

A Benchmarking of Major Seaports of India

Sandip Solanki, Krishna Murthy Inumula

Abstract: This research study uses annual time series data 1999-2017 on selected physical performance indicators vessel traffic, average pre-berthing waiting time, average turn round time (ATRT), percentage of idle time at berth to time at working berth (PIBTW) and average output per ship berth day (AOPBD) of major ports in India. These selected physical performance indicators analysed by the method of principal component factor analysis which had given equal weights to the indicators thereby ranked the ports based on the overall score. Result found that JNPT port occupies the first position with a total score of 966 awarded rank 1, followed by Ennore port second rank with a score of 789 and Kandla port occupying with rank three with a total score of 712, Kolkata, Haldia and Tuticorin ports showed poor performance and are ranked 13, 12 and 11th positions respectively.

Key Words: Port Ranking, Physical Performance Indicator, Benchmarking and Factor Analysis
JEL Code: F14, L92, P17

I. INTRODUCTION:

India has a rich history of internal and external trade through ports. Indian ports play a significant role in transforming Indian economy to a new level at par with the developed economy. The majority of industries in India & around the world are located in the coastal belts, in the vicinity of major ports. India handled the tune of 561.39 MT cargo during April –January 2018 and currently 578.86 MT of cargo during April-January 2019, through its 13 major ports, representing a growth of 3.11 per cent. In the era of the globalization, Indian ports saw a good competition among the neighbouring ports that helped more efficient import and export business contributing to national development in creating new import and export zones in the country. As seaports handle the majority of international merchandise trade, ports act as a hub for the shipping of goods between the nations and existence of developed ports help in the movement of inbound and outbound cargo between trading nations. Geographic concentrations of ports occur in all major trading regions and their solidity is strictly connected to the economic well-being of their neighbourhoods and the foreign provinces where they are connected by shipping services (Pettit & Beresford, 2008). An efficient seaport infrastructure provides comparative advantages to the nation in the global market. Therefore, the systematic appraisal of seaport efficiency can reveal their relative positions in the competitive environment. The paper has been organized into five sections. The first section gives an introduction and provides some necessary information about the background of the study. The second section assesses the literature.

Revised Manuscript Received on March 2, 2020.

*Correspondence Author

Dr. Sandip Solanki*, Symbiosis Institute of International Business (SIIB), Symbiosis International (Deemed University), Pune, Maharashtra, India. Email: sandip.solanki@siib.ac.in

Dr. Krishna Murthy Inumula, Symbiosis Institute of International Business (SIIB), Symbiosis International (Deemed University), Pune, Maharashtra, India. Email: dr.krishna@siib.ac.in

Data sources and methodology have been presented in the third session. The results have been described in the fourth section. The final and fifth section concludes with conclusions and some policy implications of the study.

II. LITERATURE REVIEW:

There is no study on physical performance indicators covering the time series 1999-2017 with particular reference to India. Some literature reviewed as below;

Jose L. Tongzon & Ganesalingam (1994) compared the performance and efficiency of the ASEAN ports by their (similar) external foils. The results inveterated that the ASEAN ports have realized advanced stages of competence in the use of cranes, berths and storage areas, with the Singapore port being the highest player. However, they are usually less effective in terms of appropriateness, labor, and use of tugs. The rates in ASEAN ports are also significantly more than those of their (similar) foreign counterparts. Rajasekar, Ashraf, & Deo (2014) highlighted that JNPT seaport rated the excellent competent port amongst designated key ports in India. Jim Wu & Lin (2008) found that the efficacy worth of the vessel seaport in India is second only to the US port of Los Angeles among the ports surveyed in the developed countries. Prabir De (2002) studied further growth in the seaport is highly dependent on how quickly new machinery and better facilities can accommodate it. Coto-Millan, Banos-Pino, & Rodriguez-Alvarez (2000) analysed annual data for the 27 Spanish ports from 1985 to 1989, highlighted that comparatively bigger seaports are economically additional incompetent. De (2006) reviewed that ports in India are becoming more wealth concentrated in the post reform period, and except one, the rest of all Indian ports showed statistically substantial variations in TFP's overall productivity factor in the last quarter of a century. The study also found that, contrary to popular belief, the post-reform economic climate still has no significant influence on the routine of Indian ports in terms of the most popular performance degree, the TFP.

Jose Tongzon, (2001) used Data Envelopment Analysis (DEA) to provide competence measurements for four Australian and twelve other global vessel ports. Research has shown that the ports of Melbourne, Rotterdam, Yokohama and Osaka are the greatest incompetent ports, based on continuous and adjustable returns to scale norms, largely due to the massive loose in their vessel berths. J. Wu, Yan, & Liu (2010) results indicated that the number of berths and the capital deployed are the most sensitive measures impacting performance of most container ports.

The study analysed 77 global container ports. Cuadrado, Frassetto, & Cervera (2004) found that the selection of a port made by clients–freight companies and export and import companies–is not based solely on location; the different port services offered and the quality of service are highly relevant. Woo, Pettit, & Beresford (2011) presented that seaport productivity is multilayered, it is not just restricted to inside procedures, but also connected to external facility features such as facility superiority, etc.

Cheon (2007) examined that port efficiency is formed not only by the strength of interplanetary rivalry, but also by the aptitude of port specialists to device groundbreaking official practices in the context of a internationalized, modest world trade arrangement.

Valentine & Gray (2001) studied that the simple structure is the most efficient form of organizational structure, whilst ownership structure does not appear to have any significant influences upon efficiency. Organizational restructuring of an inefficient port must not be seen in its own right to be the panacea, but must go hand-in-hand with new financing and investment. Pantouvakis & Dimas (2010) found that ISO-certified seaports are financially extra competent than their non-certified players. De & Ghosh (2003) found that the fundamental affiliation amongst port result and port traffic flow using Indian data. The use of the co-integration investigation resulted in performance being preceded by traffic in most ports in India. Estrada, Jenatabadi, & Chin (2017) found that the marginal level of seaport efficiency is centered on how the human capital factor can be adapted to these new changes. Park & De (2014) found that alternate DEA is a possibly prevailing method to the assessment of the general competence of ports. Atul Deshmukh (2002) found that only the JNPT seaport has exposed some optimistic competence related to other key seaports in India. Prakash Gaur, Shivani Pundir, & Tarun Sharma (2010) tried to probe on how ports in developing countries like India should increase their capacity from operative size to likely size and to complete size. The study found that if Indian seaports grow at a very high development speed, they may face size limitations. It means adding capacity without improving the efficiency of the system would result in underutilizing the potential capacity of the system. The study suggested that institutional cooperation could be used as a strategic tool to improve efficiency and, at the same time, options such as public private participation should be tested by the government to improve competition and, subsequently, the efficiency of ports.

Dwarakish & Salim (2015) studied the role played by ports in the development of a nation. Gaur et al., (2011) argued that, although major programs and actions are launched to upsurge the size of seaports, there is a lack of immediate need to increase the efficiency of port operations. J. Wu, Yan, & Liu (2009) extended the Doyle and Green model by considering the DMU groups to determine the final cross-efficiency. A new approach based on the cross-efficiency assessment method is being developed and applied to the efficiency analysis of 28 container ports in 12 Asian countries. Feng, Mangan, & Lalwani (2012) suggested that Western European seaports has to develop administration provision, decrease seaport rates, spread

seaport possession and advance seaport connectivity, while Eastern Asian seaports require to advance levies facilities, increase vicinity facilities, upsurge logistic demand, inspire intermodals and set up 'dry ports.' SangHyun Cheon (2007) observed that ports across the world have improved in their productivity due to three main reasons. These three are: (a) improvement in management in capital inputs, (b) production scale adjustments, and (c) technological progress. The study also found that large-scale ports need to be more efficient, as they have adopted in the above-mentioned points. The study also notes that port efficiencies also depend on the ability of port establishments to device ground-breaking formal practices in a global competitive environment. KM Chudasama (2009) presented that the physical facilities of ports make a significant contribution to the largely result of the seaport. The size of freight held, one of the functioning factors, meaningfully affected the outcome of seaport.

III. DATA & METHODS

A. Data and Scope

This research study uses annual time series data 1999-2017 on selected physical performance indicators vessel traffic, average pre-berthing waiting time, normal turn round period, proportion of indolent period at berth to time at working berth and average productivity per ship berth daytime of major Indian seaports. The data is extracted from Indiasta.com web portal from the source of Ministry of Shipping, Road Transport & Highways Government of India. The expansion of the seaport segment is significant for the growth of sea trade in existing globalized world. In the first four decades of post-independence, India's shipment and seaport segment saw intense development on the inventiveness of deliberate progress and lively administration provision. Over two thirds of seaport shipment handling capacity and more than half of India's national transport weight have been recognized in the first four periods of freedom.

India lacks of inter-port and intra-port competition that has led to significant increases in productivity in other countries due to unfortunate interior connectivity and a rule management that protects local seaports from economic weights. In this context, the present study identifies five physical performance indicators on the basis of which the major ports of India are benchmarked by giving them ranks based on the best performance.

B. Research Methods

Descriptive research design is used in this study, simple arithmetic measures like descriptive statistics mean and standard deviation describe the average values of data variables and their deviation from the average value. The compounded annual growth rate (CAGR) is a useful measure of growth over the study period it gives the growth rate of physical indicators over the period of time.

Correlation matrix is used to measure the linear relationship between physical performance indicators of major ports, the correlation coefficient (r) value determines the magnitude and direction of correlation, if the value of r lies between 0.75 and 1 expect high optimistic association, between 0.5 and 0.75 modest optimistic association and 0 to 0.5 low positive correlation. If the value of r lies between -1 and -0.75 expect high negative correlation, between -0.75 and -0.5 moderate adverse association and - 0.5 to 0 low negative correlation.

A comprehensive study by Nardo, M., et al. (2005). Tools for Composite Indicators Building used in this study as a reference. Principal component based factor analysis to weigh the performance indicators in port ranking, the detail methodology is as follows. Principal component analysis (PCA) based factor analysis is a method of data reduction technique in which the number of factors extracted are lesser than the variables in such a way that the first factor represent highest likely difference followed by the next highest and so on such that all likely difference in the variables or pointers represented by the least likely quantity of factors. After verifying the correlation structure of the variables the next step is to determine the number of factors to be selected based on value of Eigen value or higher proportion of explained variance methods. The standard practice is to choose factors that: (i) have associated eigenvalues larger than one; (ii) cumulatively contribute to the explanation of the overall variance by more than 60%. The next step is to rotate the factors (usually varimax method of rotation) so that the variance extracted will be distributed proportionately to the selected factors. The final step concerns the structure of the mass of the background of the factor loadings after rotation, given that the square of the factor loadings represents the percentage of the total unit alteration of the pointer clarified by the aspect. The approach taken by Nicoletti G., Scarpetta S., Boylaud O. (2000) is the grouping of sub-indicators with the highest loading factors in the composite indicator.

The factor weights are obtained by dividing the square of the factor loadings by the explained variance of that factor (Eigen value), the proportion of factor variance is obtained by dividing the explained variance by the total variance. The final weights are obtained as a sum product of proportion of factor variance and factor weights. The original variables are transformed in to standardized variables by a suitable transformation then multiplied with the final weights as a sum product to get the total score for each decision making unit (in this study the major ports of India) higher the total score better the rank in terms of physical performance indicators.

IV. RESULTS & DISCUSSIONS

Trend of Data Variables

PORT	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	AVG
Kolkata	922	687	644	677	687	730	734	891	1022	1057	1301	1301	1203	1216	1241	1314	1442	1308	1028
Haldia	1258	1405	1529	1659	1832	2086	2348	2300	2335	2389	2166	2188	1982	1943	1970	1907	2026	2087	1968
Paradip	712	886	890	887	961	1053	1187	1355	1513	1536	1531	1487	1328	1274	1443	1400	1521	1580	1252
Visakhapatnam	1654	1648	1580	1622	1677	1805	2071	2052	2346	2247	2408	2459	2432	2041	1970	1942	2019	1944	2001
Ennore	-	-	71	154	166	171	173	201	213	250	273	293	385	475	689	779	813	801	369
Chennai	1797	1765	1598	1593	1656	1669	1857	2059	2053	2078	2132	2181	2043	1928	1894	1790	1723	1600	1852
Tuticorin	1071	1205	1400	1426	1479	1435	1549	1509	1578	1524	1414	1402	1376	1292	1095	1380	1388	1662	1410
Cochin	973	969	979	945	912	821	959	907	806	757	872	819	833	875	995	997	1166	1216	994
Mangalore	749	734	763	832	878	1057	1080	1015	1144	1184	1186	1097	1136	1072	1062	1032	1243	1417	1038
Marmagao	505	539	597	626	677	664	642	699	748	805	895	853	785	475	388	519	605	760	656
JN.P.T	1338	1654	1883	1766	2105	2064	2395	2775	3119	2801	3049	3100	2923	2588	2526	2642	2780	2720	2467
Mumbai	2233	1921	1796	1629	1800	1883	2053	2087	2066	1931	2046	2052	2017	1908	2262	1959	2037	1994	1940
Kandla	1855	1452	1672	1813	1823	1940	2124	2318	2598	2517	2776	2892	2714	2784	2304	2216	2513	2568	2259
TOTAL	15067	14085	15402	15529	16651	17378	19771	20168	21529	21366	22047	21979	21165	19851	19759	19877	21488	21655	

Figure 1 Vessel Traffic at Major Ports (1999-2017)

Vessel Traffic (VT): one of the port throughput measures represents the number of vessels sailed over time mostly affected by the demand for cargo, cargo volumes and physical capacity of the port. The traffic in terms of the number of vessels (excluding container) handled by the major ports considered in the study (Figure 1) have increased from 15067 to 21655 during the period 1999-00 to 2016-17 registering a compound growth rate of 2.24%. The major ports of India experienced consistently increasing trend in vessels traffic throughout the period.

The JNPT tops the list with highest vessels traffic increased from 1338 in 1999-00 to 2720 in 2016-17, with an average container vessels traffic of 2467 with average growth rate of 12.73% during the study period, followed by Kandla Port Trust whose average vessels traffic during the period was 2259 with an average growth rate of 11.72%, Visakhapatnam port occupies third place with an average vessels traffic 2001 with an typical progression degree of 10.44%. The lowest number of vessels traded was at Ennore Port with an average vessels traffic of 369 with an average growth rate of 1.82%.

PORT	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	AVG
Kolkata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Haldia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paradip	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Visakhapatnam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ennore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chennai	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tuticorin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cochin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mangalore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marmagao	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
JN.P.T	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mumbai	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kandla	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 2 Average Pre-berthing Waiting time at Major Ports (1999-2017)

Average Pre-berthing Waiting time (APBT): Time taken by a vessel from entrance at the dock to the reporting post till it arrives at the operational berth excluding time taken for internal movement, obtained by dividing the total pre-berthing waiting time of all freight containers cruised from the seaport through a period by the number of freight containers navigated during that period.



The above correlation matrix shows how the physical indicators are correlated with each other, there exists a low positive correlation between vessel traffic vs pre berthing waiting time and turn round time, a low negative correlation exists between vessel traffic vs idle time at berth and output per ship berth day. Though not significant, turn round time and idle time at berth are having low positive correlation between them. Pre berthing waiting time and turn round time are moderately positively correlated and the correlation value is significant. There exists a significant negative correlation between idle time and output per ship berth day as the idle time at berth decreases the more the output per ship berth day.

Ranking Port performance

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.954
Bartlett's Test of Sphericity	Approx. Chi-Square	25.559
	df	10
	Sig.	.004

Both the tests (KMO is more than 0.7 and Bartlett's significant value less than 0.05) confirms that factor analysis is appropriate for the current study with the five physical indicators to measure the performance of Indian major ports.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.176	43.517	43.517	2.176	43.517	43.517	1.867	37.347	37.347
2	1.503	30.052	73.569	1.503	30.052	73.569	1.698	33.959	71.306
3	1.010	20.195	93.764	1.010	20.195	93.764	1.123	22.458	93.764
4	.217	4.344	98.107						
5	.095	1.893	100.000						

Extraction Method: Principal Component Analysis.

Factor analysis using the method of principal components extracted a total of three component accounting almost 94% contribution to the study also referred to as factors out of the five physical performance indicators considered in the study. The Eigen values (variances of the principal components) of more than 1 are considered in accounting the total variance explained. The communalities are also high justifying the maximum proportion of each indicator variance that can be explained by the principal components.

Rotated Component Matrix

	Component		
	1	2	3
VT	.043	.089	.990
APBT	-.138	.923	.214
ATAT	.338	.896	-.070
IDLETIME	.946	-.025	-.153
AOSD	-.915	-.189	-.263

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

The rotated component matrix (factor loadings) using varimax rotation shows the correlation between indicator and factors. The next step contracts with the building of the bulks from the contextual of feature loadings after rotation, given that the square of factor loadings represent the proportion of the total unit adjustment of the indicator which is clarified by the factor. Thus the first component explained variance is 1.867, followed by second component 1.698 and third component explained variance is 1.123. The proportion of factor variance is obtained by dividing the explained

variance of each factor by the total variance of all factors combined, thus the proportion of factor variance by first factor is 39.83%, second factor is 36.21% and third factor is 23.95%.

Factor Weights				Proportion of factor variance	Final Weights
VT	0.000977	0.004621	0.872409	0.398310184	0.21102
APBT	0.010176	0.50159	0.040648	0.362172728	0.195451
ATAT	0.061109	0.472476	0.004409	0.239517088	0.196514
IDLETIME	0.47911	0.000376	0.020943		0.195987
AOSD	0.448628	0.020936	0.061591		0.201028

The factor weights are obtained by dividing the square of the factor loadings by the explained variance of that factor (Eigen value), the final weights are obtained as a sum product of proportion of factor variance and factor weights. The following table gives the final weights.

The original variables are transformed in to standardized variables by a suitable transformation then multiplied with the final weights as a sum product to get the total score for each of the major ports of India, higher the total score better the rank in terms of physical performance indicators.

STANDARDIZED	VT	APBT	ATAT	IDLETIME	AOSD	WEIGHTS	VT	APBT	ATAT	IDLETIME	AOSD	TOTAL	RANK
Kolkata	2.76	2.91	1.63	1.00	1.00	21	58.04	55.33	32.59	20.00	20.00	185.96	13
Haldia	5.33	1.54	2.59	5.92	2.42	19	111.93	29.23	51.89	118.33	48.34	359.72	12
Paradip	3.39	1.32	1.78	12.41	4.56	20	71.24	25.04	35.58	248.11	91.23	471.20	10
Visakhapatnam	5.42	2.08	2.37	14.78	3.61	20	113.84	39.59	47.46	295.56	72.20	568.65	6
Ennore	1.00	2.62	3.78	23.34	8.83	20	21.00	49.86	75.55	466.74	176.59	789.74	2
Chennai	5.02	2.34	2.74	12.59	3.56		105.34	44.41	54.76	251.86	71.22	527.59	7
Tuticorin	3.82	2.24	2.81	11.79	2.18		80.21	42.54	56.14	235.78	43.52	468.19	11
Cochin	2.53	2.86	4.41	10.59	3.74		53.10	54.25	88.11	211.76	74.70	481.92	8
Mangalore	2.81	2.83	3.80	18.69	4.70		59.03	53.85	75.93	373.78	94.02	656.61	4
Mormugao	1.78	1.51	1.00	21.18	4.13		37.33	28.67	20.00	423.58	82.59	592.17	5
JNPT	6.68	2.66	4.59	28.39	5.81		140.35	50.57	91.71	567.71	116.14	966.48	1
Mumbai	5.37	2.37	2.07	11.47	2.48		112.86	45.02	41.37	229.49	49.52	478.25	9
Kandla	6.12	1.00	1.20	23.19	3.85		128.49	19.00	23.98	463.89	77.03	712.38	3

For the selected physical indicators of port performance JNPT port occupies the first position with a total score of 966 awarded rank 1, followed by Ennore port second rank with a score of 789 and Kandla port occupying with rank three with a total score of 712.

For the selected physical indicators of port performance Kolkata, Haldia and Tuticorin ports showed poor performance and are ranked from last 13, 12 and 11th rank respectively. Mangalore, Mormugao and Visakhapatnam ports stood in the next best with ranks 4, 5 and 6th rank respectively.

V. CONCLUSION

Port performance in physical indicators reflect how efficient the port operations in terms of better cargo handling, managing time lines and efficiency of port. Both inter and intra port competition is required to assess the benchmark performance so that a healthy competition prevail between the ports. The selected physical indicators viz...vessel traffic, average pre-berthing waiting time, middling turn round time, ratio of idle period at dock to time at working dock and average productivity per vessel dock day, analysed by the method of principal component factor analysis had given equal weights to the indicators thereby ranked the ports based on the overall score. JNPT port occupies the first position with a total score of 966 awarded rank 1, followed by Ennore port second rank with a score of 789 and Kandla port occupying with rank three with a total score of 712, Kolkata, Haldia and Tuticorin ports showed poor performance and are ranked 13, 12 and 11th positions respectively.

REFERENCES:

- Atul Deshmukh, "Indian Ports – The Current Scenario" Working Paper No. 14, Dr. Vibhoothi Shukla Unit in Urban Economics & Regional Development, Mumbai.
- Cheon, S. (2007). *The productive efficiency of ports: lessons from the Pacific Rim Seaport's corporatization and Strategic Management*: University of California at Berkeley, Institute of Urban and Regional
- Chudasama, K. M. (2009). Performance appraisal of Indian major ports using port ranking model. *IUP Journal of Infrastructure*, 7(1), 7.
- Coto-Millan, P., Banos-Pino, J., & Rodriguez-Alvarez, A. (2000). Economic efficiency in Spanish ports: some empirical evidence. *Maritime Policy & Management*, 27(2), 169–174. <https://doi.org/10.1080/030888300286581>
- Cuadrado, M., Frasquet, M., & Cervera, A. (2004). Benchmarking the port services: a customer oriented proposal. *Benchmarking: an International Journal*, 11(3), 320–330. <https://doi.org/10.1108/14635770410538781>
- De, P. (2006). Total factor productivity growth: Indian ports in the era of globalisation. *Maritime Economics & Logistics*, 8(4), 366–386.

- De, P., & Ghosh, B. (2003). Causality between performance and traffic: an investigation with Indian ports. *Maritime Policy & Management*, 30(1), 5–27. <https://doi.org/10.1080/0308883032000051603>
- Dwarakish, G. S., & Salim, A. M. (2015). Review on the Role of Ports in the Development of a Nation. *Aquatic Procedia*, 4, 295–301. <https://doi.org/10.1016/j.aapro.2015.02.040>
- Estrada, M. A. R., Jenatabadi, H. S., & Chin, A. T.H. (2017). Measuring Ports Efficiency under the Application of PEP-Model. *Procedia Computer Science*, 104, 205–212. <https://doi.org/10.1016/j.procs.2017.01.107>
- Feng, M., Mangan, J., & Lalwani, C. (2012). Comparing port performance: Western European versus Eastern Asian ports. *International Journal of Physical Distribution & Logistics Management*, 42(5), 490–512. <https://doi.org/10.1108/09600031211246537>
- Jim Wu, Y.-C., & Lin, C.-W. (2008). National port competitiveness: implications for India. *Management Decision*, 46(10), 1482–1507. <https://doi.org/10.1108/00251740810920001>
- Kek Choo Chung, "Port Performance Indicators" file:///O:/PUBLIC/twu_xweb/transport/publicat/td-ps6.htm (2 of 5)07/17/2005 10:00:22 AMKutin, N., Nguyen, T. T., & Vallée, T. (2017). Relative Efficiencies of ASEAN Container Ports based on Data Envelopment Analysis. *The Asian Journal of Shipping and Logistics*, 33(2), 67–77. <https://doi.org/10.1016/j.ajsl.2017.06.004>
- Langen, P. de, Nidjam, M., & van der Horst, M. (2007). New indicators to measure port performance. *Journal of Maritime Research*, 4(1), 23–36.
- Nardo, M., et al. (2005). *Tools for Composite Indicators Building*. EUR 21682 EN © European Communities, 2005 weblink: <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC31473/EUR%2021682%20EN.pdf>
- Nicoletti G., S. Scarpetta and O. Boylaud, (2000), Summary indicators of product market regulation with an extension to employment protection legislation, Economics department working papers NO. 226, ECO/WKP(99)18. <http://www.oecd.org/eco/eco>
- Pantouvakis, A., & Dimas, A. (2010). Does ISO 9000 series certification matter for the financial performance of ports? Some preliminary findings from Europe. *Maritime Policy & Management*, 37(5), 505–522. <https://doi.org/10.1080/03088839.2010.503714>
- Park, R.-K., & De, P. (2014). An Alternative Approach to Efficiency Measurement of Seaports. In H. E. Haralambides (Ed.), *Port management* (pp. 273–292). Houndmills, Basingstoke, Hampshire: Palgrave Macmillan. https://doi.org/10.1057/9781137475770_13
- Pettit, S., & Beresford, A. (2008). An Assessment of Long-Term United Kingdom Port Performance: A Regional Perspective. *Maritime Economics & Logistics*, 10(1-2), 53–74. <https://doi.org/10.1057/palgrave.mel.9100191>
- Prabir De, "Productivity, Efficiency and Technological Changes in Indian Ports" PIANC 2002, 30th International Navigation Congress, Sydney, September 2002, page 1751-1766.
- Prakash Gaur Shivani Pundir Tarun Sharma, "Ports face inadequate capacity, efficiency and competitiveness in a developing country: Case of India" Page 1 – 33.Rajasekar, T., Ashraf, P. S., & Deo, P. M. (2014). Measurement of efficiency of major ports in India—a data envelopment analysis approach. *International Journal of Environmental Sciences*, 4(5), 926–936.
- SangHyun Cheon, "The Productive Efficiency of Ports:Lessons from Pacific Rim Seaport's Corporatization and Strategic Management" Working Paper 2007-03, Institute of Urban and Regional Development, University of California at Berkeley.Tongzon, Jose. (2001). Efficiency measurement of selected Australian and other international ports using data envelopment analysis. *Transportation Research Part a: Policy and Practice*, 35(2), 107–122.
- Tongzon, Jose L. (1995). Determinants of port performance and efficiency. *Transportation Research Part a: Policy and Practice*, 29(3), 245–252. [https://doi.org/10.1016/0965-8564\(94\)00032-6](https://doi.org/10.1016/0965-8564(94)00032-6)
- Tongzon, Jose L., & Ganesalingam, S. (1994). An evaluation of ASEAN port performance and efficiency. *Asian Economic Journal*, 8(3), 317–330.
- Valentine, V. F., & Gray, R. (Eds.) 2001. *The measurement of port efficiency using data envelopment analysis*. : Vol. 22: Seoul South Korea.
- Wang, T.-F., Song, D.-W., & Cullinane, K. (2003). Container port production efficiency: a comparative study of DEA and FDH approaches. *Journal of the Eastern Asia Society for Transportation Studies*, 5(10), 698–713.

26. Woo, S.-H., Pettit, Stephen, & Beresford, Anthony. (2011). Port evolution and performance in changing logistics environments. *Maritime Economics & Logistics*, 13(3), 250–277. <https://doi.org/10.1057/mel.2011.12>
27. Wu, J., Yan, H., & Liu, J. (2009). Groups in DEA based cross-evaluation: An application to Asian container ports. *Maritime Policy & Management*, 36(6), 545–558.
28. Wu, J., Yan, H., & Liu, J. (2010). DEA models for identifying sensitive performance measures in container port evaluation. *Maritime Economics & Logistics*, 12(3), 215–236. <https://doi.org/10.1057/mel.2010.6>



Dr. Krishna Murthy Inumula - Associate Professor
P.hD (Statistics)
M.Phil (Development Statistics)
U.G.C.,_Net Qualified (Lectureship)
Certified in Project Management (PMA-IPMA)

• **PROFILE**

Professional trainer in various fields like Market Research Analytics, Statistics, Operations Management, Project Management, Econometrics, Quality Control and Business Analytics have been constantly enriching experience through the executive education development programs like Faculty Development (FDP), Management Development (MDP) and Executive Development to promote and contribute research and innovation among knowledge community.

Some of the glimpses are, conducted as a resource person Corporate Training Program MDP in Project Management and its contemporary Applications in Evaluating the Port Performance for the Employees of Gujarat Maritime Board (GMB) –Ahmadabad, Gujarat, India. Eight corporate batches were trained span over two years 2009-2011. Executed MDP - Project Management for Petro Bangla to the corporate of Bangladesh Petroleum Company, Bangladesh. Conducted MDP- Materials & Operations Management for Corporate of Oil & Gas Sector, Indian Oil Corporation Ltd. (Pipeline Division), Noida, UP, India. Chairperson for MDP in ISB&M Pune - Small & Medium Enterprises: Agenda for Profitability.

Professional data analyst in dealing with complex data models, expertise in various software like SPSS, MINITAB, EVIEWS and MSPROJECT. Time series data modelling, casual data analysis and multivariate data analysis are the core expertise. Authored and contributed to management topics around 31 papers and articles in various national and international journals and conferences. Some of the journals include Arthshastra: Indian Journal of Economics & Research, NICMAR: Journal of Construction Management, Indian Journal of Finance Prabandhan: Indian Journal of Management and International Journal of Ecological Economics and Statistics. Rich experience in handling hundred plus master's level management dissertation projects and guided so far one M.Phil. and one Ph.D. scholars in the areas of general management-marketing and project management areas respectively.

• **WORK EXPERIENCE**

Academic 12 years of teaching experience includes working with College of Management Studies, University of Petroleum and Energy Studies, Dehradun, ITM (Institute for Technology and Management), Warangal Andhra Pradesh and with International School of Business & Media, Nande, Pune.

Taught Subjects like Econometrics, Project management, Operations Management Quantitative Techniques Research Methodology at the University of Petroleum & Energy Studies in the Post & Under Graduate courses in the areas of Oil & Gas, Power, Pipe line Engineering, Gas Engineering, Energy trading, Infrastructure, Aviation, Logistic & Supply Chain, Port & Shipping Management & International Business.

Teaching Interest: Business Statistics, Operations Management, Project Management, Business Research Methods and Market Research.

Research Interest: Data Driven Models, Predictive Modelling, Simulation, Analytics and Benchmarking.

AUTHORS PROFILE



Dr. Sandip Solanki

Educational Credentials:

- Ph. D – “Globalisation and Its Impact on Indian Economy”
- M. A. in Economics – 62%
- Executive Diploma in Marketing Management – 58%

Academic Experience:

- Having more than fifteen years of teaching experience in various B-Schools as a faculty of Management. Presently working as an Associate Professor & Head International Business Dept. @ Symbiosis Institute of International Business (SIIB), SIU, Pune.

Research Experience:

- Having more than ten years of research experience which embraces more than 35 research papers publication in various Scopus & ABDC, UGC listed journals, PhD supervisor and completed research project funded by SIU.

Conducted MDP:

- Conducted Management Development Program for numerous MNCs like Wipro Ltd., Pune, Wipro Ltd., Chennai, Mahindra & Mahindra Ltd., Zaheerabad, Amdocs Pune, Awaya Pune, Welspun Ltd., Mumbai, FIEO – set up by Ministry of Commerce, Government of India etc.

Board of Studies Member:

- Chairperson, Board of Study, Faculty of Management, International Business, Symbiosis International University, Pune.

Invited as a Conference Chairperson:

- Chaired many international and national conferences in India and abroad which includes Waljat College of Applied Sciences, Muscat, Oman, Nepalese Academy of Management, Kathmandu, Nepal, etc.

Invited as a Speaker:

- Under the Ishwarbhai Ambalal Fellowship Programme at S.P. University, Anand
- Export Promotion Council for Handicrafts, at Pune
- Gujarat Technological University, Gujarat
- World Education Summit 2013 for the session of ‘Industry - Academia Bridge: Channelizing Collaborative Models’, organized by AICTE and Elets, New Delhi
- Department of Management Sciences (PUMBA), University of Pune, Pune, on March 20-21, 2009.

Associated:

- Life member of Indian Economic Association
- Life member of Gujarat Economic Association
- Member of the Indian Society for Labour Economics, New Delhi
- Indira Gandhi National Open University.

Personal Details:

- Date of Birth: 9th September 1976
- Languages Known: English, Hindi & Gujarati
- Hobbies: Music and Reading