fair and effective, universally adopted and universally implemented. In the past, IMO rules and regulations have been successful in reducing the loss of life at sea and the quantities of oil spilled by ships.

In order to operate with the required safety and efficiency, sustainable sea transport requires coordinated support from shore-side entities to shipping such as providers of aids to navigation, oceanographic, hydrographic and meteorological services, search and rescue services, incident and emergency responders, port facilities, trade facilitation measures, and cargo-handling and logistics systems.

Currently, the shipping sector has found itself at the front lines of new security threats emanating from global terrorism and from piracy on the sea lanes as well as facing traditional forms of robbery in ports or at anchor.

Security is essential for sea transport yet is largely beyond the control of the shipping industry. Therefore, the maritime transportation sector needs external assistance such as from navy patrols or on-shore action. Nevertheless, it must also take its own preventative measures to address security treats arising at sea or in ports, and which endanger both cargo and crew.

Sustainable sea transport also needs the support of a sound financial system to support its evolving requirements for economic, social and environmental sustainability. The financial sector should allow for the efficient long-term allocation of resources to advance all pillars of sustainable development.

Maritime transportation should actively engage with Classification Societies, academic institutions and other research and development entities in order to embrace new technologies and new operational practices.

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