MTCC LATIN AMERICA
Maritime Technology Cooperation Centre

Capacity Building for Climate Mitigation in the Maritime Shipping Industry Project

NATIONAL TECHNOLOGY NEEDS AND BARRIERS REPORT

Maritime Technology Cooperation Centre Latin America

(MTCC-Latin America)

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GMN | The Global MTCC Network
A global network for energy-efficient shipping

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Content

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1. Summary

This National Technology Needs and Barriers Report is based on interviews conducted during data collection for the pilot project 1 and a group exercise conducted during the First Regional Workshop organized by the MTCC-Latin America and attended by 55 participants representing maritime government agencies, universities, and service providers from 14 Latin American countries and industry experts from Europe and North America. The group exercise during the regional workshop in Panama rated six categories of barriers and opportunities, as well as the severity of their impacts and the priority of related actions. It was found that social, environmental and legal factors consistently ranked at the top of perceived barriers and opportunities. The on-site visits conducted during the data collection included shipyards as main service providers of technological services in the chosen countries. This provided a clearer view of the ship energy efficiency technologies available in those countries. With regards to relevant actions derived from this review, the MTCC-Latin America identified three relevant actions including further analysis on a case study basis, refocus of the contents of national capacity building activities in the regional and the need to formulate new pilot projects post 2019 to help countries address the issues of national energy efficiency regulatory frameworks.

2. Introduction

The primary objective of this report is to understand the needs and barriers of countries in the Latin American region with regard to the implementation of energy efficiency regulations and operations for ships, particularly the availability of energy efficiency technologies, and to determine subsequent actions that the MTCC Latin America (MTCC) could promote to facilitate their adoption and effectiveness. To this end, the MTCC utilized two mechanisms to gather information.

First, during our First Regional Workshop in Panama City on 13-15 of March 2018, the MTCC Latin America conducted a group exercise to obtain the data and views of participants on this topic. In this exercise there were 55 participants from Latin American countries representing maritime administrations, other government agencies, classification societies, service providers, port authorities, as well as universities and training institutions (see Annex II). Thirty one (31) of the total participants in the group came from the maritime administrations of the 14 countries attending the workshop. Three (3) countries from the Latin American region did not send representative for political reasons (Venezuela) and budgetary constraints (Chile and Uruguay). The methodology utilized in this group exercise included presentations from seven countries about their institutional structures, experiences, barriers and expectations in implementing energy efficient measures in their respective countries. After the presentations, the audience was divided in groups representing various sub-areas of the Latin American regions, namely North, Central, Southeast and Southwest. In the groups participants discussed barriers, opportunities and other views on the subject matter. The groups ranked the barriers and opportunities previously categorized by the consultant and MTCC staff members and proceeded to determine their perceived severity and impacts. Finally, the groups presented their findings and a general discussion took place. A consultant was hired to facilitate this group exercise and was supported by MTCC staff members and advisors. The original report from the consultant explaining the methodology used and the main results can be found in Annex II of this report. This NTNA report builds on this group exercise, also presenting further conclusions and relevant actions to address its main findings.

Secondly, as part of the visits and interviews conducted for our pilot projects, a specific questionnaire was developed to understand the availability of energy efficiency technologies in the four countries chosen, complemented with local knowledge of shipping companies and ship operators interviewed. The countries chosen for this report were Honduras, Panama, Colombia and Chile. More details as to why they were chosen are provided in the next section of this report.

3. Group exercise: Perceived barriers and opportunities

To determine the technology needs, barriers and relevant actions in the Latin American region, the MTCC identified several initial factors, dividing them into six main categories: political, social, technological, economic, environmental and legal. In our view, these categories included the main elements foreseen to play a role in the implementation of ship energy efficiency regulations.

To assess policy or political aspects, the exercise included factors such as bureaucracy, level of corruption, and government participation in regional/international agreements, for instance, as it was felt that effective climate change mitigation requires policy decisions to be taken and promoted by relevant governmental authorities. It is also known that environmental policies differ in the list of priorities depending on the ideology and values of the governing party in power.

By measuring social factors such as level of environmental awareness, attitudes towards ecological products and support for new sources of renewable energy, the MTCC tried to collect the group´s perceptions, societal and industry values, which can significantly guide trends towards reducing greenhouse gas emissions. Some environmental factors can also be construed as socially-related, as they could be a measure of social attitudes toward ecological products and climate change, among others.

Political and social factors are considered to be key to implementation and their analysis can indeed shed useful insights.

Any assessment of barriers, opportunities and needs in terms of energy efficiency would need to measure the crucial role of technology. Hence, technology-related factors such as availability of energy efficiency technology and alternative fuels, and the level of technology usage in the industry are key factors to design regulatory regimes. It is important to note that it has been assumed that Latin American countries are, in general, not recognized as producers of new technologies, so factors such as technology innovation were important to include.

Economic factors are expected to play a role in the adoption of energy efficiency schemes, as credit availability and price technology can be decisive in terms of acquiring cutting-edge energy efficiency technology, adopting greener operations, or simply implementing new ship energy efficiency regulations.

Finally, regulatory frameworks on energy efficiency and environmental law and regulations are definitively considered an essential factor in promoting and implementing energy efficiency schemes.

3.1. Barriers or constraints

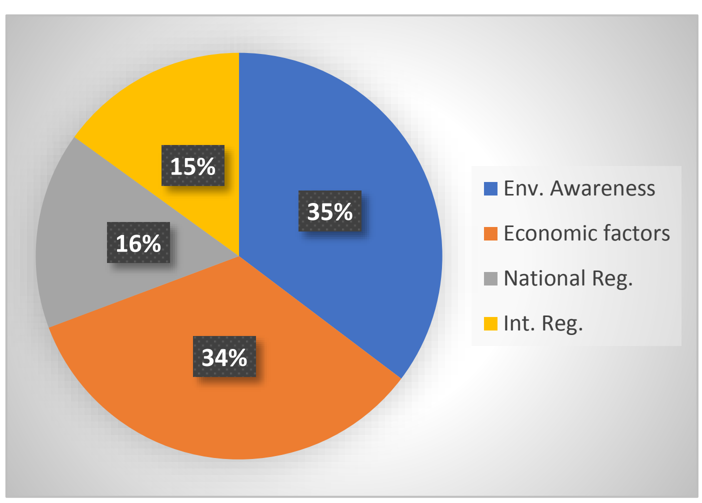
As can be seen in the report attached in Annex II, the group highlighted the following as the most common barriers:

(i) environmental awareness with 31 occurrences in the forms that were distributed to participants and attitudes towards "green" or ecological products with 23 occurrences (environmental factor);

(ii) public expenditure with 28 occurrences and price of energy efficiency technology with 24 occurrences (economic factor);

(iii) lack of regulations on energy efficiency with 24 occurrences (legal factor); and

(iv) international regulations governing the subject have not been ratified with 23 occurrences (legal factor).



3.2. Opportunities

The records of the group show the following opportunities with regards to ship energy efficiency:

(i) attitudes towards "green" or ecological products with 23 occurrences in the form filled out by participants, attitudes and support for renewable energy with 23 occurrences and environmental awareness with 19 occurrences (environmental factor);

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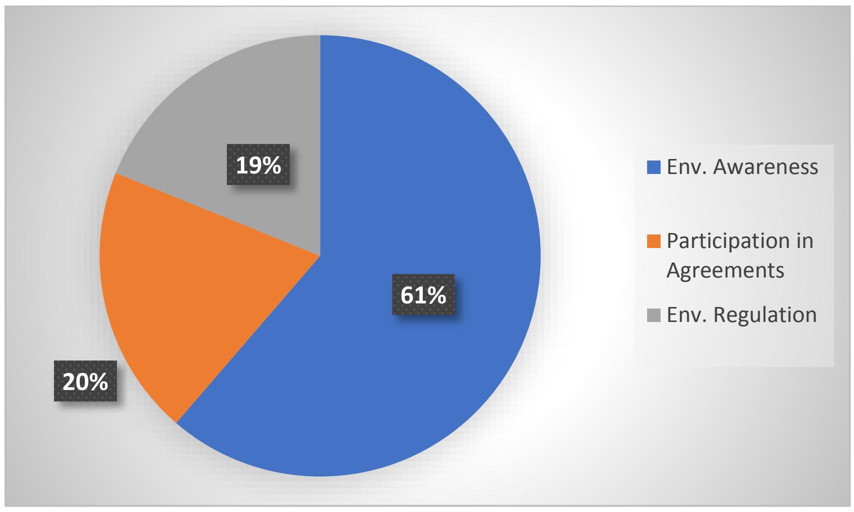
(ii) government participation in regional / international agreements with 21 occurrences (political factor); and

(iii) laws regulating environmental pollution (prevention and control) with 20 occurrences (legal factor).



Further interpretation of the results presented by the consultant confirms that there is consistency between the constraints and opportunities identified, that is:

- The top opportunities perceived by participating parties relate to the opportunity to promote or develop increased acceptance of greener options or more environmentally friendly practices;
- The other cluster of opportunities relates to the opportunity to more actively participate at the regional and international levels to advance ship energy efficiency schemes, as well as to regulate these matter at the national level; and
- Environmental regulations is considered as an area where further improvement is possible.

Interestingly, technology-related aspects do not rank neither among the top limitations or opportunities.

The following section presents aspects of the maritime affairs in the region to add context to this report.

4. Key aspects of maritime affairs in the region

The MTCC Latin America works with seventeen (17) countries. In the context of the maritime activities in general, within the Latin American region there are varying realities worth highlighting in order to better understand the dynamics of the industry in this part of the world. These are:

- The majority of maritime administrations in the region have maritime administrations belonging to the navy or coast guard military institutions. This is significant as these maritime administrations are less influenced by national political swings, thus their management style tend to be top-down and their implementation efforts are very consistent over time. These are positive characteristics when the top management is committed to energy efficiency efforts.

- In terms of ratification or adoption of MARPOL Annex VI, which contains the international provisions of energy efficiency for ships, while only six (6) countries are already parties to said instrument, a similar number of countries are in the process of becoming parties.
- Three of the seventeen countries administer international open registries (Panama, Honduras and Bolivia). While Panama is among the most successful open registries in the world, thus having a significant part of the international merchant fleet under its flag, the other two open registries in the region have a very small number of international vessels. Panama also plays an important role in the chain of maritime transport due to the high traffic of ships going through the Panama Canal and the relevance of its national ports for the transhipment of containerized cargo for the region. For these reasons, it was important for the MTCC to include Panama in this study.
- Countries in Central America have a small number of vessels under their national fleets, composed mostly of non-convention and fishing vessels. Central American countries are currently making great efforts towards ratifying and implementing international IMO ship safety, security and environmental standards, as their seaports are key for the movement of goods and passengers and their coasts experience a higher number of calls from international vessels. Honduras is the only country in Central America that has ratified MARPOL Annex VI, and also, due to its international ship registry, is one of the most active players in the international shipping in this part of Latin America. Hence, Honduras has been included in this report.
- Countries in South America have larger national fleets, which provide mostly cabotage service with a smaller number of vessels servicing international trade. Fluvial or river operations are also an important part of the movement of vessels. In South America, Chile is regarded as a reference maritime country due to its involvement in international shipping, regional cooperation in maritime affairs and the relevance of its shipping-related services. As Chile is also an active party of MARPOL Annex VI, the MTCC is of the opinion that its inclusion in this study would help provide a more accurate picture of the region.
- In Latin America, only six countries have incorporated MARPOL Annex VI as part of their national legislation. Some countries are in the process of adopting this international standard. The MTCC found of interest to include as part of this report, a country in the process of adopting MARPOL Annex VI. In this context, Colombia makes a good option due to its close cooperation with our project in the region, the recent celebration of a national workshop in Cartagena and the high traffic of foreign vessels in its coasts.

5. Ship energy efficiency in the region

This section presents the ship energy efficiency technologies available in selected countries of Latin America, based on personal interviews with ship operators in the countries and visits to local shipyards and ship repair facilities. To this end, the following table presents the main EE technologies, as well as their purpose. This table will also help shed light on the required conditions for the installation or servicing of ship EE technologies, which in turn constitutes a key defining factor for their availability in some countries.

Type of EE Technology	Purpose	Application
Hull coating	Reducing or eliminating marine growth in the hull through hull cleaning and anti-fouling paints eliminates friction of the hull through the water.	Normally applied in dry-dock facilities.
Bow optimization	This reduces the slamming of the waves increasing effectiveness of the propulsion system.	Retrofitting of this technology is be done in a shipyards.
Air lubrication	By injecting and maintaining a thin of bubbles in the underwater part of the hull, friction of through the water is reduced.	New technology still under test. It requires a purpose built air compressor, thus more likely to be used in new buildings.
Rudder efficiency	These are measures that can be retrofitted to reduce the drag and effects of the backwash motion of the propeller on the rudder.	It could be retrofitted to exiting ships, but it should be done in dry-dock.
Autopilot	Servicing of autopilots helps maintaining the vessels in route reducing wastage by failing to maintain the intended track.	Service can be provided alongside.
Propeller efficiency	These are technologies to increase the efficiency of the propeller (duct around propeller increases inflow) or to utilize the motion produce by the backwash flow of the propeller.	It could be retrofitted to exiting ships, but it should be done in dry-dock.
Tuning & optimization of ship´s propulsion systems	This is normally concerned with the rate of fuel injection to optimize the combustion per stroke.	This maintenance and tuning of engine to maintain combustion and fuel injectors within design characteristics can be done at shipyards and repair facilities.
Wind power	This technology is aimed at providing supplementary power to the ship, thus reducing fuel consumption.	It is a proven technology, however, it could require complex retrofitting of masts and rigging, presenting conflicts with, among others, designated cargo areas.
Solar power	Through this technology power is generated on board ships. The power generated is then used for feed systems, thus reducing the fuel consumption.	It is a proven technology, however, providing the on board area required for panels capable of powering main or auxiliary systems, continues to be a challenge.
Waste heat recovery systems	Exhaust gasses can be used to generate steam or electrical power, thus reducing fuel requirements in engines and auxiliary machinery.	Could be retrofitted to existing ships, but requires large investment and particular knowhow.
Ship operational data integration systems	Ship operational data integration systems combine data collected from sensors to present information on	Considered to be at an experimental stage, requires the retrofitting of

	rudder, hull, propeller and propulsion performance, as well trim condition, environmental forecast for real time decisions to improve ship energy and operational efficiency.	sensors. It is more likely to be used in newer ships.

It is important to mention that during the visits, it was common to note that a number of the interviewees could not clearly identify differences between ship energy efficiency technologies and other common ship maintenance and cost-saving operational practices. This suggests that the concept of energy efficiency as a means to optimize the use of energy in routine ship operation has not been fully internalized yet by some practitioners in both, shipping companies and in the ship building / repair industry.

5.1. Ship energy efficiency technology in Chile

The Chilean merchant fleet consists of 33 ships of international navigation. These ships include tankers (chemical, oil and gas carriers), bulk carriers and general cargo, travelling mainly from Chile to Colombia, Brazil, the Gulf of Mexico and Houston.

The main shipyard in the country is *Astilleros y Maestranzas de la Armada* (ASMAR), a state corporation belonging to the Ministry of Defense that carries out ship building, maintenance, transformation and repair work on vessels of the Chilean Navy close to 80% of its operational time. With its remaining resources, ASMAR offers services to national and foreign vessels. ASMAR provides shipbuilding services to the Chilean Navy and to third parties, mainly for the construction of smaller ships like tug boats and research vessels. It has three operational locations. The largest is located in Talcahuano and has capacity for new constructions up to 50,000 dtw and for ship repair up to 96,000 dtw. ASMAR Talcahuano maximizes the use of energy by incorporating thermal energy technology, as well as energy recovery equipment as measures to contribute to the reduction of carbon footprint with capacity and repair up to 96,000 dtw. The main ship maintenance services available include hull cleaning and painting, maintenance of main engine and auxiliary machinery and maintenance and repair of ship propellers. ASMAR´s other two plants are located in Valparaiso and Magallanes in Punta Arenas. These are smaller outlets and currently offer much more limited ship energy efficiency services; however, within their plans are to increase their energy efficiency services in line with the requirements of Annex VI of the MARPOL Convention.

The second largest shipyard is *Astilleros y Servicios Navales* (ASENAV) located in Valdivia, which also has three industrial locations totaling close to 128,000 m^2. ASENAV has ship building capability for smaller vessels and offers ship repair services to Chilean and foreign flag vessels. Other ship repair facilities include *Sociedad Iberoamericana de Reparaciones Navales Ltda*. (SOCIBER), *Astilleros CONAVRE*, both in Valparaíso, and Astilleros CONAV, S.A. in Valdivia. There are other smaller providers whose services are either geared towards recreational and fishing vessels or act as subcontractors to larger shipyards.

5.1.1 Technology available

A comparison between existing ship EE technologies and EE services available in the country suggests that some EE technologies are available in Chile either in the standard menu of services or on request or project basis. These technologies are related to hull coating, bow optimization, automatic pilot, rudder and propeller efficiency, as well as services for the optimization of propulsion systems. The following table indicates the range of ship EE technologies available in Chile.

Type of EE Technology	Availability	Comments
Hull coating	Yes	Available as part of routine maintenance of the hull
Bow optimization	Yes	It is available as an engineering project, but only on demand. The size of dry-dock facilities is a major limitation.
Air lubrication	No	It is not available, as it is normally installed in new buildings or as part of a major modification. The main shipyard does not have the capacity to build large merchant ships.
Rudder efficiency	Yes	There is the technology and know-how, but is available on demand. The size of dry-dock facilities is a major limitation.
Autopilot	Yes	Available in shipyards and other repair facilities.
Propeller efficiency	Yes	There is the technology and know-how, but is available on demand. The size of dry-dock facilities is a major limitation.
Tuning & optimization of ship´s propulsion systems	Yes	Available in shipyards, floating dry-docks and alongside.
Wind power	No	Not offered.
Solar power	No	Not offered.
Waste heat recovery systems	No	Not offered, although there is the technical know-how to undertake a project of this nature.
Ship operational data integration systems	No	Not offered.

5.2. Ship energy efficiency technology in Colombia

The Colombian merchant fleet has approximately 120 vessels, mostly tugs and some small general cargo vessels. Currently, Colombia has no ships engaged on international trade to which the provisions of Annex VI of the MARPOL Convention apply.

The main shipyard in Colombia is the *Corporación de Ciencia y Tecnología para el Desarrollo de la Industria Naval Marítima y Fluvial* (COTECMAR), which also conducts scientific and technological research. It is estimated that COTECMAR offers more than 75% of its services and resources to the Colombian Navy and government projects, with the remaining time offered to merchant ships and fishing vessels. Its services include design and construction of small vessels, as well as the customary ship maintenance and repair services such as hull cleaning and painting, and electric motors and diesel engines repair and maintenance. COTECMAR has two main industrial facilities located in Mamonal and Bocagrande, with dry-dock capacities of up to 3600 tons and 1200 tons, respectively. Regarding ship EE services, COTECMAR conducts research on hull optimization and energy efficiency on ship refrigeration systems. Although COTECMAR could be in a position to offer a larger base of ship EE services for new buildings and existing ships, this would require a substantial modification and investment in its facilities. To this end, COTECMAR is currently presenting an investment project proposal to introduce 15,000 GRT floating dock in its main facilities.

In addition to COTECMAR, the ASTIVIK Shipyard has four small dry-docks for the construction, maintenance and repair of smaller ships, while *Astilleros y Talleres Navales e Industriales de Colombia* (ASTINAVES) has a freshwater dock to attend the demands of river and inland crafts. All three shipyards are located in the Cartagena area. Smaller subcontractors and service providers include *Astilleros Unidos, S.A.* (AUSA) in Barranquilla on servicing motorboats.

5.2.1 Technology available

Our analysis indicates that interested parties can get the following ship EE services on request in Colombia: hull coating, automatic pilot, rudder and propeller efficiency, as well as services for the optimization of propulsion systems. The size of the dry-dock facilities constitute a limitation for interested vessels.

Type of EE Technology	Availability	Comments
Hull coating	Yes	Available as part of routine maintenance of the hull
Bow optimization	No	Not offered. The size of the dry-dock is a limitation.
Air lubrication	No	It is not available, as it is normally installed in new buildings or as part of a major modification. The main shipyard does not have the capacity to build large merchant ships.
Rudder efficiency	Yes	There is the technology and know-how, but is available on demand.
Autopilot	Yes	Available in shipyards and other repair facilities.
Propeller efficiency	Yes	It is available as an engineering project, but purely on demand. The size of dry-dock facilities is a major limitation.
Tuning & optimization of ship´s propulsion systems	Yes	Available in shipyards, floating dry-docks and alongside.
Wind power	No	Not offered.
Solar power	No	Not offered.
Waste heat recovery systems	No	Not offered.
Ship operational data integration systems	No	Not offered.

5.3. Ship energy efficiency technology in Honduras

Honduras has a small number of vessels trading internationally under its ship registry. This number is estimated to be close to five ships needing to comply with the provisions of Annex VI of the MARPOL Convention, namely ro-ro and general cargo vessel trading to the United States of America. While the national fleet is mainly composed of small general cargo ships, fishing boat and recreational vessels, local ports receive a number of foreign vessels bringing cargo and passengers to the country.

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The ship building and repair industry is not strong, thus the demand for EE measures is not high. Currently, Honduras has two shipyards. The Roatan Shipyard located in the Island of Roatan has a crane capable of lifting a 300-ton vessel out of the water for general repairs and maintenance, tank cleaning and hull cleaning and painting, while La Ceiba Shipyard & Marina, located in the U.S. Yachts' Marine Free Zone, provides only on-site maintenance and repair services to recreational vessels in transit.

5.3.1 Technology available

There is very limited ship EE technologies available through local facilities to vessels in Honduras, namely hull cleaning and coating, conventional autopilot technology and engine optimization, all for small vessels.

Type of EE Technology	Availability	Comments
Hull coating	Yes	Available as part of routine maintenance of the hull for smaller vessels. Ship lifting capacity is a major limitation.
Bow optimization	No	Not offered. Size of the dry-dock is a limitation.
Air lubrication	No	It is not available, as it is normally installed in new buildings or as part of a major modification. The main shipyard does not have the capacity to build large merchant ships.
Rudder efficiency	No	Not offered.
Autopilot	Yes	Available in certain repair facilities.
Propeller efficiency	No	Not offered.
Tuning & optimization of ship´s propulsion systems	Yes	Available for smaller ships.
Wind power	No	Not offered.
Solar power	No	Not offered.
Waste heat recovery systems	No	Not offered.
Ship operational data integration systems	No	Not offered.

5.4. Ship energy efficiency technology in Panama

Panama´s case is singular in the region. Panama has registered under its flag the largest international fleet in the world (about 18% of the world´s fleet), but at the same time, the great majority of those vessels do not have operational links with the country, as they are manned and operated from overseas locations. On the other hand, there is high a traffic of merchant marine vessels transiting through the Panama Canal, resulting in a large market for the ship repair and maintenance industry, including ship EE technology.

It could be argued that the ship repair facilities in Panama are among the top providers in the Latin American region because of the size of the dry-dock facilities and the know-how. The main shipyard is MEC Shipyards, with two large facilities, the first of which is located at the Pacific entrance of the Panama Canal. The yard includes three dry-docks for vessels up to Panamax size, with 12,000 m^2 of workshops. The main ship repair and maintenance services available include hull cleaning and painting, maintenance of main engine and auxiliary machinery and maintenance and repair of ship propellers. The

second location is in Veracruz, East of Balboa. This facilities has a slipway (100 meters in length and 25 meters in beam) for up to 2,000 light ship tons of weight.
Other ship repair facilities include the Astillero Nacional, S.A. located in the fishing port of Vacamonte (240 Ton shiplift) providing services to yachts, fishing, tugs coast guard ships and small cargo vessels. The Astilleros Bayano and Juan Díaz, in Coquira and Juan Díaz, respectively, offer repair options for wooden, fiber glass and steel local vessels.

5.4.1 Technology available

Out of the four countries, Panama is the one offering the best option for traditional ship EE alternatives and the best facilities in terms of location and size (up to Panama Canal size). It is common that ships from the neighboring countries send their merchant fleet to Panama for their statutory dry-dock and hull maintenance. This in turn positions the facilities in Panama as one of the better suited to offer ship EE technologies in the region. The following table presents the technologies available in this country for vessels of up to Panamax size.

Type of EE Technology	Availability	Comments
Hull coating	Yes	Available as part of routine maintenance of the hull
Bow optimization	Yes	Available on demand.
Air lubrication	No	Not available, as it is normally installed in new buildings or as part of a major modification.
Rudder efficiency	Yes	Available on demand.
Autopilot	Yes	Available in shipyards and other repair facilities.
Propeller efficiency	Yes	Available on demand.
Tuning & optimization of ship´s propulsion systems	Yes	Available on demand.
Wind power	No	Not offered.
Solar power	No	Not offered.
Waste heat recovery systems	No	Not offered.
Ship operational data integration systems	No	Not offered.

6. Conclusions and recommendations

6.1. Group exercise: Barriers and opportunities

It seems clear from the group exercise that there is not enough information to reach conclusions as to the significance and impacts of key barriers and opportunities, including technology availability in particular countries or sub-regions. To address these issues, the MTCC Latin America proposed an in-depth study on the barriers and constraints for the adoption of ship energy efficiency in the region, utilizing a case study approach to extrapolate and identify lessons learned. In addition, as a result of the group exercise in March 2018, the MTCC Latin America has refocused the content of its national workshops to address important aspects such as awareness raising among key industry players of the relevance of ship energy efficiency measures, ship EE technologies and the EE services provided by the local shipyards.

Finally, is was interesting to note that “availability of ship EE technology” did not come out at the top of neither a limitation, nor as an opportunity. This may be related to a perceived underrepresentation in the group exercise of the ship operators and ship building / repairs sectors.

6.2. Ship energy efficiency technology in the region

Clearly, the gaps between new EE technologies and the technology or measures available in the selected countries in Latin America revolves around how novel the technology is, and the cost of investment required to make it available to potential users. The majority of technologies available in the region are, comparatively speaking, mature low capital intensive technologies, which are in one way or another already well established as part of other ship operational maintenance, such as hull coating, rudder and propeller efficiency, autopilot and optimization of ship´s propulsion systems. It could also be noted that most of this technologies are designed to address efficiencies related hull resistance through the water and the optimization of propulsion forces.

Type of EE Technology	Chile	Colombia	Honduras	Panama
Hull coating	Yes	Yes	Yes	Yes
Bow optimization	Yes	No	No	Yes
Rudder efficiency	Yes	Yes	No	Yes
Autopilot	Yes	Yes	Yes	Yes
Propeller efficiency	Yes	Yes	No	Yes
Tuning & optimization of ship´s propulsion systems	Yes	Yes	Yes	Yes

On the other hand, newer more costly energy efficiency technologies such as those addressing new energy generation sources, integrating ships´ operational information for real time energy efficiency informed decisions, or related to gaining benefits from the more complex usage of wasted energy, are not yet either widely demanded or provided in Latin America. See table below

Type of EE Technology	Chile	Colombia	Honduras	Panama
Air lubrication	No	No	No	No
Wind power	No	No	No	No
Solar power	No	No	No	No
Waste heat recovery systems	No	No	No	No
Ship operational data integration systems	No	No	No	No

The availability and use of ship energy efficiency technology in the Latin American region show general patterns as follows:

a. International shipowners and ship operators in open registries tend to obtain ship technology, repair services and crew from the international market, reducing their dependence or attachments to the country where they have their vessels registered;

b. Latin America currently is not a power house in terms of the development of new ships, thus innovative ship energy efficiency technology is normally acquired overseas;
c. The ship repair industry largely provides services to national fleets, through a small number of local shipyards equipped to satisfy the demands received from smaller coasters and fishing vessels;
d. Due to predominance in numbers of navy ships compared to merchant vessels, in South America national shipyards tend to be either run by or associated with the countries´ navy. This fact has a direct impact on the time allocated to ship repair projects for non-navy clients;
e. It could be argued that the supply or availability of ship EE technologies is influenced by their regional demands and the level of maturity and acceptance of the EE technology itself;
f. Finally, the more commonly found ship energy efficiency technologies available are seen as part of routine maintenance of vessels, namely:
    - Hull maintenance and coating to optimize hull resistance
    - Propeller efficiency and conditions
    - Tuning and maintenance of ship´s propulsion systems
    - Servicing of rudder and control systems (auto pilots)
    - Maintenance of insulation piping and systems

    On the other hand, there are other ship energy efficiency technologies not readily available in the region; however, they could be considered on particular demands from clients and subject on availability of parts and expertise. These technologies are:

    - Waste heat recovery systems
    - Data integration and sharing systems to improve ship performance
    - Power generation from renewable sources (solar and wind sources)
    - Maintenance/ installation of systems to enable shore-based power supply

6.3. Recommendations

The countries chosen in this review do represent the prevalent availability of ship EE technology in the Latin American region. As mentioned earlier, it was also evident during this review that for practitioners, including ship service providers, measures to improve ship energy consumption are introduced primarily to control operational costs. The more basic of these technologies are available in the region. To address the issue of the practitioners´ traditional mindset, actions to further raise awareness, training and research are recommended. To this end, the following table summarizes the relevant actions recommended by the MTCC in Latin America, taking into consideration the timeline of the project.

Recommended Action	Barrier Addressed	Opportunity Promoted	Target Date
Pilot study to understand what particular barriers and opportunities are present to promote ship energy efficiency	- Increase understanding of the constraints and opportunities around ship energy efficiency	- Increase awareness on ship energy efficiency among the key parties interviewed.	2018-2019
Focus content of national workshops to increase awareness and understanding of international legislation and energy efficiency technology alternatives.	- Increase environmental awareness within the industry - Promote regulatory framework on energy efficiency - Disseminate information regarding ship EE technology available - Promote research and development on ship EE technology	- Increase knowledge on ship energy efficiency international legislation and guide national regulations - Expose members of the industry to ship energy efficiency technologies and best practices	2018-2019
Further explore project ideas to be implemented post 2019	- Promote regulatory framework on energy efficiency	- Help particular countries implement regulations and best energy efficiency practices in their fleets	Post 2019 (second phase of the GMN Project)

ANNEX I –Organizations participating in the First Regional Workshop

Prefectura Naval Argentina, Argentina

Direccion General de Intereses Marítimos, Fluviales, Lacustres y Marina Mercante, Bolivia

Directoria de Portos e Costas, Brasil

Dirección General Marítima, Colombia

Ministerio de Obras Públicas y Transporte, Costa Rica

Subsecretaría de Puertos y Transporte Marítimo y Fluvial, Ecuador

Direccion Nacional de Espacios Acuáticos, Ecuador

Autoridad Marítima Portuaria de El Salvador

Ministerio de Defensa Nacional, Guatemala

Dirección General de la Marina Mercante, Honduras

Secretaría de Marina, México

DIrección General de Transporte Acuático, Nicaragua

Autoridad Marítima de Panamá, Panamá

Universidad Marítima Internacional de Panamá, Panamá

Panama Shipping Registrar, Panamá

Panama Maritime Documentation Services, Panamá

Autoridad del Canal de Panamá, Panamá

Pole Star, Panamá

Armada Paraguaya, Paraguay

Dirección General de Capitanías de Puerto y Guarda Costas, Perú

Lamor Environmental Solutions, Panamá

ANNEX II –Report by IMO Consultant- Regional Workshop

BARRIERS AND OPPORTUNITIES

in the

LATIN AMERICAN REGION

I. Introduction

The first regional workshop organized by the Maritime Technology Cooperation Center for Latin America (MTCC Latin America) was conducted at Panama City, Panama from 13 to 15 March 2018. It had a total of 55 participants including presenters. The following categories were represented at the workshop: government agencies, higher education institutions, recognized organizations, MTCC Latin America, ports and their related activities, and other industry services.

MTCC Latin America was able to collect limitations and opportunities affecting the region directly from the attending representatives from the different countries during the group dynamic to determine barriers and opportunities, and plan future capacity building activities. The group was divided into four sub-groups and each group represented a sub-region within Latin America. Having the disaggregated data of sub-groups of neighboring countries provides a second tier of information to be analyzed.

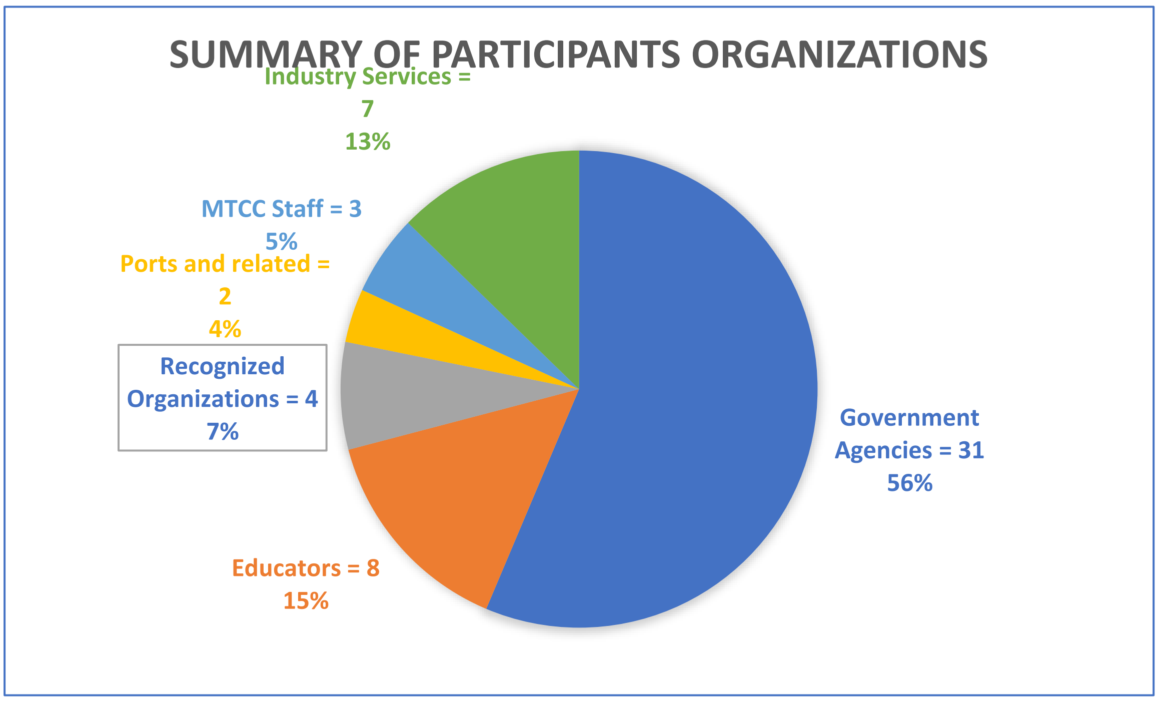
The limitations and opportunities were identified as political, economic, social, technological, environmental, and legal. A list of factors for each category was provided and it has been included as appendix I to this report.

II. Participants

The summary of participants per category is as follows:

1. thirty-one (31) participants from fourteen (14) government agencies: two (2) from each visiting country of the region and five (5) from the host country. Visiting countries included: Argentina, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Paraguay, and Peru. Chile, Uruguay and Venezuela did not attend.
2. eight (8) participants from higher education institutions: seven (7) from the International Maritime University of Panama (UMIP) and one (1) from the World Maritime University (WMU).
3. four (4) participants from recognized organizations: (1) from Lloyd’s Register of Shipping (LRS), one (1) from Nippon Kaiji Kyokai (NKK), one (1) from Panama Maritime Documentations Services (PMDS), and one from Panama Shipping Registrar (PSR).
4. three (3) participants from MTCC Latin America: head, project officer and administrative assistant.
5. two (2) participants from ports and their related activities: one (1) from Manzanillo International Terminal (MIT) and (1) from the Panama Canal Authority (ACP).

6. seven (7) participants from other sectors not identified above: three (3) from Polestar, two (2) from Syndeseas Integrated Solutions, one (1) from Lamor Environmental Solutions, and one (1) Consultant from IMO



III. Collection of Data

The workshop included a group dynamic which was conducted on 15 March 2018. The group was divided into 4 sub-groups and it was decided to pre-arrange the sub-groups to balance the categories of participants within each sub-group. The criteria consisted on having at least one (1) signatory Party to MARPOL Annex VI, at least one (1) participant from a higher education institution, and at least one (1) participant from a recognized organization in each sub-group. Participants from government agencies of non-signatory Parties to MARPOL Annex VI were distributed based on the geographic location of their countries attempting to group neighboring delegations. The rest of participants were distributed to have approximately the same number of participants in each sub-group

Sub-group 1	Sub-group 2	Sub-group 3	Sub-group 4
Brazil (2)(P)	Guatemala (2)(P)	Panamá (5)(P)	Perú (2)(P)
Argentina (2)	Honduras (2)(P)	Mexico (2)	Bolivia (2)
Paraguay (2)	Nicaragua (2)	Costa Rica (2)	Ecuador (2)
Syndeseas (2)	El Salvador (2)	UMIP (1)	Class NK (1)
UMIP (1)	PSR (1)		UMIP (2)
	Lamor (1)		
Total = 9	Total = 10	Total = 10	Total = 9

Note 1: The number in parenthetical, e.g. (2), represents the number of participants from the delegation.

Note 2: (P) stands for signatory to MARPOL Annex VI.

Note 3: Mexico was added to sub-group 3 because Colombia was not able to participate in the activities.

The objectives of the group dynamic were:
- Identification of Limitations and Opportunities
- Prioritization of Limitations and Opportunities identified during the first activity
- Possible future activities by MTCC Latin America

The dynamic consisted of three activities. The first activity was to create lists of limitations and opportunities using the coded factors attached to the pre-workshop questionnaire distributed to the participants during registration on 13 March 2018. The second activity consisted on prioritizing the limitations and opportunities factors which resulted from the first activity. The third activity was to determine the participants' preferences as far as desire future activities to be conducted by MTCC Latin America

a. First Activity

Upon formation of the sub-groups, the factors identified in the pre-workshop questionnaire by each participant were counted to determine those with the highest frequencies for each category. In this particular case, only the top three (3) factors from each category (political, economic, social, technological, environmental, and legal) were transferred to the final list for a total of eighteen (18) factors. The same process was carried out to identify the opportunities and a total of nineteen (19) factors were transferred to the final opportunities list. The list of opportunities contains one additional factor because there were two (2) social factors tied for third place. The activity collected disaggregated data at the sub-group level for future reference.

b. Second Activity

Utilizing the two (2) lists prepared during the first activity, the sub-groups proceeded to prioritize each factor using a two-step approach methodology. During the first step, each sub-group had to identify the impact level assigning either a one (1) for *Major* or a two (2) for *Minor*. For the second step, each sub-group had to identify the complexity or simplicity of the process to overcome the limitation or to exploit the opportunity by assigning (S) for *Simple* or (C) for *Complex*. The combination of the impact and feasibility of the process resulted in the priority for each factor and possible timeframe to act on them as defined in the legend below. Each individual factor was assigned a priority based on its own merit not compared to the other factors.

Legend	
Impact	1 = Major
	2 = Minor
Process	S= Simple
	C= Complex
Priority	1S = **Act (High)**
	1C = **Plan Short Term (Medium High)**
	2S = **Plan Medium Term (Medium Low)**
	2C = **Plan Long Term (Low)**

Estimated time frames:

High = not more than 12 months

Medium High = more than 12 months but not more than 36 months

Medium Low = more than 36 months but not more than 60 months

Low = more than 60 months

A final priority was assigned at the group level only when three (3) or more sub-groups had assigned the same combination. If only either the same impact or feasibility of the process was assigned by three (3) or more groups, then either the impact or the feasibility of process was reflected in the results. For factors with less than three (3) common assignments, the results were considered *undefined*.

c. Suggestions for Future Activities

A poll was taken after the completion of the two activities to seek the suggestions from all sub-groups for future activities and/or actions for MTCC Latin America.

IV. Results

For the purpose of this section, the sub-groups have been identified as sub-regions based on the geographical location of the countries that were represented in the sub-group:

Sub-group	Sub-region	Government Agencies Represented
1	Southeast	Brazil, Argentina, Paraguay
2	North	Nicaragua, Guatemala Honduras, El Salvador
3	Central	Panama, Mexico, Costa Rica
4	Southwest	Peru, Bolivia, Ecuador

1. Limitations

The table labelled "*Limitations*" includes the 18 factors with the highest frequencies identified during the first activity of the group dynamic; the top 3 factors from each category (political, economic, social, technological, environmental, and legal) were transferred to create the list. The frequencies and priorities in the table reflect the final decision of the group based on the methodology defined in section III (a) and (b).

The six factors with the highest frequencies have been listed below and the top three shaded in the table labelled "Limitations", with the darker shade indicating the factor with the highest frequency:

(i) environmental awareness (S2) with 31 occurrences,

(ii) public expenditure (E5) with 28 occurrences,

(iii) price of energy efficiency technology (E1) with 24 occurrences,

(iv) lack of regulations on energy efficiency (L2) with 24 occurrences,

(v) attitudes towards "green" or ecological products (A6) with 23 occurrences, and,

(vi) international regulations governing the subject have not been ratified (L3) with 23 occurrences.

a) Social Factor: Environmental Awareness (S2) - 31 occurrences

Despite having the highest frequency, the group could only agree that the factor has a *Major Impact Level* for the region but could not agree with the feasibility of the process. The table below summarizes the disaggregated data collected during the second activity by sub-region.

Sub-region	Impact	Process	Priority
Southeast	Major (1)	Complex (C)	1
North	Major (1)	Complex (C)	1
Central	Major (1)	Simple (S)	1
Southwest	Major (1)	Simple (S)	1

The next step in the process could be the investigation of the discrepancy by neighboring regions: Southeast versus Southwest, and North versus Central.

(b) Economic Factor: Public Expenditure (E5) - 28 occurrences, and Price of Energy Efficiency Technology (E1) with 24 occurrences

These were identified by the group as the highest economic factors affecting the region, and the second and third overall barriers, respectively. It appears that the group is concerned with low budgets from governments assigned to improve energy efficiency as well the high price of the technology. Both factors were assigned priority "1C" (*Major* impact/*Complex* process).

(c) Technological Factor: Basic Infrastructure Level (T1) – 22 occurrences

The highest technological factor was seventh overall behind social, economic, legal and environmental factors. This category finished only ahead of political factors. This confirms that the main barrier for the region are Socio-Economic factors.

Limitations			Frequency	Priority
1	P3	Bureaucracy	19	1C
2	P9	Environmental protection policy	17	1*
3	P10	Regulation / deregulation (national, regional and international)	13	1C
4	E1	Price of energy efficiency technology	24	1C
5	E2	Lack of credit sources for energy efficiency initiatives	19	C*
6	E5	Public expenditure	28	1C
7	S2	Environmental awareness	31	1*
8	S4	Awareness of health, welfare and safety	19	1*
9	S17	Attitude towards innovation	15	Undefined
10	T1	Basic infrastructure level	22	1C
11	T3	Research and development costs	20	1C
12	T5	Availability of technology energy efficiency	20	1C
13	A5	Waste management	21	1C
14	A6	Attitudes towards "green" or ecological products	23	2*
15	A8	Attitudes and support for renewable energy	21	2C
16	L2	Lack of regulations on energy efficiency	24	1C
17	L3	International regulations governing the subject have not been ratified	23	1C
18	L9	Environmental Law	21	1C
		Average Frequency =	21.11	

*Only either the impact level or feasibility of the process was assigned at the group level

Five (5) factors were assigned only either impact level or feasibility of the process, and one (1) factor was assigned *undefined*, for a total of 6 factors without an assigned priority.

2. Opportunities

The table labelled "Opportunities" includes the 19 factors with the highest frequencies identified during the first activity of the group dynamic; the top 3 factors from each category (political, economic, technological, environmental, and legal) and the top 4 factors from the social category were transferred to create the list. The frequencies and priorities in the table reflect the final decision of the group based on the methodology defined in section III (a) and (b).

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The five factors with the highest frequencies have been listed below shaded, and the top three shaded in the table labelled “Opportunities”, with the darker shade indicating the factor with the highest frequency:

(i) attitudes towards "green" or ecological products (A6) with 23 occurrences,

(ii) attitudes and support for renewable energy (A8) with 23 occurrences,

(iii) government participation in regional / international agreements (P12) with 21 occurrences.

(iv) law regulating environmental pollution (prevention and control) (L13) with 20 occurrences, and,

(v) environmental awareness (S2) with 19 occurrences

(a) Environmental Factors: Attitudes Towards "Green" or Ecological Products (A6) - 23 occurrences, and Attitudes and Support for Renewable Energy (A8) - 23 occurrences.

The group identified two environmental factors as the greatest opportunities for the region. However, despite having the highest frequencies, the group could only agree that the factors have *Minor Impact Level* for the region but could not agree with the feasibility of the process. The tables below summarize the disaggregated data collected during the second activity by sub-region for each factor.

Environmental Factors: Attitudes Towards "Green" or Ecological Products (A6)			
Sub-region	**Impact**	**Process**	**Priority**
Southeast	Minor (2)	Simple (S)	2
North	Minor (2)	Simple (S)	2
Central	Minor (2)	Complex (C)	2
Southwest	Minor (2)	Complex (C)	2

Attitudes and Support for Renewable Energy (A8)			
Sub-region	**Impact**	**Process**	**Priority**
Southeast	Minor (2)	Simple (S)	2
North	Minor (2)	Complex (C)	2
Central	Minor (2)	Simple (S)	2
Southwest	Minor (2)	Complex (C)	2

The most commonly known economic factor, Recycling (A4), was not recognized by the group as one of the top opportunities. However, it was recognized that is of *Major Impact.*

(b) Social Factor: Environmental awareness (S2) - 19 occurrences

This factor, which was identified by the group as the greatest, has also been identified as a top 5 opportunity to improve the energy efficiency capacity of the region. The discouraging aspect, perhaps, could be that the factor as an opportunity was considered of *Minor Impact.* The other social factors included in the table below received two of the three lowest frequencies. This reflects the opinion of the group that there are limited opportunities behind the social factors to rapidly educate and progress towards the conservation and sustainability of the environment.

Opportunities			Frequency	Prioritization
1	**P1**	Stability of the government and probable changes	10	2C
2	**P9**	Environmental protection policy	16	1*
3	**P12**	Government participation in regional / international agreements	21	1C
4	**E1**	Price of energy efficiency technology	10	2C
5	**E13**	Credit availability	16	Undefined
6	**E14**	Trade flows and patterns	10	2*
7	**S2**	Environmental awareness	19	1S
8	**S3**	Education Level	11	1*
9	**S4**	Awareness of health, welfare and safety	11	1*
10	**S12**	Attitudes and support for renewable energy	12	1*
11	**T4**	Technological incentives	16	1*
12	**T6**	Knowledge about energy efficiency technology	12	Undefined
13	**T8**	Alternative fuel availability	14	1*
14	**A4**	Recycling	17	1C
15	**A6**	Attitudes towards "green" or ecological products	23	2*
16	**A8**	Attitudes and support for renewable energy	23	2*
17	**L3**	International regulations governing the subject have not been ratified	16	1C
18	**L9**	Environmental Law	18	1C
19	**L13**	Law regulating environmental pollution (prevention and control)	20	1C
		Average Frequency =	15.53	

*Only either the impact level or feasibility of the process was assigned at the group level

Eight (8) factors were assigned only either impact level or feasibility of the process, and two (2) factors were assigned *undefined*, for a total of 10 (more than half of the opportunities) factors without an assigned priority.

3. Suggestions for Future Activities

The two (2) suggestions for future activities with the highest frequencies were the *Development capabilities on energy efficiency* and *Promotion of energy efficiency technology*, which are aligned with the mission of the Center.

Conclusions and Recommendations

1. Results

The group dynamic produced lists of 18 limitations and 19 opportunities of political, economic, social, technological, environmental and legal factors.

The limitation *Environmental Awareness* (S2), which is a social factor, was the factor with the highest frequency of the entire group dynamic and the list of limitations with 31 occurrences. However, the group was not able to assign a priority as it could only agree on a *Major* impact level but not the feasibility of the process. The following three limitations with higher frequencies were *Public Expenditure* (E5), an economic factor, with 28 occurrences, *Price of Energy Efficiency Technology* (E1), another economic factor, with 24 occurrences, and *Lack of Regulations on Energy Efficiency* (L2), a legal factor, with 24 occurrences. This last factor ties directly to the IMO's strategy to develop regulations for a sustainable maritime industry.

The top three opportunities were *Attitudes Towards "green" or Ecological Products* (A6) and *Attitudes and Support for Renewable Energy* (A8), both environmental factors with 23 occurrences, followed by *Government Participation in Regional / International Agreements* (P12), a political factor, with 21 occurrences. The group determined that the process to exploit the top two opportunities, *Attitudes Towards "Green" or Ecological Products* (A6) and *Attitudes and Support for Renewable Energy* (A8) is *Simple*. However, it could not agree on the impact level for them.

With regard to the suggestions for future activities, the group found that the *Development of capabilities on energy efficiency* and *Promotion of energy efficiency technology* had the two highest frequencies, which are aligned with the purpose of MTCC Latin America.

2. Analysis

Based on the results, as expected, it seems that the group is more aware of the limitations than the opportunities of the region considering that the factor with the highest number of occurrences for the entire exercise was a limitation. Furthermore, the top 6 limitations have higher or the same frequency as the top opportunity identified by the group. Also, the average frequency for the limiting factors is almost 6 occurrences higher than the average of the opportunity factors, which indicates a wider spread for the latter. The disaggregated information of the sub-groups was kept by MTCC Latin America for further analysis to identify the best possible opportunities to improve the condition of the region, if necessary.

3. Recommendations

It is my recommendation to use the two tables to direct future activities. The top limitation reflects the lack of environmental awareness. Therefore, presentations similar to those delivered during the second day of the workshop dealing with energy efficiency should be repeated during future seminars to raise awareness of the initiatives being pursued in the maritime industry. This recommendation connects directly with the two top opportunities which are environmental factors. Perhaps, presentations specifically dealing with hydrogen cells, wind farms, super capacitors, and Lithium batteries could be added to the program.

With regard to the third top opportunity, it is my understanding that ratification and implementation of MARPOL Annex VI falls within this factor. During this seminar, there was a group discussion relative to whether the reference to a footnote is mandatory and it was clarified that only IMO Resolutions within the text of the regulation are mandatory. The group also discussed several scenarios relative to the application of MARPOL Annex VI Regulation 13, which is not part of chapter 4. Additionally, inquiries relative to the issuance of the Engine International Air Pollution Prevention Certificate and completion of the Supplement to the International Air Pollution Prevention Certificate among others were raised. Including MARPOL Annex VI requirements, such as methodology to collect fuel oil consumption data and the implementation of the Sulphur limit regulations, in future seminars would provide an opportunity to clarify issues relative to the basic application of MARPOL Annex VI regulations and the implementation of those regulations. In this regard, my recommendation is to maintain MARPOL VI requirements as part of future seminars to provide the same baseline provided during the first regional seminar.

Based on the 4 sub-regions discussed in section IV above, in my opinion, it would be beneficial to invite neighboring countries of the hosts of the national workshops.

APPENDIX I

FACTORS

Political		Social	
P1	Stability of the government and probable changes	**S1**	Health awareness
P2	Labor stability	**S2**	Environmental awareness
P3	Bureaucracy	**S3**	Education Level
P4	Corruption level	**S4**	Awareness of health, welfare and safety
P5	Fiscal policy	**S5**	Attitudes towards imported goods and services
P6	Tax regime	**S6**	Attitudes towards work and career
P7	Social welfare policy	**S7**	Attitudes toward product quality and customer service
P8	Health and safety policy	**S8**	Attitudes towards saving and investment
P9	Environmental protection policy	**S9**	Emphasis on safety
P10	Regulation / deregulation (national, regional and international)	**S10**	Lifestyles
P11	Commercial control	**S11**	Attitudes towards "green" or ecological products
P12	Government participation in regional / international agreements	**S12**	Attitudes and support for renewable energy
P13	Intellectual property / patent policy	**S13**	Population growth rate
P14	Consumer protection policy and electronic commerce	**S14**	Rates of immigration and emigration
P15	Other (please specify)	**S15**	Age distribution and life expectancy rates
		S16	Average level of disposable income
		S17	Attitude towards innovation
		S18	Other (please detail)
Technological		**Environmental**	
T1	Basic infrastructure level	**A1**	Climatic factors
T2	Technological change rate	**A2**	Climate change
T3	Research and development costs	**A3**	Air and water pollution
T4	Technological incentives	**A4**	Recycling
T5	Availability of technology energy efficiency	**A5**	Waste management
T6	Knowledge about energy efficiency technology	**A6**	Attitudes towards "green" or ecological products
T7	Level of technology in the industry	**A7**	Endangered species
T8	Alternative fuel availability	**A8**	Attitudes and support for renewable energy
T9	Access to the newest technology		
T10	Internet infrastructure and penetration		
T11	Use and costs of energy		
T12	Other (please specify)		
Economic		**Legal**	
E1	Price of energy efficiency technology	**L1**	Intellectual property law, patents
E2	Lack of credit sources for energy efficiency initiatives	**L2**	Lack of regulations on energy efficiency
E3	Growth rates	**L3**	International regulations governing the subject have not been ratified
E4	GDP trends	**L4**	Discrepancy with other national legislations
E5	Public expenditure	**L5**	Consumer protection and electronic commerce
E6	Inflation rate	**L6**	Labor Law
E7	Types of interest rates	**L7**	Health Law
E8	Interest rates	**L8**	Data Protection Law
E9	Exchange rates	**L9**	Environmental Law
E10	Unemployment trends	**L10**	Occupational Health and Safety Law
E11	Labor costs	**L11**	Fiscal Law
E12	Stage of the commercial cycle	**L12**	Tax Law
E13	Credit availability	**L13**	Law regulating environmental pollution (prevention and control)
E14	Trade flows and patterns		
E15	Level of consumer disposable income		