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Evaluating Health System Efficiency using Data Envelopment Analysis: A case of Indian Healthcare System

Shawnn Melicio Coutinho
Goa Institute of Management, Goa, India
Ch. V. V. S. N. V Prasad
Birla Institute of Technology and Science (BITS) Pilani, Goa, India
Rohit Prabhudesai
Goa Institute of Management, Goa, India

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Abstract

Purpose-With increased demand and restricted healthcare resources, it becomes important to take a step back and evaluate the efficiency of healthcare delivery. The present study aims to evaluate the health system efficiency of India by benchmarking it against its peers in BRICS countries and against OECD countries.

Design/Methodology/Approach: The input and output variables required for measuring the efficiency of healthcare system were identified. A Data Envelopment Analysis (DEA) approach was used and efficiency frontier identified with the rankings of the BRICS and OECD countries. India is thus benchmarked against its peers (BRICS) and against OECD countries.

Finding: India was found to operate at the efficiency frontier along with China, Russia, Brazil, and South Africa, however it ranked fourth. When benchmarked against OECD countries, India operates on the efficiency frontier along with Canada, Greece, Japan, Korea, Mexico, Spain, Sweden, Switzerland, Turkey, Great Britain, Chile and Israel. Countries like Germany, United States of America, Czech Republic, Slovakia and Lithuania operate at a lower healthcare efficiency and need to use their resources wisely.

Practical/Research Implications: Developing countries like India can look to improve its healthcare system delivery by replicating best practices of healthcare systems from its peers and the top 10 OECD countries. Majority of the OECD countries in the top 10 have implemented universal health coverage, have higher physician and nurse density and higher hospital bed ratios. They are inclined towards branded drugs vis-à-vis generics and have follow evidence-based medicine. From a theoretical perspective, it adds to the body of literature of DEA and health system efficiency.

Originality/Value: This is a pioneer study that benchmarks India against its peers and against OECD countries drawing unique insights about healthcare efficiency

Key Words: Healthcare, Healthcare System Efficiency, Healthcare Efficiency, Data Envelopment Analysis, Ranking Methods

Paper type: Research paper

1. Introduction

With the raging COVID19 situation, many health systems have come under stress and raises more questions than answers about the efficiency of our health systems (Pinho, 2020). Healthcare is complex system of systems that interact in highly intricate and variable ways with multiple stakeholders and is faced with increasing demand and reduced resources (Bhattacharjee and Ray, 2014; Faezipour and Ferreira, 2011; Myllärniemi and Helander, 2012; Schiavone et al., 2020). Health systems have evolved over time and many countries in the world both developed and developing, in the recent past have undergone a health sector reform. Many of the changes are structural as well as policy (Collins et al., 2000; Katuu, 2018). While sustainability of healthcare remains the focus of most countries in order to improve the quality of life, there exists a gap in the way healthcare is delivered in the developed countries and the underdeveloped and developing countries (Faezipour and

Ferreira, 2011; Lubitz and Wickramasinghe, 2006).

With a population of 1.35 billion people, India is the second most populous country in the world. A key component of growth for any country is the health of its population and most countries spend a significant amount on healthcare. Healthcare in India is quite unique, while more than 65% of the expenditure is out-of-pocket driven by a robust private sector, 35% is catered by government (Bahadur and Shah, 2015; IBEF, 2018). If India is a land on contradictions, the situation is amplified in Healthcare. 65% of the healthcare gets delivered by the private sector which is predominantly availed by the mid-income and higher income sections of society (Banerji and Azad, 2013; Rastogi and Sharma, 2020). While various states have dabbled with state insurance schemes, the penetration level of such schemes remains low. Availability of healthcare facilities is skewed towards the urban areas which has about 26% of the population whereas 72% of the rural population has access to only 33% of the beds (Bhatia and Taneja, 2018; KPMG, 2015). On the demand side, there is rising income levels, greater health awareness levels (both preventive and curative) and increasing lifestyle diseases like diabetes. On the supply side, there is huge investments in hospitals, infrastructure and research and development. The number of doctors have increased to 8.4 lakh in 2017 (IBEF, 2018). There is also a policy support by the government in terms of health insurance schemes like Ayushman Bharat, the launch of Pradhan Mantri Jan Yojana (PMJAY) to provide 5 lakh insurance coverage to 100 million families every year. The government has also provided tax relief on medical technology products manufactured in India. On the positive side, India has launched a lot of unique programs like National Rural Health Mission, Central Government Health Services (CGHS), Child Health programs (covering maternal and child health) and National Health Programs (communicable and non-communicable diseases). These schemes along with the Private sector has been bearing the healthcare burden of the country and has significantly improved the healthcare system efficiency. However, a lot needs to be done. Ayushman Bharat aims to increase penetration by providing health coverage to BPL citizens of the society. The use of lean practices adopted from manufacturing can also help improve healthcare services as demonstrated at a not for profit organization like Arvind Eye Care (Díaz et al., 2012)

With the healthcare sector expected to reach USD 372 billion by 2022 (IBEF, 2018) there is need to access the healthcare efficiency in India and compare how it fares against peers and against the best in the world. Such a study will help identify areas of improvements and best practices that help improve health outcomes not just for India but other developing countries as well.

Healthcare system efficiency can be viewed from the perspective of outputs to inputs, where the objective is either to increase output for the same level of input or reduce input to sustain same level of output. As India has increased its health expenditure, it becomes extremely important to evaluate if these resources are being managed efficiently as compared to other countries.

2.Literature Review

World Health Organization defines health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' (World Health Organisation, 1946). This definition has remained the same until date and most countries try hard to meet this objective.

Cambridge dictionary defines healthcare as 'the set of services provided by a country or an organization for the treatment of the physically and the mentally ill', while Merriam-Webster defines it as 'the maintaining and restoration of health by the treatment and prevention of disease especially by trained and licensed professionals (as in medicine, dentistry, clinical psychology, and public health)'.

Major participants in the healthcare system include, patients, physicians, paramedical, hospitals, pharmacies, government institutions, insurance agencies, policy makers etc. (Faezipour and Ferreira, 2011; Taurino et al., 2017). These stakeholders exhibit complex relationships thus making the healthcare system a complex, system of systems. Current health systems face an increased threat of sustainability due to increasing demand and

reducing resources (Coiera and Hovenga, 2018).

A health system normally has three objectives, the health status of the population, the responsiveness and equity. The degree to which the system is able to achieve these objectives is connected to the efficiency of the system (Bem et al., 2014). Healthcare system efficiency can be measured at the macro (health system) or micro level (individual healthcare units). Health Efficiency can also be viewed from the perspective of outputs to inputs, where the objective is either to increase output for the same level of input or reduce input to sustain same level of output.

While there is no economic reason, why a doctor would need to be efficient but we see that with the number of hospital closures, the delivery of healthcare system appears to be inefficient (Hollingsworth et al., 1999). Hollingsworth et al, examine efficiency and productivity from an economic point and propose Data Envelopment Analysis as a method of measurement. Frontier techniques i.e. identification of best practice frontiers can be used to evaluate performance of healthcare providers (Lovell, 2005). Two commonly used methods are Stochastic Frontier Analysis (SFA), which is regression based and second is Data Envelopment Analysis, which is linear programming based.

Data Envelopment Analysis as a concept was initially developed by Farrell in 1958 and developed by Charnes, Cooper and Rhodes in 1978 (Debata et al., 2014) and although was initially developed in the areas of econometrics and operations research and now have found applications in Healthcare (Benneyan et al., 2008). The input variables may include number of clinical staff, operating costs, nurse patient ratios, whereas the output variables may include clinical outcomes, access, patient satisfaction and safety. It works on identifying the best practice efficiency frontier. Benneyan, Sunnetci et al show that DEA can be applied at both a hospital level, for hospital benchmarking, department level, for department benchmarking and at national healthcare systems level, to benchmark healthcare systems across countries.

For a country level study DEA can have health input variables like health expenditure, number of doctors, nurses, hospital beds, immunization rate and from the output variables, life expectancy, non-mortality rate (adult and infant) etc. (Benneyan et al., 2008; Hadad et al., 2013; Ibrahim and Daneshvar, 2018; Popescu et al., 2014). Most of the studies use Charles Cooper Rhodes (CCR), BBC models with input or output orientation (Asandului et al., 2014; Behr and Theune, 2017; Bem et al., 2014; Benneyan et al., 2008). DEA has been used to study the efficiency frontier, to identify best practices and benchmarking (Moran and Jacobs, 2013). DEA can be conducted at a city or county level to evaluate health system efficiencies within a country to help optimise resources (Wu et al., 2008).

DEA analysis can also be carried out at a hospital level to measure and compare technical efficiency across hospitals in view to improve efficiency with input parameters as number of doctors, nurses, technicians, number of beds, fixed assets, operating expenses and output parameters such as in-patient days and patient mortality. Such tools can be used to provide input to policy formulation and implementation (Debata et al., 2014; Dharmapala, 2009; Harrison and Coppola, 2007; Hu et al., 2012; Nguyen et al., 2012; Pavitra, 2013).

From the analysis above, DEA is a robust multi-input, multi-output tool that helps to identify the efficiency frontier. The objective of this paper is thus to compare the Indian healthcare system with other in BRICS and OECD countries and identify best practices and benchmarks. India as country has never been bench marked or incorporated in global healthcare efficiency studies.

3.Method and Procedure

Healthcare system efficiency can be measured as a ratio of outputs to inputs, where the objective is either to increase output for the same level of input or reduce input to sustain same level of output

For the purpose of this paper a model comprising four input variables and three output variables have been shortlisted. These variables are chosen based on variables supported by literature to assess health system efficiency. The input variables selected are, total health expenditure per capita, total number of doctors (per thousand inhabitants), total number of

nurses (per thousand inhabitants), total number of hospital beds (per thousand inhabitants). The output variables selected are, life expectancy at birth, infant survival rate and maternal survival rate. Health expenditure here is taken as final consumption of health including personal healthcare (curative, rehabilitative care, long-term care, ancillary services and medical goods). Total health expenditure includes government, household out-of-pocket payments, NGO and health insurance. Infant survival rate and maternal survival rates are calculated from their respective mortality rates. Both these indicators are relevant for developing countries as a measure of outcome. The data is taken from the OECD database (https://data.oecd.org/healtheqt/hospital-beds.htm).

Data Envelopment Analysis (DEA) is an established method for calculating healthcare system efficiency. The Decision Making Units (DMU) are the individual countries. The productivity of the health system is the ratio of Health Output/Health Input. The aim can be to maximise the output (Output Oriented) for a given input or minimize the input (Input Oriented) for a given output.

DEA is a non-parametric linear programming technique and work of Charles-Cooper-Rhodes (CCR Model) and is used in various other industries as well to measure efficiency. The advantage of DEA over other models is it easily provides options for multiple inputs and multiple outputs. Depending on the scale chosen the envelopment surface or efficiency frontier will change. Two scales that are generally used are Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). In Constant Returns to Scale the output and inputs change by the same amount (example double the inputs means output will be doubled), whereas VRS essentially means the production may return decreasing, constant or increase returns to scale. Healthcare will exhibit VRS since doubling healthcare input might not double life expectancy.

3.1 Procedure for Data Envelopment Analysis using Springer software

The DEA solver was developed by Kaoru Tone and is a Microsoft excel based solver. It is available in both basic and professional editions.

Step 1: Preparation of Data File

The excel sheet has to be prepared based on the template where the input (I) and output (O) variables need to highlighted and marked separately as suffixes. The Decision making units (DMU) is included in the first column, followed by the input (I) and output variables (O)

Step 2: Selection of DEA Model

The learning version of the solver comprises of 28 cluster of DEA models and can handle data of 50 decision-making units, while the professional version is used for large-scale data sets.

All the models can be classified into three basic groupings: 1. Radial 2. Non-radial and Oriented 3. Non-radial non oriented. Radial means the inputs and outputs are proportionate, whereas non-radial indicates disproportion between input and output variables. Orientation can be either input or output i.e. the objective towards either output maximisation or input minimization. The notation followed to describe DEA models: Model Name - I or O with C, V or GRS, where I or O means Input or Output orientation, and C means constant, V to Variable returns to scale. GRS means general returns to scale. For Example CCR-I means Charnes-Cooper-Rhodes model with Input orientation. The super efficiency model the best performers have full efficiency i.e. one and other DMUs will be ranked with respect to these. Greater than one indicates superefficient.

Step 3: DEA Computation

Select the data set prepared in step 1 and select workbook for saving results. The results can be stored as a separate file than the data set.

Step 4: Results

The result of the analysis has eight work sheets; Worksheet Summary gives the statistics on the data set and the summary report of the analysis. The Worksheet score has the DEA score, reference set, ranking of each DMU

4.Data Analysis

For the purpose of the analysis, the data is taken from OECD database (2018 data or latest

available). For values not available in OECD, the data is taken from WHO database (2018 or latest available). Both the data bases where accessed in May 2020. The DEA has been carried out on the SPRINGER Excel based software (free version, version 8). Two models have been used in the DEA. Firstly, Output Oriented Super Efficiency Based with Variable Returns to Scale. The model was used since our aim is to maximise Health care output, variable returns to scale instead of constant returns since one might not be able to increase returns beyond a certain limit (example life expectancy cannot be doubled if health expenditure is doubled). Secondly, BCC Input Oriented was used to identify countries who might not be using their resources properly. The consolidated data for the input and output variables is given in Table 1 (See Table 1)

Country	(I)Health Expenditure per Capita PPP USD	(I)Total Number of Doctors per 1000 inhabitants	(I)Number of Nurses per 1000 inhabitants	(I)Total Number of Beds per 1000 inhabitants	(O)Life Expectancy at Birth	(O)Infant Survival Rate per 1000	(O)Maternal Survival Rate per 100000
Australia	5005.32	3.68	11.68	3.84	82.6	996.7	99994
Austria	5395.11	5.18	6.85	7.37	81.7	997.1	99995
Belgium	4943.54	3.08	10.96	5.64	81.6	996.4	99995
Canada	4974.33	2.76	9.96	2.5	82	995.5	99990
Czech Republic	3057.62	4.12	8.06	6.63	79.1	997.3	99997
Denmark	5298.82	4	9.95	2.5	81.2	996.2	99996
Finland	4228.21	3.81	14.7	3.28	81.7	998	99997
France	4964.71	3.37	10.8	5.98	82.6	996.2	99992
Germany	5986.43	4.25	12.93	8	81.1	996.7	99993
Greece	2238.17	5.479	3.31	4.21	81.4	996.5	99997
Hungary	2046.78	3.32	6.51	7.02	75.9	996.5	99988
Iceland	4349.09	3.94	14.85	2.91	82.7	997.3	99996
Ireland	4915.49	3.18	12.16	2.96	82.2	997	99995
Italy	3427.81	3.99	6.71	3.18	83	997.3	99998
Japan	4766.07	2.43	11.34	13.05	84.2	998.1	99995
Korea	3191.55	2.34	6.8	12.27	82.7	997.2	99989
Luxemburg	5070.17	2.98	11.72	4.51	82.2	996.8	99995
Mexico	1137.96	2.43	2.9	1.38	75	987.9	99967
Netherland	5288.44	3.6	11.18	3.32	81.8	996.4	99995
New Zealand	3922.64	3.33	10.17	2.61	81.9	995.7	99991
Norway	6186.92	4.82	17.81	3.6	82.7	997.7	99998
Poland	2056.36	2.38	5.1	6.62	77.9	996	99998
Portugal	2861.38	5.1	6.7	3.39	81.5	997.3	99992
Slovakia	2290.33	3.42	5.65	5.82	77.3	995.5	99995
Spain	3322.62	3.88	5.74	2.97	83.4	997.3	99996
Sweden	5447.11	4.12	10.9	2.22	82.5	997.6	99996
Switzerland	7316.61	4.3	17.23	4.53	83.6	996.5	99995
Turkey	1226.59	1.87	2.07	2.81	78.1	990.8	99983
Great Britain	4069.57	2.85	7.8	2.54	81.3	996.1	99993
United States	10586.08	2.61	11.74	2.77	78.6	994.2	99981
Chile	2181.73	2.59	13.3	2.11	80.2	993	99987
Estonia	2231.41	3.47	6.19	4.69	78.2	997	99991
Israel	2779.66	3.14	5.08	2.99	82.6	996.9	99997
Slovenia	2859.45	3.1	9.92	4.5	81.1	997.9	99993
Latvia	1748.54	3.21	4.57	5.57	74.8	995.9	99981
Lithuania	2415.82	4.56	7.71	6.56	75.6	997	99992
Brazil	1281.62	2.16	10.12	2.2	75.7	986.8	99940
Russia	1513	4.04	8.47	8.05	72.6	994.4	99983
India	208.77	0.78	1.5	0.53	68.9	968	99855
China	688.00	2.01	2.7	4.2	76.5	992	99971
South Africa	1071.56	0.79	1.32	2.8	63.4	971.2	99881

Source: Author Calculations

Table 1.
Input and Output Variables for OECD and BRICS Countries

5.1 Benchmark India against BRICS countries (Brazil, Russia, India, China and South Africa)

We see that India has the lowest health expenditure (208.77) among the BRICS countries, the lowest doctors (0.78) and nurse (1.5) density and the lowest bed density (0.53). Since health expenditure, doctor density, nurse density, hospital bed density has a strong correlation with life expectancy, maternal survival rate, infant survival rate, India may be well advised to increase these health inputs.

DEA Ranking of BRICS Countries

Table 2.
Country ranking based on Super efficiency and variable returns to scale and BCC input oriented model

DEA Ranks (Super efficiency, output oriented with variable returns to scale model)			DEA Ranks (BCC, input oriented model)		
Country	Score	Rank	Country	Score	Rank
CHN	1.037908	1	IND	1	1
BRA	1.017795	2	CHN	1	1
RUS	1.000845	3	ZAF	1	1
ZAF	1	4	BRA	0.9999	4
IND	1	4	RUS	0.998	5

China Ranks 1 among BRICS countries (See Table 2), followed by Brazil and Russia. While all the countries are efficient (based on the model), the model places India at the bottom along with South Africa in terms of health outcomes. India can move up the rankings if it is able to increase its healthcare expenditure. From an input oriented perspective, Table 2 (See Table 2) shows, for the given amount of Inputs, India fares better along with China and South Africa. However, Brazil and Russia need to make better use of the input resources. India is doing well on the limited resources it deploys for healthcare.

5.2 Benchmark India against OECD countries

The Base year chosen for the analysis is 2018 due to completeness of all variables.

Based on table 3 (See Table 3), we find that India (with the lowest health expenditure, less number of doctors and nurses to population ratio, have good health output variables) operates within the efficiency frontier. This is noteworthy, because, if India is able to increase investment in healthcare, it will significantly impact the life expectancy, infant survival, maternal survival rates. Again, countries such as Germany, United States of America, Czech Republic, Slovakia and Lithuania continue to be operating at a low efficiency level despite their high healthcare expenditure. Based on table 3 (See Table 3), Canada, Japan, Korea, Spain, Sweden, Turkey, Chile, Israel and India make good use of their resources. While France, Norway, Netherlands, Austria and Germany, for the level of existing health output, could better utilise their healthcare input.

6.Finding and Discussion

When we analyse highly ranked countries like Canada, Korea, Japan etc we find that Canada has a distinctive health system, with elements from both United Kingdom and United States of America. Although health was a provincial subject before 1961, universal hospital insurance was adopted in 1961 and universal medical insurance since 1971 (Vayda and Deber, 1984). What makes the Canadian health system unique is the decentralisation of medical insurance at the provincial and territory level offering free healthcare at the point of care. These basket of services though narrow are portable across the country and is regarded highly for creating equitable access to healthcare (Martin et al., 2018). Korea, on the other hand improved its

Country rankings based on Output Oriented Super Efficiency Based with Variable returns to Scale

DEA (Super efficiency, output oriented with variable returns to scale model)			DEA (BCC, input oriented model)		
DMU	Score	Rank	DMU	Score	Rank
CAN	1	1	CAN	1	1
GRC	1	1	JPN	1	1
JPN	1	1	KOR	1	1
KOR	1	1	ESP	1	1
MEX	1	1	SWE	1	1
ESP	1	1	TUR	1	1
SWE	1	1	CHL	1	1
CHE	1	1	ISR	1	1
TUR	1	1	IND	1	1
GBR	1	1	GRC	0.9999	10
CHL	1	1	MEX	0.9999	10
ISR	1	1	GBR	0.9999	10
IND	1	1	POL	0.9996	13
FIN	0.9999	14	SVN	0.9995	14
NOR	0.9999	14	LVA	0.9994	15
POL	0.9999	14	EST	0.9993	16
EST	0.9999	14	CHE	0.9991	17
SVN	0.9999	14	IRL	0.9989	18
LVA	0.9999	14	FIN	0.9987	19
IRL	0.9998	20	PRT	0.9986	20
PRT	0.9996	21	HUN	0.9902	21
ITA	0.9992	22	LUX	0.975	22
NZL	0.998	23	USA	0.9562	23
LUX	0.9976	24	NZL	0.9535	24
ISL	0.9975	25	ITA	0.9519	25
AUS	0.9966	26	ISL	0.9355	26
FRA	0.9957	27	LTU	0.9225	27
HUN	0.9947	28	DNK	0.9009	28
NLD	0.9941	29	BEL	0.8796	29
BEL	0.9934	30	CZE	0.874	30
DNK	0.993	31	SVK	0.869	31
AUT	0.9923	32	AUS	0.8404	32
DEU	0.9887	33	FRA	0.83	33
USA	0.988	34	NOR	0.8265	34
CZE	0.9855	35	NLD	0.8209	35
SVK	0.9836	36	AUT	0.7631	36
LTU	0.9778	37	DEU	0.6463	37

Source: Author Calculations

Table 3.
Ranking of OECD countries with India included based in super efficiency output oriented model

health outcomes drastically after 1989 after adopting universal health coverage and paralleled by economic development coupled with high healthcare spend (WHO, 2014). By 2000 all, the insurance schemes were merged into one scheme with single payer with uniform contribution and benefits package improving disbursement of funds. The patients have freedom to choose the healthcare provider as long as they pay the higher out of pocket charges in tertiary care hospitals. The Korean system which currently ranks high in the analysis is quite unique and offers a lot of valuable insights (Banerji and Azad, 2013). The Health Care Systems Reforms Act 2000 regulated the prescription system. Previously pharmacists could prescribe and physicians could dispense drugs, which led to a lot of unethical practices and over prescription. After regulation, pharmaceutical costs were brought down by 30% thus reducing the burden on the healthcare system. The government sets the reimbursement limit at the retail level and the wholesalers are free to set their prices (No margin capping as in India). All citizens are compulsorily members of the National Health Insurance. Korea offers a lot of choice to its physicians when it comes to choice of drugs for reimbursement, compared to other OECD countries, which had 3000-8000 drugs (all formulations) Korea had in 2008, 20000 drugs for insurance reimbursement. The NHI sets the price of the drug based on its price in seven countries, namely, USA, UK, Japan, France, Germany, Italy and Switzerland. Such benchmarking helps it to rein in prices of the drugs.

Similarly, countries like Japan has been providing universal health coverage to its citizens since 1960, coupled with high economic development and high health expenditure, it has been able to achieve high health outcomes including world's highest life expectancy (Sakamoto et al., 2018). The Japanese Healthcare system is also quite unique, compared to other countries there are high barriers to entry for generics, compared to the USA it takes four years for a generic to be introduced with no incentive like 180 days exclusivity, as in the case of USA (Banerji and Azad, 2013). Besides the new generic formulation can only be introduced/listed in reimbursement only in the month of July thus increasing barriers of entry. The generic player is also mandated to supply the drugs in all strengths and formulations (tablets, injectable etc.), thus raising barriers of entry. The government sets the reimbursement limit at the retail level and the wholesalers are free to set their prices (No margin capping as in India). Most physicians view generics especially from India and China as low quality. While Japan remains, open to generics by Japanese players. These barriers of entry along with superior healthcare delivery might be some of the reasons for its higher healthcare system efficiency.

As both Korea and Japan are in the top of the ranking of healthcare efficiency, it is interesting to note that both have regulations for reimbursement are retail with no margin regulation for wholesalers and both avoid generics due to lower quality products as compared to branded.

Spain too has a universal health coverage funded by the tax payer and operating through the public sector (García-armesto et al., 2010). Provisions are free of cost at the point of delivery except for pharmaceutical prescriptions for people less than 60 years, which happens through co-payment of about forty percent. In addition, some of the specialised care is outsourced to private sector. Apart from the mandatory public insurance, the people can also opt for private voluntary insurance, which is complementary and used for specialized care. Spain health expenditure is lower than the European average due to the existence of co-payment.

Among the BRICS countries, China ranks higher and might provide a few insights to India. While both China and India have a lot of commonalities like extremely high population levels, both offer alternative therapies, both suffer from counterfeits and spurious goods, China has been able to provide better healthcare than India and its piers in BRICS from the study. China has consistently increased its expenditure on healthcare year on year as a percentage of GDP but has also increased regulations to rein in expenditure (Banerji and Azad, 2013). More than 90% of its population in covered under government healthcare schemes (universal medical coverage). To control the healthcare cost it has established the National Essential Medicine System, which helped streamline the system deficiencies like differential prices for same drug across provinces, overpriced, and over prescribing by

government centres to make-up operational losses, removing bonuses to physicians working in government hospitals on generated revenue (reduce over prescription). While China has regulations it has followed a cost plus approach to pricing and at the same time provided sufficient margins to retailers and wholesalers. There are areas of improvement in the Chinese healthcare system as well (Ying et al., 2012), the government funding needs to be increase to make the hospitals self-sufficient so that they don't have to depend in service based revenues to break even. China may have to look towards a balance between, government spend, employers spend and individual spend to drive improvements in healthcare financing. Appropriate reimbursements is another area for improvement.

While the United States spends a lot on health care the outcomes are not commensurate with the spending (Amlung, 2013; Hollingsworth et al., 1999; Wang et al., 2011). The American healthcare system differs from the European counter parts on various fronts (Amlung, 2013). Firstly, there is no 'one' healthcare system in the United States, there exists multiple sub systems in parallel with a few overlaps. Although some states have similar healthcare systems, some states may have systems are diverse as Netherlands and Germany. While four major entities exists, Service Purchaser, Insurances, Service Provider and consumers, the managed care did not develop uniformly due to different laws in each individual states. Financing of insurance and purchasing of services through third party is unique to the American Healthcare System. America's low health system performance may be due to rising number of uninsured people, rising healthcare costs and low health outcomes. American democracy has always focussed on healthcare efficiency based on market driven forces (Lee and Bae, 2010) and paid little attention to equity, causing lack of access to healthcare and rising cost and the problem of a large number of uninsured population. Universal health coverage may a step in the right direction although many argue about the increased burden of healthcare cost. Use of information technology in healthcare has been cited by Linda and Terry in their paper as an effective tool to bring down healthcare costs in the United States (Byrd and Byrd, 2010). .An Evidence Based Medicine (EBM) approach (Harrison and Radcliffe, 2010) is also being recommended to supplement and improve healthcare spends and quality of healthcare in the United States. It recommends clinicians to refer to original literature to use effective and efficient medical treatment modalities across the quantum of care to improve healthcare efficiency.

7.Theoretical Implication

Present study has benchmarked India against its peers (BRICS) and OECD countries through the Data Envelopment Analysis (DEA). The study found India to be operating within the efficiency frontier, however, with room for improvement as it ranks 5th among its peers and 13th among the OECD countries. This study also highlights that many developed countries like USA which have high healthcare spends, operate on a lower efficiency frontier than some developing nations. From a theoretical perspective, the study also adds to the body of literature of the Data Envelopment Analysis and health system efficiency.

8.Practical Implication

India, while it has the lowest healthcare expenditure within the BRICS and OECD countries, operates on the efficiency frontier, that is to say, it utilises its inputs efficiently. Any increase in health care expenditure, increase in physician, nurse density, hospital bed density, will help it to significantly improve health outcomes in terms of life expectancy, infant survival and maternal survival ratios.

Like most emerging economies, India needs to build a more robust public system to deliver efficacious and economical healthcare (Bahadur and Shah, 2015). There exist major challenges of inadequate and misallocated resources, beside the problem of scattered distribution making access and timely medical intervention difficult. The public system is also plagued by lack of capacity and lack of trained medical and paramedical staff and substandard services. The issues cited above force the populace to seek medical care in private institutions, which then raises the question of affordability.

India can learn and implement from the five countries highlighted above, Canada, Spain,

South Korea, Japan and China. It can leverage from having Universal Health Coverage by increasing its government spend (%GDP) and at the same time have stronger regulations on generics and prescription to avoid over prescribing. Both Japan and South Korea have shown that healthcare efficiency can be increased by not increasing the percentage of generics but by proper monitoring and regulations and price settings.

In conclusion, Asian countries like Japan and Korea are leading the pack when it comes to healthcare system efficiency (maximizing the output variables of life expectancy at birth, maternal mortality rate and infant mortality rate, for the given level of input variables of healthcare expenditure, number of doctors, nurses and beds). Countries like India are performing fairly well, even better than USA when evaluated on the same efficiency parameters. On the same metric, although India seems to be efficiently using current resources, other member of the BRICS, perform better than India. Increasing physician, nurse and bed density will propel India into the same league as its peers. While, healthcare delivery structure cannot be changed overnight, adoption of best practices of South Korea, Japan and China, namely increasing healthcare expenditure, universal health coverage, capping retail reimbursements, providing justified margins for wholesalers, tighter regulations, maintaining right mix of branded and generics might help India to move up in the rankings. India can also learn from the laxity of USA in terms of having control on reimbursements and having a uniform healthcare system with universal health coverage, which seem to be a common factor across the better performing countries. Evidence Based Medicine (EBM) is also recommended to improve healthcare efficiency.

9.Future Directions and Limitations of the study

The present study considers only BRICS and OECD countries and can be extended to include many other countries. The study considers four input variables of total health expenditure per capita, total number of doctors (per thousand inhabitants), total number of nurses (per thousand inhabitants), total number of hospital beds (per thousand inhabitants). Similarly, three output variables of life expectancy at birth, infant survival rate and maternal survival rate have been considered. The study can be extended to include many more measures like, nutrition, lifestyle, disease burden, income level etc.

References

Amlung, V.. (2013), “Main Characteristics of the American Healthcare System 2, Managed Care”, *Organization and Instruments,* Vol.1965, available at:https://doi.org/10.1007/978-3-642-38712-8.

Asandului, L., Roman, M. and Fatulescu, P. (2014), “The efficiency of healthcare systems in Europe?: a Data Envelopment Analysis Approach”, *Procedia Economics and Finance,* Vol.10 No.14, pp.261-268.

Bahadur, L.R. and Shah, S.H. (2015), “Healthcare management in the Indian public sector”, *Int. J. Economic Policy in Emerging Economies,* Vol.8 No.4, pp.332-346.

Banerji, A. and Azad, M. (2013), “Review of Asia-Pacific'S Healthcare Systems With Emphasis on the Role of Generic Pharmaceuticals”, *Academy of Health Care Management Journal,* Vol.9 No.1/2, pp.53-74.

Behr, A. and Theune, katya. (2017), “Health System Efficiency?: A Fragmented Picture Based on OECD Data”, *PharmacoEconomics - Open, Springer International Publishing,* Vol.1 No.3, pp.203-221.

Bem, A., Ucieklak-Je, P. and Prdkiewicz, P. (2014), “MEASUREMENT OF HEALTH CARE SYSTEM EFFICIENCY”, *Management Theory and Studies for Rural Business and Infrastructure Development*, Vol.36 No.1, pp.25-33.

Benneyan, J.C., Sunnetci, A. and Ceyhan, M.E. (2008), “Data envelopment analysis models for identifying and benchmarking the best healthcare processes”, *Int. J. Six Sigma and Competitive Advantage,* Vol.4 No.3, pp.305-331.

Bhatia, R. and Taneja, U. (2018), “eHealth in India: a model for healthcare accessibility at the ‘bottom of the pyramid”, *International Journal of Electronic Healthcare,* Vol.10 No.1/2, pp. 6.

Bhattacharjee, P. and Ray, P.K. (2014), “Modelling and optimisation of healthcare systems?: an overview”, *Int. J. Logistics Systems and Management,* Vol.19 No.3, pp.356-371.

Byrd, L.W. and Byrd, T.A. (2010), “Examining the effects of healthcare technology on US hospitals’ operational cost”, *International Journal of Healthcare Technology and Management,* Vol.11 No.1/2, pp.96.

Coiera, E. and Hovenga, E.J.S. (2018), "Building a Sustainable Health System", *Yearbook of Medical Informatics,* Vol.16 No.01, pp.11-18.

Collins, C.D., Green, A.T. and Hunter, D.J. (2000), "NHS reforms in the United Kingdom and learning from developing country experience", *Journal of Management in Medicine,* Vol.14 No.2, pp.87-99.

Debata, B.R., Patnaik, B., Mahapatra, S.S. and Sreekumar, N.A. (2014), "Efficiency measurement in medical tourism: a DEA approach", *International Journal of Process Management and Benchmarking,* Vol.5 No.1, pp.90.

Dharmapala, P.S. (2009), "Adding value in healthcare service by improving operational efficiency using Data Envelopment Analysis", *Int. J. Operational Research,* Vol.5 No.1, pp.73-88.

Díaz, A., Pons, J. and Solís, L. (2012), "Improving healthcare services: lean lessons from Aravind", *International Journal of Business Excellence,* Vol.5 No.4, pp.413.

Faezipour, M. and Ferreira, S. (2011), "Applying systems thinking to assess sustainability in healthcare system of systems", *Int. J. System of Systems Engineering,* Vol.2 No.4, pp.290-308.

García-armesto, S., Abadía-taira, M.B., Hernández-quevedo, C. and Bernal-delgado, E. (2010), "Spain Health system review", *World Health Organization,* Vol.12 No.4.

Hadad, S., Hadad, Y. and Simon-tuval, T. (2013), "Determinants of healthcare system's efficiency in OECD countries", *The European Journal of Health Economics,* Vol.14 No.2, pp.253-265.

Harrison, J.P. and Coppola, M.N. (2007), "The impact of quality and efficiency on federal healthcare", *Int. J. Public Policy,* Vol.2 No.3/4, pp.356-371.

Harrison, J.P. and Radcliffe, K. (2010), "Evidence based medicine as a strategy for quality improvement", *Int. J. Public Policy,* Vol.5 No.2/3, pp.133-142.

Hollingsworth, B., Dawson, P.J. and Maniadakis, N. (1999), "Efficiency measurement of health care?: a review of non-parametric methods and applications", *Healthcare Management Science,* Vol.2 No.August, pp. 161-172.

Hu, H., Qi, Q. and Yang, C. (2012), "China Economic Review Analysis of hospital technical ef fi ciency in China?: Effect of health insurance reform", *China Economic Review, Elsevier Inc.,* Vol.23 No.4, pp.865-877.

IBEF. (2018), "Indian Brand Equity Foundation".

Ibrahim, M.D. and Daneshvar, S. (2018), "Efficiency Analysis of Healthcare System in Lebanon Using Modified Data Envelopment Analysis", *Journal of Healthcare Engineering,* Vol.2018.

Katuu, S. (2018), "Healthcare systems: typologies, framework models, and South Africa's health sector", *International Journal of Health Governance,* Vol.23 No.2, pp.134-148.

KPMG. (2015), "Healthcare in India: Current State and Key Imperatives", Vol. 2015.

Lee, K.-H. and Bae, K.-H. (2010), "Pursuing an extension of the' Minnowbrook spirit' in the US healthcare system", *Int. J. Public Policy,* Vol.5 No.2/3, pp.222-236.

Lovell, C.A.K. (2005), "Frontier analysis in healthcare", *International Journal of Healthcare Technology and Management,* Vol.7 No.1/2, pp. 5.

Lubitz, D. von and Wickramasinghe, N. (2006), "Healthcare and technology?: the doctrine of networkcentric healthcare", *Int. J. Electronic Healthcare,* Vol.2 No.4, pp.322-344.

Martin, D., Miller, A.P., Quesnel-Vallée, A., Caron, N.R., Vissandjée, B. and Marchildon, G.P. (2018), "Canada's universal health-care system: achieving its potential", *The Lancet,* Vol.391 No.10131, pp.1718-1735.

Moran, V. and Jacobs, R. (2013), "An international comparison of efficiency of inpatient mental health care systems ?", *Health Policy, Elsevier Ireland Ltd,* Vol.112 No.1-2, pp.88-99.

Myllärniemi, J. and Helander, N. (2012), "Healthcare system as a value network", *World Review of Entrepreneurship, Management and Sust. Development,* Vol.8 No.2, pp.196-207.

Nguyen, T.T., Lee, D.W. and Lee, H.J. (2012), "Comparison of technical efficiency of South Korean and Vietnamese public hospitals in 2006-2009", *International Journal of Public Policy,* Vol.8 No.1/2/3, pp.149.

Pavitra, P. (2013), "Productive efficiency analysis of primary healthcare services in Afghanistan: a DEA study", *International Journal of Behavioural and Healthcare Research,* Vol.4 No.2, pp. 204.

Pinho, M. (2020), "The challenge posed by the COVID-19 pandemic?: how to decide who deserves life-saving medical devices?", *Internaltional Journal of Health Governance,* available at:https://doi.org/10.1108/IJHG-08-2020-0090.

Popescu, C., Asandului, L. and Fatulescu, P. (2014), "A Data Envelopment Analysis for Evaluating Romania's Health System", *Procedia - Social and Behavioral Sciences,* Elsevier B.V., Vol.109 No.1994, pp.1185-1189.

Rastogi, S. and Sharma, A. (2020), "Expectations from a private multi-speciality hospital?: a moderated-mediation analysis", I*nternational Journal of Pharmaceutical and Healthcare Marketing,* Vol.14 No.2, pp.325-348.

Sakamoto, H., Rahman, M., Nomura, S., Okamoto, E., Koike, S., Yasunaga, H., Kawakami, N., et al. (2018), "Japan Health System Review", *World Health Organization, Regional Office for South-East Asia,* Vol.8 No.1, available at: http://apps.who.int/iris/bitstream/handle/10665/259941/9789290226260-eng.pdf;jsessionid=793E7F28273806A2F763882D242BCB1A?sequence=1.

Schiavone, F., Leone, D., Sorrentino, A. and Scaletti, A. (2020), "Re-designing the service experience in the value co-creation process?: an exploratory study of a healthcare network", *Business Process Management Journal,* available at:https://doi.org/10.1108/BPMJ-11-2019-0475.

Taurino, T., Bellomo, D. and Turco, S.R. Lo. (2017), "Systems engineering approach to healthcare performance analysis", *International Journal of Society Systems Science,* Vol.9 No.1, pp.58.

Vayda, E. and Deber, R.B. (1984), "The Canadian health care system: An overview", *Social Science and Medicine,* Vol.18 No.3, pp.191-197.

Wang, J., Yan, R. and Guo, P. (2011), "Comparative analysis of international healthcare systems", *Int. J. Business and Systems Research,* Vol.5 No.1, pp.85-103.

WHO. (2014), "Health Systems in Transition", *Republic of Korea.*

World Health Organisation. (1946), "Preamble To The Consitution Of The World Health Organisation As Adopted By The International Health Conference; Signed On 22 July 1946 By The Representative Of 61 States And Entered Into Foce On 7 April 1948", *International Health Conference,* No.2, pp.100.

Wu, C.-H., Chang, C.-C. and Kuo, K.N. (2008), "Evaluating the resource allocation efficiency of the healthcare system in Taiwan", *Int. J. Public Policy,* Vol.3 No.5/6, pp.403-418.

Ying, W., Shen, J.J., Mei, S. and Moseley, C.B. (2012), "Why healthcare became so expensive in China? The transformation of healthcare financing during Chinese economic development", *Int. J. Public Policy,* Vol.8 No.1/2/3, pp. 4-20.

APPENDIX1:

List of OECD Countries

Australia (AUS)	Japan (JPN)	Great Britain (GBR)
Austria (AUT)	Korea (KOR)	United States (USA)
Belgium (BEL)	Luxemburg (LUX)	Estonia (EST)
Canada (CAN)	Mexico (MEX)	Israel (ISR)
Czech Republic (CZE)	Netherland (NLD)	Slovenia(SVN)
Denmark (DNK)	New Zealand (NZL)	Latvia (LVA)
Finland (FIN)	Norway (NOR)	Lithuania (LTU)
France (FRN)	Poland (POL)	Chile (CHL)
Germany (DEU)	Portugal (PRT)	
Greece (GRC)	Slovakia (SVK)	
Hungary (HUN)	Spain (ESP)	
Iceland (ISL)	Sweden (SWE)	
Ireland (IRL)	Switzerland (CHE)	
Italy (ITL)	Turkey (TUR)	

Source: Author