

Benchmarking and Probing its Applicability : Major Seaports of India

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A b s t r a c t

The study has traced significant improvements in overall efficiencies both at organisation and industry where benchmarking standards are set for implementation. The study also found that techniques used in setting benchmarking standards are ever evolving and are being derived from a wide gamut of sciences. The study also found that benchmarking of seaports is still evolving. Taking a cue from this study, the authors, as a further extension to this study, propose to benchmark performance standards for container terminals of the major ports of India. This review of literature has been taken-up by authors to evaluate the status of studies on benchmarking and to identify the scope for benchmarking container terminals at the major ports of India.

Keywords: Efficiency, Productivity, Benchmarking, Seaports, Standards, Port Performance.



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Benchmarking is a tool for systematic and continuous improvement of processes by which performance of firms is compared with that of the best in class. Benchmarking is a method of measuring and improving organizational performance of a firm by comparing it with that of best (Stapenhurst & Stapenhurst, 2009). Right from its introduction during 1980 by Xerox, the concept of benchmarking has evolved and extended its scope into numerous functions and hierarchal levels of business entities. Benchmarking is a prerequisite for Total Quality Management (TQM) and is determined by the level of market competition. Business entities operating in dynamic environment strive to set standards of performance and take competitive advantage over competing entities. Benchmark performance standards set by a firm become standards for other competing firms. It is a continuous management process wherein the best firm tries to upgrade its performance levels to new heights and other organizations try to update their performance to the levels of the best performer. Benchmarking philosophy helps organizations to identify their deficiencies and take cues from the best performer to improve.

(Matters and Evans, 1997) suggested that the kind of benchmark a company should undertake is dependent on company's characteristics and circumstances. M. Zairi, (1998) advocated that benchmarking would bring numerous benefits including sustainable improvement overall efficiency, innovation in managing operations, effective team-building, competitiveness, gap identification, employee motivation, etc. Benchmarking studies across the world covering sectors such as agriculture, manufacturing, logistics, physical infrastructure, services, banking, etc. are contemplated to set standards of performance and enhance overall business efficiency. Techniques to set standards of benchmarking are being derived from numerous research backgrounds. Parametric and non-parametric models developed in research backgrounds such as medicine, social sciences, scientific, arts and humanities, bio-chemistry, etc. are being inter-operably used to benchmark business performances. At the same time, numerous researchers are employing statistical, mathematical, and econometric models to check efficiencies and develop benchmarking standards.

To sustain in this dynamic business environment organisations that strive to improve their efficiencies alone can sustain for longer period. Organisations in their continuous quest for improvement look to the experiences and success stories of best in class business units and attempt to catch-up with the efficiency standards by the top performers. Peng Wong & Yew Wong, (2008) argue that benchmarking is an essential cornerstone for companies to remain at the forefront of excellence in a level playing field market. Magd & Curry, (2003) argue that superior quality cannot be guaranteed unless the organisation establishes relevant service performance measures and compares its achievements against those of the service leader. At the same time, benchmarking is not a process of business that is to be taken care by a particular section of an organisation. It is an integrated continuous system covering all levels and functions of a business unit. Comm & Mathaisel (2000) have suggested that in order to be successful in benchmarking, there must be a supportive management team, access to partners who have solved the problem must be available and a knowledgeable benchmarking team must be in place to solve any problems identified.

The current paper is aimed to review literature available on benchmarking, its application in various sectors and finally

research works on benchmarking seaports. Research papers from various databases are considered for review and are discussed in Table-1. The study found research works on benchmarking in areas extending to manufacturing, airports, shipping, logistics, water supply, etc. Research works covering (Sea) Port Efficiency, the area of prime focus for this paper, are presented in tabular form and discussed.

Since the aim of this paper is to have a thorough understanding of the hitherto studies on benchmarking at ports, a detailed analysis of context in which these studies are made, techniques applied, conclusions drawn, and gaps & scope for further studies are presented in chronological order. This is followed by a detailed discussions that led to identification of need for benchmarking at major ports of India. It may be noted that government of India, soon after attaining independence in 1947 has taken over strategic sectors of the economy under its control. Accordingly, seaports, came under the purview of government of India and today, 12 of them are registered under Major Ports Act, 1963. Since the major ports contribute to growth of foreign trade of India, it is imperative to have standards of performance that make them efficient and compete with the private ports in India. The research paper identified an immediate need to benchmark performance of ports especially, the container terminals at major ports to understand their actual level of performance. Benchmarking of container terminals would be a step in right direction as containerization of sea-bound cargo has picked-up even in India. A study on setting of benchmarks and compare the efficiency at which Indian container terminals are currently operating proves an understanding on the measures to be taken to enhance their productivity to international standards.

This paper is divided into five sections with introduction as first section, followed by review of literature on the concept of benchmarking as section two. Section three devotes on understanding existing literature benchmarking in various sectors and is followed by section four that covers benchmarking studies on (sea) ports and terminals. Section five explains about the major conclusions drawn from this paper and proposed for the further study interests of the authors.

I. Literature on Benchmarking:

Numerous authors and institutions have worked on understanding the concept, significance, and usage of

benchmarking studies. Port Regulators Of South Africa, (2014) in their report stated that benchmarking is a tool which assists to measure comparative operating performance and identify best practices that can be adopted for improving service levels at port terminals. Williams, Brown, & Springer (2012) in their qualitative meta-analysis of 32 research papers published between 2005-2010 found soundness of benchmarking theories/practices, resource scarcity, reluctance to new practices, and specific implementing new practices as major hurdles for studying benchmarking. The study proposed strategies including proper communication and training, leveraging of right people, and TQM implementation covering formal plans, communication, training, and motivating workforce to overcome these constraints. Moriarty, (2011) proposed a new definition of benchmarking that encompassed various business activities and, when implemented, results in overall effectiveness.

Adebanjo, Abbas, & Mann (2010) used multi-national survey to study the level and mode of usage of benchmarking and found it to be a popular and reliable tool for improving organizational efficiency. The study found usage of informal benchmarking to be common over best practice benchmarking and organisations are moving towards improving processes at various levels and functions. The study found key issues like lack of right partners, clarity of requirements, technical knowledge, management commitment, employee training, communication systems, etc. impend the implementation of benchmarking (Adebanjo et al., 2010). Benchmarking technique has few obstacles in its implementation including barriers to adoption and growth; lack of understanding, partners, technical knowledge to plan, management commitment, and proper training. Moriarty & Smallman, (2009) studying concepts of benchmarking found that existing studies focused on pragmatism and praxis rather than epistemology. The study initiated development of rigorous theoretical base for practices that can motivate organisations to opt for benchmarking of business processes. Francis & Holloway, (2007) reviewed the themes under which benchmarking studies are made to find a neglect in studies long-term qualitative and quantitative effects and perspectives of key stakeholders. Anderson & McAdam, (2005) studied contribution of benchmarking and performance measurement on organizational change found that,

irrespective of size, businesses' focus on benchmarking operational issues is more than the strategic level where they are to be actually focused. Vorhies & Morgan (2005) studied potential business performance benefits in marketing due to benchmarking and found sustainable competitive advantage as a resultant of benchmarking process. Bauer, Tanner, & Neely (2004) developed an audit template covering planning, collection, analyzing, adaptation, and review of data for benchmarking business organisations.

Kyrö, (2003) in his study observed that, although, benchmarking has evolved as a tool to improve organization's performance and competitiveness, its definitions and classifications vary among scholars as per time and criteria that they focus on. Paixão & Bernard Marlow, (2003). Globalization process has brought numerous uncertainties and to meet these ports have to transform and become competitive by proactively adopting new management strategies. Dattakumar & Jagadeesh (2003) reviewed research works on benchmarking and proposed a new scheme of classification that would fill certain existing gaps. Boulter (2003) studying legal implications on benchmarking especially intellectual property and competition law observed that lack of authoritative literature to address issues raised by interface between law and the transfer of benchmarking practice knowledge can create legal complications. At the same non-existence of common legal regime across nations can influence international studies on benchmarking. Kyrö (2003) reviving benchmarking concept and classification for both theoretical and practical purposes argued for a revival due to evolution of new benchmarking forms i.e. competence, globalization, and networking. Extension of the technique to semi-public and private (including small sized) organizations mandated detailed classification and therefore proposed three interactive forces influencing benchmarking. Rickards (2003) proposed a mechanism to create balanced scorecard covering reasonable number of indicators with benchmarks and measure management performance using Data Envelopment Analysis (DEA). Yasin (2002) reviewing existing literature observed that benchmarking process, of late, has expanded to strategic levels of organisations from the previously confined area business operations. However, lack of theoretical developments constrain its multi-faceted application. Freytag & Hollensen (2001) proposed seven

phases for benchmarking including functions to be benchmarked; significance of each subject area; whom to benchmark against; gathering benchmarking information; identification of performance gaps; process of learning from 'best in class'; and change implementation. The study suggested that benchmarking will open an organisation to change and learning, with overall goal of achieving competitive excellence. Hinton, Francis, & Holloway (2000) studying best practice benchmarking in UK highlighted some of its advantages and also disincentives among various public and private sector organisations. Their study suggested that benchmarking has to extend beyond result comparison to cover process improvements and that benchmarking has to become organizational continuous culture. Issues such as team working, communication flows, change management, expert supervision are essential for sound benchmarking. Woon (2000) assessed Total Quality Management (TQM) implementation at 240 organisations in Singapore to suggest Singapore Quality Award Programme should continuously undertake frequent assessments of organisations to track their progress and help develop Singapore's economy.

Bhutta & Huq (1999) basing on their studies on companies that have devised customized benchmarking processes, developed a five step benchmarking model that can be used by any organisation that opts for benchmarking its performance. Andersen & Moen (1999) studying linkage between the concepts of benchmarking and poor quality cost measurement, devised an integrated framework that can be standard element in quality management and TQM toolbox and lead to higher recognition and improved results for both concepts. Wah Fong, Cheng, & Ho (1998) introducing benchmarking to management practitioners emphasized on its classification and process model. Further, the study has proposed key tips for organisations that attempt to implement benchmarking. Elmuti & Kathawala (1997) explaining benchmarking processes highlighted need for cognizance of ethical and legal issues and suggested that overall objective of benchmarking is to assist companies achieved world-class competitive capability.

Review Editor (2008) in the book discussed the usage of benchmarking in various scenarios and explained experiences of various companies in dealing with distinctive areas of benchmarking. The findings help in devising a

comprehensive and robust mechanism to undertake benchmarking procedure at organisations that intend to improve on their standards of performance. Mohamed Zairi & Youssef (1995) reviewing research publications found that benchmarking is the process of raising awareness within organisations and developing culture of continuous learning and improvement.

II. Benchmarking studies at various sectors:

Biffi & Tuissi (2017) conducted longitudinal study, albeit with small sample size, on usage of benchmarking in manufacturing sector and found no clear relationship between benchmarking and operational performance. T. W. Chung, Ahn, Jeon, & Van Thai (2015) measured operational efficiency and set benchmarking standards for major Cargo Airports in Asia Pacific region. Study concluded that performance improvement creates competitive edge and offer a potential to improve efficiency of airport operations across a whole range of challenges and issue faced while handling cargo terminals. Strojny (2015) benchmarked efficiency and effectiveness of public administration units in Polish region with limited data set. Usage of Analytic Hierarchy Process (AHP) technique helped in customizing analysis of information needs and in better comparison of public authorities.

Joo & L. Fowler (2014) using DEA technique, measured and benchmarked operational efficiency of 90 airlines across Asia, Europe and North America with limited variables. Study found that operational efficiency in some airlines is at the cost of other efficiency parameters such as customer service rating and financial performance. Argued that revenue and expenses are significant to determine operational efficiency. Bhanot & Singh (2014) using DEA technique benchmarked performance indicators in Indian Railway Container Business and selected Private Players to find better efficiencies at private operators.

Panwar, Nepal, Jain, & Prakash Yadav (2013) using survey and case method assessed the state of implementation of benchmarking technique in automobile industry. Study observed usage of bench marking technique at strategic level at a nascent stage mostly due to non-availability of workforce, expertise, and financial resources. Salem (2013) studied problems faced by industrial companies in UAE and found that cultural work environment influences acceptance of benchmarking by workforce. Study proposed that

sensitivity towards information on best performance and employee behavior in carrying out benchmarking hold key for its successful implementation.

Park, Lim, & Bae (2012) developed a benchmarking method that can gradationally choose benchmark targets by considering minimization of inputs reduction and output expansion so as to prioritize efficiency improving resources. Jørgen Anfindsen, Løvoll, & Mestl (2012) constructed best practice benchmark and developed methodology to compare samples with benchmarks. Study found that fuzzy set theory facilitates relative independence of sample size and its distribution and also easy to compute. The study developed benchmarks that can be applied to few or even to singleton samples. Sajjad & Amjad (2012) set benchmarking through total quality management and organizational performance in telecom sector of Pakistan. Model developed is useful to improve implementation and practice efforts of organisations that look for TQM. Jørgen Anfindsen et al. (2012) developed best benchmark practice and model for comparison of marine bunker fuel suppliers. The developed model is powerful and less sensitive to outliers and suitable for small datasets and even single numbers. Sapcharoenkul, Anussornnitisarn, & Sooksmarn (2010) analysed efficient performance at production units to check the root cause analysis for benchmarking internal processes. Internal benchmarking method used to compare production line helped in tracing the inefficiencies existing in processes.

Zhu & Erikstad (2011) benchmarked performance of shipping companies by comparing interrelationships between various inputs with Key Performance Indicators (KPIs) to identify the ideal Key Performance Standards (KPSs) for benchmarking of maritime logistics chains. By evaluating cause and effect followed by simulation model between various inputs and KPIs, traced key causes for different levels of output. Cappelli, Guglielmetti, Mattia, Merli, & Francesca Renzi (2011) conducted survey to find training requirements that a “peer” should acquire to perform “evaluation” activities for approach based benchmarking. The study proposed training contents that can help in development of independent evaluation on basis of Common Assessment Framework (CAF) and perform evaluation activities in a systematic manner that can be compared among different administrations. Hilmola (2011) using DEA technique developed efficiency benchmark measurement models for public transport systems with an

aim to reduce CO₂ emissions. All the four models used for efficiency measurement showed similar results. The study suggested minor changes can make some of the low efficiency DMUs as efficient units.

Kannan (2010) proposed an analytic hierarchy framework to Indian Ocean container carriers for benchmarking their service quality. Study identified and clustered attributes to decide service quality of Indian container carriers. Further 7 clusters and 4 decision choices were hypothesized and AHP hierarchy is structured. Priority weights were given to each criteria and sensitivity analysis checks made to see if there is any impact of change in weights on benchmarks. Gap analysis was also done to assess strengths and weaknesses each of the carriers. Björklund (2010) developed and successfully tested a two step benchmarking tool that can be used to improve corporate social responsibility in purchases. Adebajo et al. (2010) Measuring usage level of benchmarking at organizations, and compared its popularity against other improvement tools found that best practice benchmarking that is most beneficial is not, actually, used by organizations. Study also found that process benchmarking covering a wide range of activities including operational aspects have taken over financial benchmarks as a key driver. Ajelabi & Tang (2010) analyzed about how benchmarking principles are applied to enhance project management process and performance. A review of studies helped in suggesting mechanism to evaluate and improve project management performance. As an outward looking evaluation tool, benchmarking compares actual activities at a project with standards set at the best project. The study concluded that such comparison helps in identifying gaps and to improve efficiency. Nunes & Bennett (2010) investigated environmental initiatives on green operations of 3 major automotive companies and benchmark them against each other. Company wise analysis of green initiatives followed by Toyota, GE, and Volkswagen prove greater advances in environmental safety measures beyond production processes and cover their product performance, supply chains, non-manufacturing facilities, and final disposal. Presley & Meade (2010) proposed methodology and framework for construction firms and contractors to develop sustainable measures in benchmarking efforts. The study developed a generic framework for a green build to benchmark. It developed a comprehensive tool to address tactical and strategic impacts in decision making and in benchmarking sustainability.

Min & Joo (2009) assessed competitive strengths of 12 leading 3PLs in US to find that financial efficiency can be improved only by setting industry financial standards. Rapid expansion of business scope through mergers and acquisitions and globalization may impact financial efficiency of Third Party Logistics (3PLs). Non-asset based 3PLs have better ability to improve financial efficiencies. BCC model of DEA mitigates impact of economies of scale on 3PL's financial efficiencies and helps in identifying true sources of inefficiencies.

Moffett, Anderson Gillespie, & McAdam (2008) postulated key factors required for benchmarking and performance measurement, by taking-up a survey in UK. They have developed a conceptual elements for lead benchmarking. Vagnoni & Maran (2008) developed an application for benchmarking of Health District Activity Plans (HDAP) of Italian public sector health care units. The study collected data to find "best practice" HDAPs. A hypothesis of HDAP content model was developed to know the overall best practices. Goncharuk (2008) using DEA technique, compared efficiency of gas distribution companies of Ukraine (54) and of America (20) to trace benchmark standards. Study found that companies where there is no majority owner have shown best financial results and efficiencies. It also found smaller sized firms reporting better efficiencies. Raymond (2008) proposed benchmarking of public procurement system in Sri Lanka. The study found improvement in demand for transparency and accountability of public sector in developing countries, where opposition to inefficient delivery systems has grown. Therefore, benchmarks, here, were required to ensure efficiency standards in public sector. Peng Wong & Yew Wong (2008) reviewed literature on supply chain benchmarking with an aim to redress imbalances and enhance DEA modelling approach in this area. Authors found that supply chain benchmarking is different from other sectors and need a thorough understanding of the processes involved in it. Authors also suggested for review of DEA to make it flexible and accommodate sector specific intricacies. Lee (2008) using Regression analysis and DEA studied energy efficiency at government offices of Taiwan to find improved efficiency levels. Mitra Debnath & Shankar (2008) using DEA attempted to benchmark telecom services in India traced the parameters and segregated input and output variables required for such benchmarking. The study observed great diversity in relative performance of service providers which could be a great threat for the sector.

Deshpande, Yalcin, Zayas-Castro, & Herrera (2007) proposed a discrete simulation approach to benchmark performance measures of terminal operations for less-than truck load freight carriers. The model helped in benchmarking key performance measures of existing operations and in testing alternative scenarios of performance. Jaques & Povey, (2007) studied attitudes of business advisers of UK in identification of benchmarking tools and found a dip in development of diagnostic benchmarking tools and suggested for development of new business support tools that recognize changes in client maturity, especially, to support small and start-up business units.

Henderson Smart, Winning, Gerzina, King & Hyde (2006) developed model for benchmarking teaching and learning processes for Dentistry program at University of Sydney, Australia and suggested for its adaptation of their model at primary, secondary, tertiary and continuing levels of education. Pin Lee, Zailani, & Lin Soh (2006), using discriminant analysis, proposed guidelines to manufacturing sector on factors for benchmarking. The study argued that bigger size firms easily opt for adopting of benchmarking and found employee participation as a key factor for benchmarking adaptation followed by top management commitment and role of quality department. Gebauer, Friedli, & Fleisch (2006) traced success factors, on the basis of benchmarking indicators, for enhancing service revenue at manufacturing companies and proposed necessary changes in firm's activities, organizational culture and structures. Chan, Chan, Lau, & Ip (2006) using double AHP method, developed benchmark process for postal industry in Hong Kong. Using both qualitative and quantitative data, performance of benchmarked company against its competitors is measured which, is followed by identification of best practices for improvement. The proposed model is expected to suggest on inefficiencies that need to be improved on. W. Chung, Hui, & Lam, (2006) developed a benchmarking model for energy efficiency at commercial buildings by multiple regression analysis and renormalized significant factors for an energy-use intensity.

Wynn Williams (2005) proposed that internal benchmarking, process benchmarking and proper public documentation will lead to proper public reporting system at public sector units in New Zealand. Chen (2005) proposed competitive and strategic model for airport performance and suggested for development of key success factors and

strategic benchmarking standards to secure competitive advantage. Graham (2005) reviewed benchmarking studies in airport industry to find considerable progress in research on performance measurement in this sector. However, as per this review, benchmarking for inter-airport comparison for airports of different countries is constrained due to incompatibility in input and output variables. Austin, (2005) setting of pricing and other policies of Airways Corporation of New Zealand Ltd. Using Economic Value Addition (EVA), a success strategy, income in absence of benchmarking mechanism. Lin (2005a, 2005b) checked significance and impact of using service quality variables in benchmarking water and sewage industry and argued that mere inclusion of cost aspects might not bring in true efficiencies.

Yasin, Wafa, & Small (2004) studied the implementation of JIT systems at manufacturing organisations and advocated usage of benchmarking for better results and for reducing potential problems in JIT implementation. Fuchs & Weiermair (2004) reviewed existing models and proposed an extension to the existing models of benchmarking tourism services.

Magd & Curry (2003) critically appraised the usage of benchmarking tools at public sector organizations in UK. Study found that to achieve best value performance, public sector organisations need to set service performance measures and compare their achievements with service leader in the industry. Benchmarking helps in enhancing financial, operational efficiencies. It also helps in identification of gaps and supports to frame policies that reduce inefficiencies.

Jackson (2001) reviewed research studies on need and forms of benchmarking studies in Higher Education (HE) of United Kingdom (UK). Study identified key imperatives, agenda of benchmarking HE in UK. Study also proposed scope, mode, and connotations of usage in UK's HE. W. K. Chung (2001) studied benchmarking exercise at Singapore's productivity leaders to trace their levels attained for best practice, strengths and weaknesses, inequalities in maturity of practices, priority areas for improvement, and linkage between Total Quality Management (TQM) maturity and business performance. The study argued that organisations would be at higher level TQM maturity levels due to several factors and benchmarking, as such, provides

useful findings to advance and TQM initiatives. (Hackman, Frazelle, Griffin, Griffin, & Vlasta 2001) developed an input-output model covering critical resources to measure and benchmark efficiency levels at warehouse. Study proposed that efficient firms need not be profitable and vice-versa.

Smith (2000) studied potential for generation and evaluation of consumer based benchmarking with a focus on health, education/professional, and retail in service sectors. The study found that information received from customers to be valuable in developing a comprehensive external benchmarking involving both competitive and generic measures. Longbottom (2000) found growing interest among industry towards benchmarking process due to improved results. Study also found critical factors for transfer among organisations and suggested strategic planning process, development of customer benchmarking methods, critical factors for transferring best practices among organisations, and adaption to post-modern attitudes for successful benchmarking.

Kouzmin, Löffler, Klages, & Korac Kakabadse (1999) studying public sector organisations observed that benchmarking process that is resisted by most, is actually, when implemented, bringing competencies in public administration. As a resultant benchmarking has gaining and there is a need to devise suitable measurement instruments meet the requirements of highly-risky information technology driven experiences of developments and failures of public sector.

Love, Bunney, Smith, & Dale (1998) argued that most organisations and people using benchmarking jargon refer it to as competitive analysis of product and equipment and not benchmarking of processes. Authors also observed sparsity of written material based on actual benchmarking experiences.

Bagchi (1996) studying benchmarking experiences of US based companies found improvements in standards of work processes due to benchmarking and proposed a benchmarking process based on their observations at various organisations.

Studies cited and discussed above suggest existence of benchmarking studies in various fields including manufacturing, energy, gas distribution, construction, automobile, transportation, telecom, railways services, tourism, health,

education, warehousing, airports, airlines, and shipping covering both public and private sector entities. Analysis of these research works proves that benchmarking is gaining popularity among business entities as a sustainable technique for improving efficiency. It also proves that existence of stakeholder involvement, clarity in processes to be benchmarked, smooth communication flow, usage of right technique, etc. are required for implementation of successful benchmarking. Techniques used for benchmarking include both parametric and non-parametric in nature are ever evolving and are based on the requirement of organisations that are being considered. The review also proves a greater need for benchmarking of public sector organisations, especially after initiation of privatisation initiatives across the world. This alone can make them competitive and reset their standards of performance to meet the business challenges. Review also proves that reliability of indicators and data hold the key for setting of foolproof benchmarking standards.

III. Benchmarking in port sector:

Measuring of sea port/terminal performance in the form of efficiency and productivity has been an interest of researchers. But, studies on benchmarking of ports/terminals have started recently and are limited in number. It is interesting to note that a majority of existing studies on benchmarking in this sector have considered container ports/terminals.

At the backdrop of privatisation initiatives across the world and resultant improvement in world trade, existence of robust and reliable ports has become a necessity to support foreign trade of nations across the world. Both traders and shipping industry are looking to ports and terminals that have strong hinterland connectivity and support in safe and speedy movement of their cargo. Privatisation of this sector has paved way for establishment of more ports/terminals

and resulted in intense competition among the players. This has mandated existence of standards for performance that act as benchmarks for the various stakeholders in the sector. Therefore, port authorities, irrespective of ownership model followed, are opting for benchmark their performance against the best performer to improvise on their inefficiencies. De Langen (2015) in the report on benchmarking of ports, argued that within next five years port performance benchmarking covering both efficiency and effectiveness vectors, with or without the cooperation of port authorities, will happen as users started gaining understanding and measuring end-to-end supply chain performance so as to improve their own competitiveness and create value addition for their own customers. While Wang & Cullinane, (2016) felt that non-existence of comprehensive quantitative benchmarking for port centric studies is a major constraint and dependence on qualitative comparisons and/or measures developed in social network analysis has resulted in non-consideration of 'directed' and 'weighted' network features of maritime container transportation.

Researchers, Vaghi & Lucietti (2016) suggested dwell time as critical for defining scenarios of port competitiveness and benchmarking, as it may be largely reduced by implementation of pre-clearance processes. An attempt to set benchmark standards for Hong Kong Port was taken up, Marine Department (2006) by considering 20 container ports, including Hong Kong Port, for analysis. The study has not used any technique to determine standards but analyzing selected container terminals of the world with variables such as costs incurred, physical features, and usage of IT. While Cuadrado, Frasquet, & Cervera (2004) proposed process of analysis and evaluation with different sequences and phases, processes, and dimensions for benchmarking at a port.

A detailed analysis of 16 research works collected on port/terminal benchmarking is presented in the following Table: 1.

Table: 1 Author-wise Literature Review on benchmarking studies specific to port/terminal efficiency

Author	Context	Technique	Variables	Conclusions	Gaps/Scope for further studies
(Serebrisky et al., 2016)	Developed a model for technical analysis for Latin American and Caribbean container ports using 10 year (1999-2009) panel data on 63 ports.	Scholastic Frontier Analysis (SFA)	Input: Berth Length, Terminal Area (m ²), Mobile Cranes with > 14 tons capacity, Gantry Cranes (No.) Output: Throughput (TEU)	The model developed bifurcated its input variables – total cranes as ship-shore cranes and mobile cranes, binary variable for taking advantage of cranes mounted on vessels for container handling, and binary variable for form of container cargo as transshipment and import/export. By using trans-log production function proved that with an average combination of inputs, gains in productivity from quay length and quay cranes are largest, followed by mobile cranes and terminal area. Using binary variable, the study proved that transshipment cargo and onboard cranes are significant to productivity. Classifications like container vs. multi-purpose terminals, Country's GDP, shipping liner connectivity, trade openness, etc. also influence output and technical efficiency. Private and land-lord ports bring-in efficiencies.	For further studies, proposed usage of alternative dimensions of efficiency measurement such as dwell times, crane productivity.
(Suarez-Alemán, Morales Sarriera, Serebrisky, & Trujillo, 2016)	Assessed container port performance at 203 ports for the period 2000 to 2010 using parametric and non-parametric approaches.	SFA, DEA, & Malmquist Productivity Index (MPI)	Input: Terminal Area (m ²), Berth Length (m), Mobile Cranes (No.s), Quay Cranes (No.s) Output: Throughput (TEUs)	Technology is not driving force for improvement in productivity. Developing regions improved scale-efficiencies during periods of financial crisis. Pure efficiency determines port productivity. SFA results prove that infrastructure inputs (quay length, no. of quay cranes and mobile cranes) help predict throughput, but, highest elasticities are associated with quay cranes and berth length. Understanding of market conditions and port level operations would help improve efficiencies rather than broad public policies.	

(Lu, 2014)	Assessed capabilities of various non-parametric approaches to measure port efficiency across 61 container ports for the period 2012-13	DEA & Free Disposal Hull (FDH)	Input: No. of Berths, Berth Length (m), Ave. Berth Depth (m), Terminal Area (m ²), Storage Capacity (TEU), Quayside Gantry Cranes (no.s), Yard Cranes & Tractors Output: Throughput (TEU)	DEA is a better technique to measure and benchmark efficiency than FDH which lacks sensitivity to analyze port efficiency. Study also found ship turnaround time and throughput are needed as output indicators to measure port efficiency.	Variables relating to physical parameters alone are considered.
(Port Regulators Of South Africa, 2014)	Compared performance of South African ports against a other international ports. Performance of a total of 20 Ports is compared.	Review Paper	Input: Total Area (ha), Length of berths (m), no. of cranes. Output: Throughput (TEU)	Study found South African ports registering variable results in comparison to global ports. It initiated benchmarking a basic activities of port.	More studies are required to benchmarking process to include various terminal performance measures covering marine services, berth productivity related to vessels, and optimal and efficient use of infrastructure at port.
(Bichou, 2013)	Compared performances of 60 container terminals for the period 2004 to 2010 and formulated numerous hypothesis to test sensitivity of benchmarking results to port market and operating conditions.	DEA	Input: Terminal Area (m ²), Max. Draft (m), Quay Length (m), Quay Cranes Index (TEU), Yard -Stacking Index TEU/1000m ² , Trucks & Vehicles (no.s), Gates (no.s) Output: Throughput	Variations in terminal operational aspects and market conditions greatly influence terminal efficiency. Study found that exogenous factors and market characteristics can have significant effect on terminal's efficiency ranking even for terminals with similar levels of operational efficiencies. At the same time level of automation, operating policies, work procedures, yard storage policy, gate operating procedures also influences efficiencies of terminals.	Efficiency measurement of container terminals and benchmarking should consider basic structure and mechanism applied for operations at the terminals and ports.

(Park et al., 2012)	Benchmarked performance of 34 international ports and proposed a DEA-Stepwise benchmarking method.	DEA	Input: Berth Length (m), Terminal Area, CFS, No. of loading machine Output: No. of unloading machines, No. of loadings	Proposed two models Benchmarking Distance Minimization (BDM) and Sensitivity Analysis applied DEA (SA-DEA) that can set benchmarking targets for inefficient ports based on minimization of reduced or expanded resources and identification of preferential resource improvement.	Existence of numerous ports between evaluated port and efficient port makes method ineffective and cumbersome. Further studies needed on reducing number of steps involved in benchmarking.
(Munisamy & Singh, 2011)	Assessed 69 Major Asian Ports to benchmark performance based on their technical and scale efficiency.	DEA	Input: Berth Length, Terminal Area, Total Refer Points, Total Quayside Cranes, Total Yard Equipment. Output: Total Throughput	The study found pure technical inefficiency as a significant factor than scale inefficiency for overall technical inefficiency at these ports. Study suggested for better port management and operational plans to reduce inefficiency. Study found that size and ownership structure do not influence efficiency at container ports	Ownership actually influence port efficiency. The study on container terminals considered ports that have multipurpose berths and multiple cargo operations.
(Hung, Lu, & Wang, 2010)	Benchmarked 31 container ports of Asia-Pacific Region using operating efficiency, scale efficiency targets, and variability of DEA efficiency estimates.	DEA Techniques	Input: Terminal Area (m), Quay Cranes (No.s), Container Berths (No.s), Length of Berths Output: Throughput (TEUs)	Suggested improvement in management practices in line with containerization to reduce pure technical inefficiencies which are resulting in technical inefficiencies. Expansion of ports to meet growing business. Setting scale efficiency targets provide guidelines for policy-makers to optimize resource utilization and economic scale. DEA studies should use Bootstrapping to detect reliability of efficiency ranking.	Study has not covered qualitative aspects of efficiency. Further studies with panel data can bring more clarity of efficiency of container ports.
(Sharma & Yu, 2009)	Fused data mining tool, Self-Organizing Maps (SOM) and DEA to develop a new technique to measure efficiency of inefficient container terminals	SOM & DEA	Input: Quay Length, Terminal Area, Quay Cranes, Transfer Cranes, Straddle Carriers, Reach Stackers Output: Throughput	Usage DEA to measure efficiency and set benchmark for inefficient terminals may give biased results, especially, for terminals that have differ in size, operating practices, and working in different environments.	Decomposing container terminal operations and investigating those processes is proposed as scope for further studies.

<p>(de Koster, Balk, & van Nus, 2009)</p>	<p>Aimed to compare efficiency scores of benchmarking and find reasons for such divergence.</p>	<p>DEA</p>	<p>Input: Quay Cranes (No.s), Quay Length, Terminal Area (hc), Output: Throughput (TEU)</p>	<p>Results show large terminals work with better efficiency than smaller ones and transshipment terminals performing efficiency in comparison to import/export terminals.</p>	<p>Issues such as non-differentiation between terminals and ports, comparing of small and large ports on same lines, comparing import/export terminals along with transshipment terminals are influencing the conclusions being drawn. Even reliable publicly available data does not reveal true facts on indicators being considered for the study. Assessment of indicators that reveal minute work processes, generally not in public domain, can alone bring the true efficiencies.</p>
<p>(Dias, Azevedo, Ferreira, & Palma, 2009)</p>	<p>Compared efficiency levels at 10 Container Terminals Iberian Peninsula to benchmark</p>	<p>DEA</p>	<p>Input: Cranes (no.) Workforce, Terminal area (ha.), Trailers (no.), Yard Equipment (no.), Quay Length (m) Output: Throughput (TEUs), Container Moves/hour/ship</p>	<p>Lack of in-depth performance variables constrained the study. Maintenance of such data helps port authorities in identifying their performance.</p>	<p>Study relied on a single year data.</p>

(de Koster et al., 2009)	Compared 38 container terminals with annual throughput of over 500,000 TEUs	DEA	Input: Quay Cranes (no.s), Quay Length (m), Terminal Area (ha). Output: Throughput	Compared results of benchmarking studies with results of this study.	
(Bichou, 2006)	Proposed an integrative framework for port performance by taking ports under logistics and supply chain management approach.	Review Paper		Conceptualizing of port performance from logistics and supply chain perspective helps in better assessing of performance & benchmarking. Proposed a supply chain framework by linking internal processes and external channel orientations, analyzing and integrating various performance dimensions.	
(Antão, Guedes Soares, & Gerretsen, 2005)	Benchmarking for European Ports for efficiency improvement.	Primary Data Collection using Questionnaire	Port specific information covering: General information, Statistics, Facilities, Services, Organization, Finance, Security and safety, Health, Environment, Employment, and Future developments and miscellaneous issues.	Study found that data required for benchmarking is neither readily available and nor standardized for taking-up benchmarking studies. Most ports are not aware of requirements and regulations regarding health, safety, security, and environmental issues.	Main focus is on small and medium ports.
(Cuadrado et al., 2004)	Proposed processes, dimensions and mapped them for benchmarking of ports services with port management indicator, competitor indicator, and comparative indicator perspectives.	LR; Analysis of reports on public and private ports; Personal Interviews; Administration of Questionnaires	All activities that a port performs are considered.	The study concluded that port services can be analysed with dimensions such as: time, safety, and cost against concrete indicators to know efficiencies and work on improving inefficiencies.	

(Tongzon, 1995)	Compared 23 international ports by dividing them into three groups for the year 1991.	PCA	Input : Gantry Cranes (no.s), Location (in binary) Number of Ship Visits, Vessel size and cargo exchange (TEUs per ship), Container Berths (no.s) Output : Throughput (TEUs)	Identification of ideal benchmarks is a key constraint in comparison of port efficiency. Assessment of efficiency can be justifiable if homogeneous ports are compared.	No differentiation could be made between input and output variables.
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From the above literature on benchmarking at ports, it is clear that studies in this area are less in number but slowly evolving. It can also be noted that most of the studies on benchmarking are taken-up at container terminals/ports. Rise in containerized cargo and container terminals, probably, is the prime reason for phenomenon. Studies used both parametric, non-parametric techniques to benchmark port performances. DEA has been the most popular tool used for studies measuring efficiency and benchmarking. Studies have proven that benchmarking at ports has paved way for performance enhancement. Studies are based on publicly available data which, often times, do not cover key indicators and at the same time are not totally reliable. Researchers argue that availability of data on key indicators would help in devising quality benchmarks.

While studies on benchmarking of ports are gaining ground across the world, no such attempt is made in Indian context. While, studies assessing efficiency and productivity at Indian ports are in existence, no initiative is still taken to set standards of performance in Indian context. Considering benefits of benchmarking on improving standards of performance, as highlighted by various international studies considered in this review paper, the authors propose to set benchmarking standards of performance for the major ports of India.

IV. Conclusions:

The paper reviewed research works pertaining to benchmarking concepts, its need, scope, and contribution to performance enhancement. Review of these research works has given opportunity to understand the significance of benchmarking in performance improvement. This is followed by an analysis of research works relating to

benchmarking in various sectors of economies across the world which, has proven considerable improvement in efficiency at organisations that have opted for benchmarking. Finally, review of research works on sea ports/terminals has also proven the existence of huge scope in this area for research. It is observed that most of the existing studies are constrained by data availability. Existing studies have proved that apart from the broad port performance indicators, there exist considerable number of other performance factors at the operational level of a port that can influence performance of seaports. Researchers have started benchmarking port performance basing on some of these latent performance indicators and helped authorities in improving port efficiency. Benchmarking studies on ports are based on indicators that contribute significantly to efficiency, but are not in public domain. Indicators such as level of technology, existence of reliable resources, workforce skillset, customer satisfaction, socio-economic influences etc. are used to set standards of performance. Therefore, it is evident that such a study would bring out the actual factors at the minutest level of port operations that contribute to efficiency/inefficiency of a port. Benchmarking studies on the major ports of India would bring out more factors for setting of standards as most of these ports are equipped to handle multiple cargo and have common facilities for a wide variety of cargo that they handle. It is also observed that DEA as a popular tool to set benchmarking standards at port and terminals due to its ability to handle multiple input and output variables. Taking a cue from the international studies, the authors, as further studies, propose to set benchmarking standards for the major ports of India.

Inferences drawn from the literature gaps makes it evident that, researchers used publicly available data that provided broader picture of port performance. But this data does not reflect true picture of the ground level factors at berth, yard, gate, starboard side operations that influence actual performance of a terminal. Therefore, the authors propose to get data from the actual operations sites involving various processes at a terminal/port for accessing the factors contributing to efficiency/inefficiency and determine performance benchmarks standards. Authors propose to set benchmark standards covering activities such as berth utilization rate, average turnaround time, average pre-berthing time, berth output per crane, equipment utilization rate, gate throughput, throughput per worker, cost per employee, and reasons for resource wastage and underutilization.

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