COLLABORATION BETWEEN PUBLIC AND PRIVATE SECTORS TO DEVELOP SEAPORT INFRASTRUCTURE PROJECTS WITH SUSTAINABILITY DIMENSIONS.

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ABSTRACT

Post COVID 19, as countries are focusing on revival of their economies, seaport development, particularly in emerging economies is gaining importance. Also, it is of relevance that the development process is inclusive with due consideration to sustainability aspects. To wholistically analyze the sustainability aspects that can strongly contribute to conservation of marine ecosystem and the Sustainability Development Goals (SDGs), the paper analyses environmental, social, economic, technological and institutional sustainability as the key elements where there is opportunity for the public sector and the private sector to collaborate in the process of development of seaport infrastructure. In addition to the seaport authority and private operators which are the principal partners in the Public Private partnership (PPP) arrangement, the authors consider Policy Makers, Financing Institutions and Local community at the seaport as relevant stakeholders in sustainable development of seaport infrastructures. The paper is divided into three sections. The first section is centered on knowing the nuances of infrastructure development and the importance of sustainability adoption in seaports. The second section connects infrastructure development in seaports with principal partners in the PPP set up and key stakeholders that can majorly contribute to the infrastructure development of seaports with due sustainability considerations. The third section elaborates on key sustainability dimensions -environmental, economic, social, technological and institutional that can be adopted in seaports through collaboration among key public and private partners.

Keywords- Public Private Partnership, Principal Partners, Key Stakeholders, Sustainability Elements, Collaboration, Marine ecosystem, Seaport infrastructure projects.

INTRODUCTION

Infrastructure development at seaports facilitates trade and commerce between countries thereby boosting their economy. However, in the process the ecological system gets impacted if the development ignores sustainability dimensions in and around the seaports. As the pace of infrastructure development increases, there is growing need to adopt sustainability to minimize the harmful impact on the marine ecosystem. Developing economies face a dual challenge of catering to increase demand for adequate seaport infrastructure on the one hand and the need to responsibly develop this infrastructure in

line with the goals outlined in UNSDG. Consequently, governments are seeking enhanced participation of private sector and exploring concessional investment opportunities not just for development of infrastructure projects in seaport but also to have it developed with due consideration on sustainability aspects.

According to the port reform toolkit published by the Public–Private Infrastructure Advisory Facility (PPIAF) of World Bank, different port management structures are used worldwide but in the majority of large and medium sized ports the landlord port model is used.[1] The landlord port model bifurcates responsibilities between Seaport Authority and the Service Provider, the two principal partners in the PPP set up. The Seaport Authority is primarily responsible for planning, design and regulatory functions while the private sector Service Providers operators are generally entrusted to develop and operate specific terminals dedicated to handling particular types of goods. The private sector need to have the technical capabilities in developing such structures and in generally responsible for arranging financing requirements for its development. This sort of formalized relationship between the public seaport authority and the private operator defining the roles and responsibilities of each of the actors is termed as Public Private Partnership (PPP) . There is a spectrum of possible contractual arrangements between these entities. These range from relatively short-term service contracts to long-term joint venture arrangements called concession agreement. The concession agreement are thus a binding mechanism involving key stakeholders associated with infrastructure development in seaports.

INFRASTRUCTURE DEVELOPMENT AND SUSTAINABILITY

Seaport being the essence of maritime trade requires Infrastructures to facilitate the process of cargoes handling, transportation and storage. According to London Maritime academy [2], Port infrastructure is a mixture of facilities and equipment, including breakwaters, docks, cranes and other equipment. To ensure all these elements work optimally, seaports must keep them well- maintained and functional. Seaport being the essence of maritime trade requires Infrastructures to facilitate the process of cargoes handling, transportation and storage. Countries having access to seaports consider it as a very critical infrastructure for economic reasons. As defined by America's Cyber Defense Agency [3]: "Critical Infrastructure are those assets, systems, and networks that provide functions necessary for our way of life. There are 16 critical infrastructure sectors that are part of a complex, interconnected ecosystem and any threat to these sectors could have potentially debilitating national security, economic and public health or safety consequences." Seaports are part of the Marine Transportation system and are part of the 16 critical infrastructures. Therefore, the development of the infrastructure at the seaports and upkeep of the infrastructure developed can assume much significance. Infrastructure development at seaports primarily is carried out for three major reasons , which are as follows :-

- Development of new seaports – Development of new seaports have

been a constant phenomenon since the industrial revolution. Developed countries with maritime resources have witnessed rapid growth in development of seaports in the 19th century. In the current century, developing economies having access to sea are constantly exploring opportunities for development of new seaports to cater to the need emanating out of economic and demographic growth . The investment for creation of new seaport complexes at project level is usually termed as greenfield project investments . These green field projects are very capital intensive and gestation time for completion is long . New seaport development from scratch can provide opportunities to develop the infrastructure with the latest technologies and sustainability criteria can be easily integrated in the process of development . However, this is dependent on the seaport authority to specify such requirements in the concession agreement , competencies of private sector to develop it and capacity of private sector service providers to raise the needed financing for its development. Private Sector Service Providers also ensures environmental clearance from the concerned authorities for the development of a new seaport . Environmental clearance from the regulators will enable the SPV with support from its parent company to approach lenders to the projects. Financing Institutions evaluates the economic feasibility of developing the new seaport and also minutely examines the sustainability aspects particularly to ensure that the project does not negatively impact the ecosystem and adversely affect the livelihood of the local population.

- Revamping existing seaport capacities- Seaports need to continuously develop and augment their cargo handling capacity to remain competitive . Therefore, to facilitate handling of larger volume of cargo and greater number of vessels visiting the seaports, development of infrastructures at seaport becomes essential . The investment in increasing the berth and cargo handling capacity at seaports is generally referred to as brown field investment projects . To enable the visit of larger ships to the coast, capital dredging initiatives are carried out by the seaport authorities. Also, necessary modification related to the increase in cargo has to be in place . The stock yard needs to be revamped to accommodate the increased cargo, and the material handling system should be accordingly designed to handle all of the cargo. To remain competitive seaports, need to have an efficient system of providing electricity to ships while the ships are berthed, which requires the related electrification infrastructure . To improve efficiency, seaports also upgrades their manual cargo handling system to automated mechanized systems. This not only improves efficiency but also contributes to a decrease in pollution because of improved cargo handling. Therefore, any infrastructure development activities in the seaport complex has to be well planned and coordinated among

all stakeholders particularly the public Seaport Authorities and the private Service Providers. Revamping existing infrastructures with proper coordination and including sustainable elements help all the stakeholders-the Seaport Authorities, the private sector Service Providers as well as the local communities who benefit from reduction of pollution.

- Making seaport resilient to climate hazard-Seaports are increasingly being exposed to climate hazards like floods, tsunamis, hurricanes etc. With rise in sea level many of the infrastructure in the seaport are at risk of submergence. Many of the studies have predicted alarming climate events that can impact many seaports across the globe. Therefore, seaports have to continuously climate proof the infrastructure and focus on climate resilient development of infrastructures . Climate resilient measures can be having a robust early warning system, exploring nature-based solution measures to check flooding and innovative designing of new infrastructure that are planned to be developed. Other adaptation actions that seaport can adopt in engineering ,technology ,insurance , planning design and development area are as follows[4].
- Prioritizing the development of resilient structures that can withstand potential climate events like floods, tsunamis and cyclones. Exploring nature-based solutions as an alternative to conventional civil structures, that can be a full proof remedy to counter such challenges in the medium to long term.
- Long term planning to consider the future climatic threats should be made while procuring material handling equipment and systems. The likelihood period of usability of such equipment and systems can be determined through application of stress testing models.
- Climate proofing and making necessary upgradation if required to the places of storage.
- Using innovative systems to determine dredging requirement particularly capital dredging which are mostly carried out by seaports. Proper scheduling of such activity in predetermined intervals with room for accommodating exigencies can be part of the monitoring system.
- Exploring mechanization of processes where there is possibility of environmental benefits as an alternative to manual processes to increase efficiency. Systems can be improved in the areas of material handling, storage , energy generation and in cooling systems. If required existing systems can be revamped.
- Having an adequate risk mitigation strategy to counter unforeseeable accidents. Routine inspection of existing systems and having risk coverage by way of insurance if not already existing can be beneficial.
- Inhouse development of capacities of existing personnel and familiarization on sustainable aspects through trainings and workshops also are the areas seaport authorities can focus on.

The above three requirements for infrastructure development in seaports also brings forth the necessity to develop the infrastructure that will serve the purpose for a long time . The developed infrastructure should withstand the climatic hazards the occurrence of which have increased in recent times because of climate change. With the growing importance of seaports striving to be climate resilient there is increasing focus on adoption of sustainability in development of infrastructures . It has been gaining considerable importance, particularly in emerging countries . Emerging countries need to continuously invest in infrastructure developments at seaport to meet the rising demand in domestic and international trade. However, the countries cannot lose sight of the long-term consequence if sustainability is delinked from infrastructure development . Seaport Authorities to improve their corporate governance are understanding the importance of engaging with environmental and social groups and are prioritizing complying with regulatory norms of the country. The best practices available internationally and the guidelines issued by international organizations like IMO relevant in the area of infrastructure development are being taken seriously by all stakeholders. Seaport Authorities and Service Providers have now an increasing responsibility to jointly develop the infrastructure meeting all the sustainability criteria. Financing Institutions are also guided by Responsible financing guidelines and are looking for investments that meet their internal guidelines on environmental and social frameworks which also considers equal gender representation in policy formulation and decision-making particularly in relation to involvement of local communities in and around seaport complexes. Thus, the role of these key stakeholders in addition to the principal partners in the PPP set up have been gaining importance. The engagement of all stakeholders enable the sustainability elements to be captured in its entirety during the infrastructure development process in the seaports thereby benefiting the whole marine ecosystem.

PRINCIPAL PARTNERS IN PPP AND KEY STAKEHOLDERS

The primary responsibility of infrastructure creation and development in the seaports lies with the seaport authorities as they own the seaports. The seaport is managed either through public corporations or public trusts. Although public authorities own the ports, the infrastructure investments and operations are generally outsourced to private players. Private service providers have to comply with the policies laid down from time to time by policy makers and develop the entire seaport or a particular terminal as per the concession agreement . Therefore, the role of Policy makers is crucial in the infrastructure development in seaports. Private service providers also have to continuously engage with the local communities during the development stage . Financing Institutions provide bulk of the financing required by the service providers to develop the infrastructure. Considering the above, the main stakeholders identified in this paper who are associated with infrastructure development in seaports under PPP arrangements are the Seaport

Authority , Seaport Service Providers , Policy Makers , Financial Institutions and the Local Communities. A brief on each of these partners and stakeholders is as follows.

Seaport Authorities

Seaport Authorities are mostly from the public sector, and they are responsible for every infrastructure development that are carried out in the seaport domain. Based on the needs of the seaport, they make development plans . They may outsource consultants that help them design the project for development . It would be useful if the seaport authorities at this stage involve relevant stakeholders and through consultation process make investment planning . Involving prospective private sector service providers and specialists in social and environmental domain helps in due consideration of sustainability factors during the planning process. The private sector actors who finally wins the bid and executes the contracts benefits from the initial consultation phase. Seaport Authorities can have a common platform for exchanging information and knowledge among stakeholders. Seaport authorities are presently focusing on using technology and systems to improve efficiency and engagement with stakeholders. To remain competitive, numerous seaports have begun to implement Port Community Systems (PCS), where all port information is centralized and data exchange between port stakeholders is safer and faster. Desired outcomes from the implementation of PCS, apart from increasing the quality of data are minimizing paperwork, supporting data connections between different stakeholders, enhancing and facilitating activities across the entire transport and logistics chain to stakeholders, etc. Port authorities act as initiators and creators of the sustainable port development strategy on behalf of the whole port community. By developing and implementing PCS, port authorities are becoming real digital hubs, where available data is gathered and exchanged between various stakeholders. One of the reasons for creating PCSs is that port service users and customers need an increasing amount of information every day to innovate and optimize their own processes. Such innovations in trade, logistics, transportation, and port sectors should not only address the internal needs of each individual company, but also those of the companies and other entities that make up the entire supply chain[5]

Seaport Service Providers

The seaport service providers are the private players engaged by the port authorities to carry one or more activities within the seaport premises as per the PPP arrangement. The bid process starts with the Seaport Authority issuing Request for Proposal (RFP) documents which are generally published on the seaport website and in the newspapers of the country. These documents contain details of the project development requirements and the details of the bid process which may have a separate technical and financial stage. The private sector bidder is selected through a competitive process as per the criteria mentioned in the RFP document. Quite often , the private sector players form a separate entity called Special Purpose Vehicle that participates in the bidding process. SPVs are created for the particular

project and after the completion of the development and operation , the SPV existence ends. They have separate legal obligation from that of the parent company and are considered bankruptcy remote . The SPVs as per the concession agreement are entrusted generally responsible to design , build and operate the infrastructure. Maintenance responsibilities lie with the SPV for the agreed years of operations and the SPV may sub contact the maintenance activities to any specialised entities. In most of the concession agreement , the SPV is responsible for arranging finance for the project . This sort of arrangement with seaport authorities is popularly termed as DBOF (Design , Build, Operate and Finance) contracts. Sometimes as agreed upon in the concession agreement the SPV may be assigned only responsibility to Design , Build and Finance the infrastructure with the operations of the terminals managed by Seaport Authority . In either of the above scenario, the SPV depends on its principal sponsor the parent company that arranges debt and equity financing from public and private financial institutions. The parent company generally based on its competencies and experience build over the years have sound credit rating assigned by independent Credit issuing entities. The sound credit ratings of the parent company enable them to raise debt from Financing Institutions. Equity in the SPV is contributed by the parent out of its own fund or sometimes it raises fund from the market . To arrange financing from the financing institutions at a concessional pricing , SPV sometimes offer corporate guarantee of the parent company. However, according to Y. Ke, X. Liu and S. Wang ,Lenders should be strongly involved in the project to ensure the project's feasibility instead of requiring more guarantees from the sponsors which creates more barriers for project implementation when the financial conditions are not very attractive.[6]

Policy Makers

In most of the seaports most of the policies and regulations are made either by the Seaport authorities or by the national governments or jointly through different commitees. Many international organizations like International Maritime Organization (IMO), European Sea Ports Organisation (ESPO), International Association of Ports and Harbors (IAPH) provide guidelines which are helpful for Port trusts and national governments in framing policies related to compliance and seaport operations. With respect to seaport infrastructure development there is plenty of opportunity for the policy makers to act as facilitators to enhance seaport sustainability . Policy makers can frame guidelines on inclusion of nature-based solutions wherever possible . There can be policies on usage of renewable energy systems in seaports and replacing conventional polluting energy applications in staggered manner. Policy makers can spearhead in creation of enabling environment wherein all sorts of support including financial are available to private players so that they can prioritize including sustainable components while designing seaport infrastructure projects. Policy makers can also explore ways to design regulatory schemes to integrate pollution

mitigation mechanisms with long term climate change adaptation goals to develop seaport infrastructure which is resilient to climate change [7]. Policy and legal frameworks that facilitate, support and accelerate effective action on adaptation and resilience- building for ports and other critical transport infrastructure have a particularly vital role to play in strengthening risk governance and increasing resilience on the ground. Policies, strategies and plans establish agreed objectives, priorities and commitments which, among others, inform the provision and use of resources as well as institutional frameworks, and can provide important incentives for advancing port resilience. Legal frameworks are both powerful and vital tools to facilitate and advance implementation, along with accountability[8]. Policy makers can coordinate and integrate their efforts in internal negotiations such as the annual Conference of the Parties (COP) meetings . These meetings under the United Nations Framework Convention on Climate Change (UNFCCC) are held annually to chalk out strategy for sustainability adoption in the marine transport domain.

Financing Institutions

Both Public and Private Financing Institutions are key stakeholders involved in the development of seaport infrastructure. Development Finance Institutions (DFIs) , Climate Funds and the Sovereign governments are the Public Finance Institutions that are active in the seaport infrastructure development space. Commercial Banks, Insurance companies, Pension funds, Infrastructure Funds and some private equity funds look for opportunities in the infrastructure space where the risk in investment is low to moderate. Of these private entities, infrastructure funds and pension funds are the only entities that are in a position to provide debt with long tenor that are best suited for infrastructure development at seaports

Private Financing Institutions

Pension funds and Insurance companies are the prominent private sector financing entities that look for long-term investments projects to match their long-term deposit base . They prefer steady cash flow over a long period of time and a great level of certainty and generally are ok with low returns on investments. In the case of infrastructure development at seaports they prefer investing in existing set up where the risk is perceived less compared to an investment area where there is the adoption of new technology . Therefore, the private entity or the SPV that executes the PPP contract can reach out to these long-term investors provided they infrastructure development activities that are attempted are considered to have proven cash flow generating potential and tested in the past . The Pension funds and insurance companies active in infrastructure financing are generally strong international players and have a strong appetite to fund long tenor projects . Many of the entities over time strengthened their in-house capacity to evaluate sustainable oriented projects and would prefer such investment to build a sound reputation among its shareholders . These entities can classify such investment in sustainable infrastructure in seaports depending on the very nature of investments as Socially

Responsible Investments (SRI), ethical finance, impact investing or social investment.

Public Financing Institutions

Development Finance Institutions (DFIs) , Climate Funds and the Sovereign governments are the Public Finance Institutions that are active in the seaport infrastructure development space . These Public Finance entities support PPP and fund projects with a strong sustainability angle. These institutions, through a range of financial instruments which include concessional loans, guarantees and technical assistance on select projects, can create an enabling environment for private sector investments. DFIs are able to provide finance with very attractive terms because of their shareholder capital and their strong credit rating which allows them to borrow large amounts of money at attractive interest rates on international capital markets. The DFIs look for a positive return on investment over a long tenor which suits most marine infrastructure development projects . Prominent among the DFIs that are active in funding marine infrastructure projects are the International Finance Corporation, World Bank and the Asian Development Bank . Prominent bilateral DFIs that are active in the infrastructure financing space are Kreditanstalt für Wiederaufbau (KfW), Agence Française de Développement(AFD) and the Japan International Cooperation Agency (JICA). There are National DFIs like Brazilian Development Bank (BNDES) and Development Bank of Southern Africa (DBSA) which also funds long term marine infrastructure projects.

Climate Funds (CFs)

There are also another set of public long-term investors that can play an instrumental role in sustainability adoption during infrastructure development processes. These funds are provided with resources from mostly developed countries to focus on financing climate projects in developing and underdeveloped countries. Green Climate Fund(GCF), Global Environmental Facility (GEF) and the Adaptation Fund (AF) are CFs which are active in providing concessional funding to projects that tries to diminish carbon footprints and oriented toward strengthening climate adaptation. These CFs prioritize sustainability inclusions and have stringent criteria for investing in projects with strong climate rationale. These CFs are mandated by their governing Boards to extend long term loans and selectively invest in equity of companies to catalyze private capital. Underdeveloped countries and developing countries particularly vulnerable to impacts of climate change are particularly benefited by these institutions.

Local Communities :

Local communities are a key stakeholder in the seaport infrastructure development process . Seaport Authorities are specifying clauses to consider the social aspects of local communities in the concession agreement . SPVs, which executes the infrastructure development contracts, is responsible to ensure proper safety and employment conditions for the local community . According to World Bank [9] PPPs can graduate from being a pure public

private partnership to a people-oriented PPP strongly considering and implementing policies in the PPP design that are people centric and considers due importance to sustainable elements. The people centric PPP called People First PPP (PfPPPs) can be identified by outcomes which are beyond the normal
techniques that are used in project evaluation. These outcomes which projects can focus on are as follows

- Outcomes aiming to enhance social aspects including due consideration on essential services aspects.
- Outcomes designed to consider economic sustainability
- Outcomes that are oriented towards prioritizing environmental sustainability
- Outcomes are easy and replicable across geographies
- Outcomes that aims to enhance with all relevant stakeholders.

ELEMENTS OF SUSTAINABILITY AND COLLABORATION BETWEEN STAKEHOLDERS

Private sectors are inherently guided by profit considerations and to expect seaport Service Providers to embed sustainability elements in marine infrastructure development on their own appears farfetched. Seaport Authorities are primary responsible for development of infrastructure at seaports. However, Seaport authorities need support from other principal partners in the PPP set up and other stakeholders to have sustainability-oriented considerations during the process of planning and designing of infrastructures. Since many of the aspects are technical in nature, collaboration between Public Seaport authorities, Private sector operators, Financing institutions and community in the seaport is very crucial to develop marine infrastructures with sustainability considerations.

Environmental Sustainability

Seaport Authorities and Seaport Service providers have a common goal to develop seaport infrastructures that serves their respective interests in terms of timeliness of completion of the project and the project generating the envisaged returns on investments. In the whole process of project development unless there is a clear specification of ways to include sustainable elements in the concessional agreement there is a little motivation for the private sector to initiate measure to protect marine ecosystem. To develop a robust marine infrastructure in a sustainable way, the first essential step for the public sector port authority is to initiate a consultation process during the planning stage with prominent experts in the marine environmental field to examine the feasibility of incorporating nature-based solutions and sustainable elements in the concessional agreement clauses. The role of Seaport Authority in prioritising environmental sustainability is immense. Through carefully laid policies and effective planning , measures that are environmentally friendly can be included in the project design. Consultation with environmental specialists and prospective private sector service providers will help all stakeholders to align on the best technologies and measures. More weightages can be accorded to sustainable criteria in the technical bid evaluation process. Some of the areas where

environmental measures can be specified by the public sector in the concession agreements enabling private sector to sustainably develop infrastructure with due considerations to conserving the fragile ecosystem are as follows.

Measures to protect the coastline

Seaport coastline can be protected through different measures. Instead of the traditional civil structures, nature-based solutions can be explored wherever feasible to protect the coast. Normally the Nature-based Solutions once developed are long lasting and requires less maintenance compared to civil structures which are to be regularly maintained and periodically upgraded, . Conservation and afforestation of mangrove forests and sand breakwaters are few nature-based solutions that have been attempted . Other innovative environmentally friendly measures can be explored .

Measures to protect aquatic life

Aquatic life including coral reef should be considered while infrastructures are developed . Aquatic flora and fauna can be a vital source of livelihood for local communities and they are also found to be diminishing the water pollutants. Public sector in collaboration with private sector can explore possibility of creating eco-tourism infrastructure near the seaport. Ecotourism, defined as “environmentally responsible travel and visitation to relatively undisturbed natural areas”, to enjoy and appreciate nature, is often used to enhance the natural capital, while protecting and promoting protected areas. Ecological benefits can translate into economic benefits, and this includes market benefits (goods or services observed through a market transaction; example: the increase in tourism) and non-market benefits (not achieved by a market transaction; example: the benefit to people from knowing that a threatened species is protected)[10]. Seaport authority can explore allocating a separate land parcel for eco-tourism with the private sector being responsible to develop it.

Measures to contain water Pollution

Marine Infrastructure development has been going on since ages and many of the development have ignored ecological considerations. This has resulted in damage to the coastline and the natural way to combat climate change phenomena like sudden flood and tsunamis. Aquatic creates and fragile plantations have been impacted by infrastructure developments across seaports. Water pollution can be diminished if the efluents reaching the water are properly treated. Proper wastewater discharge system and treatment plants are beneficial sustainable measures that can be integral part of seaport infrastructure development and can be seriously considered.

Measures to check air pollution

Major air pollutants near the seaport complexes are the oxides of Sulphur and Nitrogen and small dust particles caused by shipping liners and port operations that include the handling of dirty (coal and iron ore) cargoes. Increase in global trade and shipping volumes will likely exacerbate shipping-sourced emissions and attributable health burdens in the near future, and in light of the International Maritime Organization (IMO)'s goal to reduce GHG emissions by 50% by 2050 compared to

2008, even more ambitious emission control efforts are needed to not fail this climate goal. Therefore, significant shipowner investment and commitment to improved and more efficient ship design and operational performance, wide adoption of LNG and biofuel use, wind power and electrification are needed, as well as improved IMO oversight and enforcement of established rules[11]. Steps can be initiated by private sector service providers in collaboration
with public sector Port Authorities to implement measures that substantially reduce air pollution. Seaport authorities can collaborate with private project developers during planning of the infrastructure development to explore installation of dust suppression technologies. Innovation in material handling systems and conversion of conventional energy sources to renewable ones can be very useful in checking air pollution.

Social Sustainability

It is very essential that Seaport Authorities and private Service Providers consult with the local communities during the planning stage of infrastructure development in seaports and the local communities remain engaged throughout the project implementation and operation stages. Public Sector port authorities can specify clauses to incorporate sustainable elements which holistically considers the social aspects in the project design and development. Private Sector while making design for the infrastructure development can include measures that contribute to wellbeing of the societal ecosystem. Thus, through coordination and collaboration between the principal public and private stakeholder, social aspects can be duly taken into consideration through the process of development of seaport infrastructure. Few suggestions that can enhance social sustainability with the collaboration of public and private sector are as follows.

Measures to address livelihood issues

Aquatic creatures are sensitive to the construction work in and around seaports . The normal breeding cycle can be impacted resulting in less catch effecting livelihood of communities dependent on these marine resources. Therefore, these factors should be taken into consideration and suitable measures that protects local population livelihood can be part of the infrastructure development process. To foster positive relationships with local communities, industry stakeholders should engage in transparent communication, support community development projects, and mitigate the negative impacts of shipping activities on coastal habitats and livelihoods[12].

Safety, Health and Well-being measures

Local communities and workers at the site are exposed to safety and health risks during construction stage of the infrastructure development in seaports. Safety aspects are an essential element in infrastructure development and should be focused on by all stakeholders. Adequate measures to prevent any accident should be in place. Relevant safety guidelines, training and operations manuals should be made available to all those who are exposed to such risks. Well- being measures like schools and hospitals near

the seaport vicinity managed by the Seaport Authorities in collaboration with Private Service Providers are essential features of social sustainability measures. By demonstrating a commitment to the well-being of the community, seaports can enhance their reputation and gain a social license to operate, which fosters trust and positive relationships with stakeholders[13].

- Measures to improve and develop skills

Seaport staff, workers and local communities can be imparted regular skill upgradation knowledge through workshops and training. Vocational training institutions can be established either within or in close proximity of seaport complex. Public and private sector can work together to impart professional training to employees in the seaports. Seaport Authorities and private Service Providers can jointly take initiative to set up learning facilities and develop training centres in tie up with specialised institution and universities . These initiatives will help the employees, staff and temporary workers to gain knowledge. The training can also include module on sustainability and its adoption in seaports thereby making the trainees well aware of the sustainability dimension . The training can help in the professional career development and the organisation can benefit from the new perspectives from the trained employees on sustainability and its implementation during infrastructure development in seaports. The employees well trained in their respective domain and on sustainability issues can help in fine tuning existing norms and having new ones for ultimately benefiting all stakeholders .

- Economic Sustainability

Infrastructure development in seaports are capital intensive projects wherein there is a strong need for collaboration between public and private sector. The public sector attaches utmost importance to the development of the infrastructure with clear economic goals in tune with the economic benefit for the country. Infrastructure investment yields positive, enduring, and often immeasurable returns to people, communities, and society and is thus affordable to society at sufficient levels of fiscal support [14]. The private sector expects a commensurate return to its risk while developing seaport infrastructures which is very technical and capital intensive project. The private sector service providers are generally responsible to arrange for debt to finance the infrastructure . Equity infusion in the SPV created is done primarily by the parent sponsor. The return on investment increases for the equity investors if the debt arranged is concessional in nature. Incorporating measures related to sustainability while designing seaport infrastructure projects, may increase the project cost and consequent requirement of additional financing. To address the issue public sector Seaport Authorities can actively consult with the private Service Providers to segregate the cost that are budgeted for sustainability inclusions. Concessional financing from developmental financial institutions and climate funds can be tapped by the private sector with a performance guarantee from the port authority ensuring that the envisaged sustainable components are incorporated in the project development contributing to the holistic development of the marine ecosystem. With strong collaboration between the public and private sectors and continuous engagement with the financing institution economic sustainability aspects can be prioritised. Financial concessions that can come into play to facilitate economic sustainability are as follows.

- Concessional finance

Arranging concessional finance from non-commercial financing sources. Multilateral Development Banks (MDB)/Developmental

Financial Institutions and Climate Funds provide funding to mainstream sustainable projects. The financing instruments are very concessional in nature including grants and reimbursable grants. Special incentives can be initiated by Seaport Authorities to stimulate private sector include more sustainable elements while developing seaport infrastructures. The public authority can create a separate technology upgradation fund
that the private sector can draw upon in concessional finance terms to upgrade or adopt modern technologies that are efficient and environmentally friendly .

- Long Loan Tenor

Developing infrastructure projects incorporating sustainable elements require long gestation period. A long tenor loan and adequate moratorium in servicing of loan helps the private sector to efficiently develop and operate the project. An important task of public policy should be to create favourable conditions for intensifying long-term lending, which is especially important for the maritime industry. [15]

Cash flow in the initial period are less and it gradually stabilizes over the period of concession. Considering this a structured repayment schedule for loan servicing and long tenor of the loan is always beneficial for the project and all the stakeholders associated with it.

- Innovative financing

Issuance of blue bonds can be used to incorporate sustainable elements in the infrastructure project development. A blue bond is a debt security issued to raise capital specifically to finance the implementation of the SDGs related to the ocean, the seas and marine resources, as well as the transition towards a sustainable ocean economy. There are a number of SDGs which a blue bond can relate to given the diversity of factors relevant to a sustainable ocean based economy. Corporates, financial institutions, governments, and municipalities can issue blue bonds to fund ocean-related assets and to deliver initiatives that support the SDGs [16].

- Technological Sustainability

Use of advance technology during the development of seaports not only brings efficiency in the operations but also has a positive impact on the marine ecosystem. To attain technological sustainability collaboration between private and public sector is very crucial. Private sector can be incentivised to make the best use of the state-of-the-art technology available in the marine infrastructure domain. Public sector can ensure that the best technology is used through clear specifications in the concession agreement. A separate fund can be earmarked for technology upgradation that will be concessional in nature. Few measures that can be adopted in the infrastructure development related to technology are as follows.

- Process Mechanization

Usage of mechanized material handling equipment not only brings efficiency but also diminishes the chances of pollution that is associated with manual operations. There are different dust suppression technologies available to control pollution emanating from dust particles during material handling process and in the storage yard. Many of the technologies applications are automated and there is minimal manual interventions thereby keeping the employees less exposed to the pollution emanating from dust particles. The roads within the seaport complexes can be paved using nature-based solutions thereby providing double benefits of reducing pollution as well as making the roads resilient to heat and storm water.

- Application of energy efficient technologies

According to K-L.A.Yau, et al., recent research on smart ports have revolved around the

application of Internet of Things, cold ironing, renewable energy generation and storage, energy management, locating systems and code recognition for containers, the use of AIS data for trajectory estimation, and resource management. Future investigations could be made to explore, design, and develop new smart port applications, collaboration platform among different ports, enhanced terminal operating system, collaboration with smart ships, completely digitized autonomous smart ports, as well as big data analytics, blockchain, and cyber security solutions [17]. The electrification of ports and their transformation into smart energy infrastructures represent one of the most promising solutions toward the decarbonization of the maritime industry. [18].

- Application of advanced information technologies

Staying abreast of the new technologies can help seaports improve operational efficiencies and improve overall safety . Modern remote sensing technologies, such as RFID for identification and location, cameras and built-in computer vision algorithms, could contribute to safer and shorter handling time in comparison to classic container terminals[19]. Seaport Service Providers can embrace new Information and Technologies (ICT) to bring in efficiency in operations . Cloud computing and 5G technology can also be explored to improve development of infrastructures at seaports.

- Institutional Sustainability

While social, environmental , economic and technological sustainability have been focused a lot, institutional sustainability is gradually being stressed upon . Port authorities and Private sector players being the key stakeholders, can work together to improve institutional sustainability . Few dimensions of institutional sustainability are :-

- Regulatory compliance

Complying with regulatory norms of the country is a paramount requirement of the seaport authority as well as the private sector involved in the development of seaports . There are many international and national guidelines that can be adopted while developing infrastructures in seaports that will contribute to adoption of UNSDGs. There is a need to periodically revisit the local policies and regulations to accommodate the latest technology assimilation within the seaport complexes. According to R. Canessa et al., local regulations need to be developed to promote the implementation of optimal microgrid designs with cold ironing technologies and to address the problem of requiring substantial investment to carry out this type of project [21]. Development of regulatory frameworks in tune with technology advancement and prioritizing sustainable criteria will benefit all stakeholders in the long run.

- Process improvement

Seaport Authorities and private Service Providers can engage to set up a platform to exchange relevant information and knowledge and also to settle issues if any . Since the infrastructure development at seaports takes a long time for development and the concession for operations are usually set for 20 to 30 years there can be occasions where change in process or improvement of existing mechanisms may be required . Therefore, having a mechanism to discuss among stakeholders help all stakeholders to be more involved and facilitate decision making which are mostly on a consensus basis. Many of the seaports have introduced single window clearance mechanisms to ease approval processes. Single window approval ensures a timely and effective way of getting things fixed while the infrastructure is being developed. Since the gestation time for the development of the seaport infrastructures are long, single window clearance mechanism helps remove bottleneck midway in project implementation.

Development of infrastructure in a timely manner is a benefit to all stakeholders. According to M. Sadiq *et al*., policy development and incentives can be provided to have smart technologies that can improve energy efficiencies and reduce GHG emissions [21]

- Monitoring and Supervision

Monitoring and Supervision of projects while on implementation is very crucial in achievement of institution sustainability . Public sector in collaboration with the Private sector can design a framework to have effective monitoring and supervision of the activities . Periodic impact assessment after closure of the development phase always benefits the stakeholders to understand how well the project is benefiting the ecosystem.

CONCLUSION

Most ports have emphasized the identification, mitigation, and monitoring of impacts, as well as improved energy management, and stakeholder engagement–particularly linked to environmental policy development[22]. Enhancing environmental sustainability through additional clauses in port concession agreements, beyond existing regulations, also raises concerns about impacting port competitiveness, potentially disadvantaging concessionaires, particularly in markets where ports compete for the same market share and clientele. Such measures may increase demand for a level playing field across the port sector. However, environmental sustainability is an urgent, collective priority that should not be viewed solely through a competitive lens among enterprises or port authorities. At the same time, market dynamics and realities must be acknowledged. Achieving sustainability requires a balanced approach, integrating economic, social, and environmental objectives rather than prioritizing one over the others. Effective governance is essential in this context: it involves setting clear goals and priorities, addressing challenges and finding adequate solutions, accommodating diverse interests, making thoughtful compromises at the highest level, and seeking consensus wherever possible [23]. While each port is unique, there is some scope for joint action and convergence among seaports with respect to these aspects. Port authorities and terminal operators are only able to fully benefit from initiatives toward the greening of concession procedures if these actions are embedded in a chain approach toward the environment (ship, port, terminal, warehouse, and inland transport). Green concession agreements miss their effect when treated in isolation. Any green concession policy should give incentives to firms to integrate environmental issues into their management practices, while avoiding making terminal operators victim of any unfair or ineffective green policies. Eventually, such an approach will benefit both the port authority and the terminal operating companies [24].

Infrastructure development in seaports is a capital-intensive activity with involvement of number of stakeholders and alignment of diverse interests among stakeholders is not easy. Seaports are considered very vital for the country’s economy and are subject to rules and regulations. infrastructure development with sustainability adoption is a challenging activity for all stakeholders and especially for the private sector service

providers. However, strong collaboration between the principal partners that is the public Seaport Authority and the private Service provider in the PPP set up and with all key stakeholders identified in the paper can help adoption of sustainability with all its dimension that include environmental, economic, social, technological and institutional. It is essential to consider resilient infrastructure development and sustainability are interrelated and can be considered both sides of the same coin. It would be beneficial if all the principal partners in PPP and relevant stakeholders engage with each other at the planning stage of infrastructure development at seaports exchange ideas and collaborating to maximise sustainability adoption during the development process. A common forum ensuring due consultation among the stakeholders from the planning to the execution will have maximum positive impact on the overall sustainability and on the planned execution of the infrastructure development in the seaports.

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