
OPERATIONS RESEARCH AND ANALYTICS IN HEALTHCARE

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ABSTRACT

Purpose: With rising demand and limited healthcare resources, it's more vital than ever to take a step back and assess healthcare delivery efficiency. The purpose of this study is to assess India's health-care system efficiency by comparing it to that of its BRICS peers and OECD rivals.

Approach: The input and output variables needed to assess the efficiency of the healthcare system have been discovered. The efficiency frontier was established using a Data Envelopment Analysis (DEA) technique with the rankings of the BRICS and OECD countries. As a result, India is compared to its counterparts (BRICS) as well as OECD countries. Finding: India, along with China, Russia, Brazil, and South Africa, was determined to be operating at the efficiency frontier, but it ranked fourth. India, along with Canada, Greece, Japan, Korea, Mexico, Spain, Sweden, Switzerland, Turkey, the United Kingdom, Chile, and Israel, is on the efficiency frontier when compared to OECD countries. Countries with lesser healthcare efficiency, such as Germany, the United States of America, the Czech Republic, Slovakia, and Lithuania, must make prudent use of their resources. Implications for Practice and Research: Developing countries, such as India, can improve the quality of their healthcare systems by replicating best practises from their peers and the top ten OECD countries. The majority of the top OECD countries have universal health coverage, higher physician and nurse density, and higher hospital bed ratios. They prefer branded medications over generics and practise evidence-based medicine. It adds to the body of literature on DEA and health system efficiency from a theoretical standpoint.

Keywords: Healthcare, Healthcare System Efficiency, Healthcare Efficiency, Operation Research.

I. INTRODUCTION

With 1.35 billion inhabitants, India is the world's second most populous country. A country's healthcare system is vital to its growth, and most countries spend a lot on it. In India, the private sector drives over 65% of healthcare spending, while the government covers 35%. If India is a land of contradictions, the healthcare situation is abysmal. 65% of healthcare is provided by the private sector, largely to middle- and upper-income people. The current COVID19 situation has put a lot of strain on our healthcare systems, raising more questions than answers about their efficiency (Pinho, 2020). Healthcare is a complicated system of systems dealing with rising demand and limited resources. Many rich and developing countries have lately implemented health-care changes. (Bhattacharjee & Ray, 2014) Many of the changes are in structure and policies. In order to improve their populations' quality of life, most countries are working on healthcare sustainability. (C.D. Collins , A.T. Green , D.J. Hunter, 2000) The goal is to either increase output for the same input or reduce input to keep the same output. As India's health spending grows, it's more important than ever to analyse how well it's administered.

The "Data Envelopment Analysis" (DEA) method of operation research is what we are applying in our research work. The DEA is a well-known technique for measuring healthcare system efficiency. The Decision-Making Units are made up of individual countries (DMU). The productivity of a health system is determined by the ratio of health output to health input. (Zhihua Zhang, Jianping Li, 2020) The goal can be to maximise output for a given input (Outcome Oriented) or to minimise input for a given output (Input Oriented). The Charles-Cooper-Rhodes (CCR Model) non-parametric linear programming technique is used to measure efficiency in a range of industries.

DEA has the benefit over other models in that it can accommodate a large number of inputs and outputs (Charnes A., W. W. Cooper and E. Rhodes, 1978). Depending on the scale selected, the envelopment surface or efficiency frontier will be different. Two often used scales are Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS). Both the output and the inputs vary by the same amount in Constant Returns to Scale (doubling the inputs, for example, doubles the output), whereas VRS essentially means that the production can

give diminishing, constant, or growing returns to scalability. Healthcare will demonstrate VRS since doubling healthcare intake may not increase life expectancy.

The availability of healthcare services is biased towards urban areas, which account for roughly 26% of the population, while rural areas only account for 33%. Increasing money, health awareness, and lifestyle disorders like diabetes are all variables that influence demand. (KPMG, 2015) On the supply side, huge investments are made in hospitals, infrastructure, and R&D. The government also supports Ayushman Bharat and the Pradhan Mantri Jan Yojana (PMJAY), which would cover 5 lakh families every year. The Indian government has also exempted medical technologies from taxation. Of prominence are the National Rural Health Mission, Central Government Health Services (CGHS), Maternal-Child Health Programs, and National Health Programs. (IBEF, 2018) These measures, in collaboration with the private sector, have considerably enhanced the country's healthcare system's efficiency. However, there is still more to be done. With the healthcare sector predicted to grow to USD 372 billion by 2022, it's important to assess India's healthcare efficiency and compare it to peers and the best in the world.

Such a study will aid in identifying areas for improvement and best practises that will benefit not only India but also other developing countries' health results.

II. LITERATURE REVIEW

Innovative operations research (OR) strategies have been created for a variety of applications, which includes working room planning, emergency department staffing, breast most cancers screening, radiotherapy therapy planning, long-term care planning, and domestic healthcare planning. The healthcare optimization problem has acquired a lot of interest for extra than 30 years. However, recently, as fertility quotes have declined in nearly all developed international locations and lifestyles expectancy has elevated globally, optimization troubles in the medical region have come to be extra outstanding and have attracted the enthusiastic activity of the Operations Research community. (Jain, Shah, Sath, Marfatia, & Khandelwal, 2018) Over the years, the focus has progressively accelerated from aid allocation and strategic planning to including operational problems such as useful resource scheduling and treatment planning.

Hospitals can advantage from healthcare research now not only in terms of higher managing their patients, but also in phrases of offering higher remedy whilst gaining efficiency. World Health Organization defines fitness as 'a nation of entire physical, intellectual and social well-being and not merely the absence of disease or infirmity'. This definition has remained the same till date and most countries attempt tough to meet this objective.

Cambridge dictionary defines healthcare as 'the set of offerings furnished by way of a us of a or an organisation for the remedy of the bodily and the mentally ill', while Merriam-Webster defines it as 'the keeping and restoration of health by way of the treatment and prevention of ailment particularly via skilled and licensed authorities (as in medicine, dentistry, scientific psychology, and public health) (Shawnn Melicio Coutinho, 2021). In both developed and growing countries, fitness care is one of the most vital sectors. The healthcare sector includes hospitals, medical devices, scientific trials, outsourcing, telemedicine, clinical tourism, health insurance, and clinical equipment.

The healthcare system includes patients, doctors, nurses, hospitals, pharmacies, government agencies, insurance companies, and policy makers. Their numerous relationships make the healthcare machine a complex system. Assets are decreasing and demand is rising. To provide a sustainable quality of life, this complex system of systems must be balanced. Sustainability considers future generations' desires without compromising present-day needs. The societal issue of sustainability is critical in healthcare. (Schwarzkopf, 2014) The social perception focuses on equity, empowerment, accessibility, participation, cultural identity, and institutional sustainability. It is important that patients are happy. Patient satisfaction refers to satisfaction with relation to cost, availability of services and resources, and patient well-being. It's like "consumer satisfaction." The social side of healthcare systems is explored using systems thinking.

The Institute of Medicine distinguished "idealness" as one of six key "focuses on progress" in its latest report on quality. However, understanding deferrals stay common, bringing about disappointment, unfavourable clinical outcomes, and regularly greater expenses. This instructional exercise depicts a few regions wherein patients

regularly experience critical and possibly risky deferrals and presents activities examination (OR) models that have been created to help decrease these postponements, regularly at practically zero expense. It likewise portrays the hardships in creating and carrying out models just as the components that increment the probability of accomplishment. At long last, it talks about the chances, huge and little, for utilizing OR then again philosophies to fundamentally affect practices and approaches that will influence convenient admittance to medical services. In hospitals, it is not uncommon for lagging patients to wait for beds in emergency room waiting rooms and corridors on stretchers. As we all know, falls in hospitalized patients usually cause fractures and serious complications. When the nurse answers the call button slowly, falls will occur more frequently. While waiting for service in other situations is inconvenient and annoying, in healthcare, delays can be dangerous or even fatal. (Green, 2008).

Although the difficulty of healthcare optimization has obtained huge attention in latest decades, many problems are now turning into greater and more essential and applicable due to the getting old populace due to the decline in delivery prices in nearly all developed international locations and the enlarge in the average lifestyle's expectancy worldwide (Rais & Viana, 2010). OR is now more used to solve daily hospital management, resource-limited operations, or treatment planning issues in healthcare. There is also discovery of many new optimization problems and the development of many new solutions. Key healthcare optimization issues include service planning, resource scheduling, logistics, medical treatment, disease diagnosis, and preventive healthcare.

A health care system usually has three objectives, the health fame of the population, the responsiveness and equity. The diploma to which the gadget is in a position to acquire these targets is linked to the efficiency of the device. Healthcare system effectivity can be measured at the macro (health system) or micro stage (individual healthcare units). (David R. Mack, 1999) Health Efficiency can additionally be viewed from the point of view of outputs to inputs, the place the objective is either to enlarge output for the equal degree of input or reduce enter to preserve same stage of output.

While there is no financial reason, why a health practitioner would need to be efficient however we see that with the quantity of health centre closures, the delivery of healthcare system appears to be inefficient. Lockward Hillington, take a look at effectivity and productiveness from a financial factor and recommend Data Envelopment Analysis as a technique of measurement. (Ibrahim & Daneshvar, 2018) the use of Data Envelopment Analysis (DEA), a method especially splendid when more than one outputs are produced from more than one inputs. Frontier strategies i.e., identification of high-quality exercise frontiers can be used to consider performance of healthcare providers (Lovell, 2005). Two frequently used methods are Stochastic Frontier Analysis (SFA), which is regression based and 2d is Data Envelopment Analysis, which is linear programming based.

Although first created in the fields of economics and operations research, Data Envelopment Analysis has found applications in healthcare. The input factors include clinical personnel, operating costs, nurse patient ratios, whereas the output variables include medical outcomes, access, patient satisfaction, and safety. It searches for the quality exercise efficiency frontier. (Ibrahim M. D., n.d.) Benne yan and Senett show that DEA may be used to benchmark health centres, hospitals, branches, departments, and even entire countries. whereas Stochastic frontier evaluation (SFA) is an economic modelling approach. Its roots are in the stochastic manufacturing frontier fashions introduced by Aigner, Lovell, Schmidt, Meeusen, and Van den Broeck. (Charnes A., W. W. Cooper and E. Rhodes, 1978)

DEA evaluation can additionally be carried out at a health facility level to measure and compare technical effectivity throughout hospitals in view to enhance efficiency with input parameters as range of doctors, nurses, technicians, range of beds, constant assets, operating charges and output parameters such as in-patient days and patient mortality. Such equipment can be used to provide input to coverage components and implementation (Coutinho, Prasad, & Prabhudesai, 2021)

From the analysis above, DEA is a robust multi-input, multi-output device that helps to identify the efficiency frontier. The goal of the lookup paper is to use operation research to compare the efficiency of India's healthcare system to that of its BRICS and OECD rivals. and discover quality practices and benchmarks. India as United States has in no way been bench marked or integrated in world healthcare effectivity studies.

III. METHODOLOGY

The efficiency of a healthcare system can be quantified as a ratio of outputs to inputs. A model with four input variables and three output variables has been chosen as the basis for this paper. These factors were chosen based on variables that have been shown to be useful in assessing health-care system efficiency in the literature. Total health expenditure per capita, total number of doctors, total number of nurses, and total number of hospital beds were used as input variables (per thousand inhabitants). Life expectancy at birth, infant survival rate, and maternal survival rate are the output variables chosen. The whole expense of health care, including personal healthcare, is characterised as health expenditure. Government, household out-of-pocket expenditures, non-governmental organisations, and health insurance all contribute to total health spending. The survival rates of infants and mothers are determined using their relative death rates. The information comes from the OECD database. (Health at a glance, 2019)

The method of Operation research which we are using in our research paper is “Data Envelopment Analysis” (DEA). DEA is a well-known tool for estimating the efficiency of healthcare systems. Individual countries make up the Decision-Making Units (DMU). The ratio of Health Output/Health Input determines the health system's productivity. The goal can be to maximise the output for a given input or to reduce the input for a given output.

DEA is a non-parametric linear programming technique developed by Charles-Cooper-Rhodes (CCR Model) that is used to measure efficiency in a variety of sectors. The advantage of DEA over other models is that it can readily accommodate many inputs and outputs. The envelopment surface or efficiency frontier will differ depending on the scale used. Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) are two often used scales. In Constant Returns to Scale, both the output and the inputs vary by the same amount, whereas VRS essentially means that the production can yield decreasing, constant, or increasing returns to scale. Because doubling healthcare intake may not double life expectancy, healthcare will exhibit VRS.

IV. DATA ANALYSIS

The data for this analysis is sourced from the OECD database (2018 data). For values not available in OECD, the data is taken from WHO database (2018 data). Both the data bases were accessed in July 2021. The DEA has been carried out on the SPRINGER Excel based software. Two models have been used in the DEA. Firstly, Output Oriented Super Efficiency Based with Variable Returns to Scale. This model is used because our goal is to maximize health care output, variable returns to scale rather than constant income, because a person may not increase income up to a certain limit. Second, BCC Input Oriented is used to identify countries whose resources may not be used correctly. The consolidated data for the input and output variables is given in Table 1 (See Table 1).

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

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
Netherlands	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: Authors Calculations

We see that among the BRICS countries, India has the lowest health spending (208.77), doctors (0.78) and nurses (1.5) have the lowest density and the lowest bed density (0, 53). Since health spending, physician density, nurse density, hospital bed density has a strong correlation with life expectancy, maternal survival rate and infant survival rate.

Table 2: DEA Ranking of BRICS Countries

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

Source: Authors Calculations

China ranks first among the BRICS countries (see Table 2), followed by Brazil and Russia. Although all countries are efficient (based on the model), the model ranks India and South Africa at the bottom of the health outcomes. If India can increase its medical expenditures, India can improve its ranking. From the perspective of input orientation, Table 2 (see Table 2) shows that for a given amount of input, India performs better than China and South Africa. However, Brazil and Russia must make better use of input resources. India has done a good job with its limited resources deployed for healthcare.

Due to the completeness of all variables, the base year chosen for the analysis is 2018. According to Table 3 (see Table 3), we find that India (lowest health spending, number of doctors and nurses to the population is and the production variable of good health) operates within the efficiency frontier. This is worth noting, because if India can increase investment in health care, it will significantly affect life expectancy, infant survival, maternal survival rates. Similarly, countries such as Germany, the United States of America, the Czech Republic, Slovakia and Lithuania continue to operate with inefficiencies, despite high health expenditures according to Table 3 (see Table 3), Canada, Japan, South Korea, Spain, Sweden, Turkey, Chile, Israel and India make full use of their resources. And France, Norway, the Netherlands, Austria and Germany, in terms of the current level of health output, can make better use of their medical investment.

V. FINDINGS AND DISCUSSION

When we look at high-ranking countries like Canada, Korea, Japan, and others, we see that Canada has a unique health-care system that incorporates components from both the United Kingdom and the United States of America. (B.Deber, 1984). Although limited, this basket of services is transferable across the country and is well respected for ensuring fair access to healthcare (Danielle Martin, 2018) Korea, on the other hand, has made significant progress.

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

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

Sources: Authors Calculations

Following the adoption of universal health coverage, health outcomes improved dramatically, accompanied by economic growth and high healthcare spending. Later, all of the insurance plans had been combined into a single payer scheme with a consistent contribution and benefits package, which improved money disbursement. Patients have the option of choosing their healthcare provider as long as they are willing to pay for tertiary care facilities. The Korean system, which is presently ranked first in the analysis, is extremely distinctive and provides a wealth of information (Sri Ghulam Nabi Azad, 2013). Previously, pharmacists and physicians could both prescribe and dispense medications, which resulted in a lot of unethical activities and over prescription. Pharmaceutical costs were reduced by 30% after regulation, easing the financial strain on the healthcare system. At the retail level, the government sets the reimbursement ceiling, but wholesalers are allowed to establish their own pricing. The National Health Insurance is compulsory for all people.

Similarly, nations such as Japan, which has provided universal health care to its residents since 1960 and has achieved good health results, including the world's greatest life expectancy spending (Sakamoto H, 2018). The Japanese healthcare system is also extremely distinctive; in comparison to other countries, there are significant

hurdles to entry for generics; for example, in the United States, it takes four years for a generic to be launched with no inducement such as 180 days of exclusivity (Sri Ghulam Nabi Azad, 2013). The generic player is also required to provide the medications in all strengths and forms. Most doctors consider generics, particularly those from India and China, to be of poor quality.

Given that both Korea and Japan are at the top of the healthcare efficiency rankings, it's worth noting that both have retail reimbursement rules with no margin requirements for wholesalers, and both avoid generics owing to inferior quality products when compared to branded medicines. Spain, like the United States, has a universal health care system that is funded by taxes and administered by the government (Bernal-Delgado, 2010). Furthermore, certain specialised care is outsourced to the commercial sector. People can choose between required public insurance and private voluntary insurance, which is supplemental and utilised for specialised treatment.

China, the most developed BRICS country, may be able to help India with some useful information. While China and India share many characteristics, such as large populations, alternative treatments, counterfeits and fake goods, the study found that China has superior healthcare to India and the BRICS. China's healthcare spending as a percentage of GDP has risen year after year, although constraints have tightened to contain costs. More than 90% of the population is covered by government programmes (universal medical coverage) (Sri Ghulam Nabi Azad, 2013). This helped streamline system problems such varied prices for the same drug across provinces, overpriced, and overprescribing by government centres to cover operational losses, and abolishing bonuses for physicians working in government hospitals on income generated (reduce over prescription). While China has restrictions, it has adopted a cost-plus pricing model that allows retailers and wholesalers to profit. (Wang, 2012) The Chinese healthcare system might also be improved, for example, by increasing government funding to make hospitals self-sufficient and less reliant on service-based income to break even. To improve healthcare funding, China may need to balance government, employer, and consumer spending.

The U.S. healthcare system differs from that of many European countries on a number of fronts. There is no 'one' healthcare system, instead, there are many subsystems operating in parallel with a few overlaps (Hollingsworth, 1999). Despite the existence of four key entities, managed care has not developed universally due to differing regulations in each state. Another area where there is room for improvement is appropriate reimbursements - the United States spends a lot on health care but results do not match the amount spent.

The American Healthcare System is unique in that it finances insurance and purchases services through a third party. The growing number of uninsured individuals, rising healthcare expenditures, and poor health outcomes may all contribute to America's poor health system performance.

American democracy has traditionally prioritised healthcare efficiency based on market forces (Yong-bae Ji and Choonjoo Lee, 2010), with little regard for fairness, resulting in a lack of access to healthcare, growing costs, and a huge uninsured population. Although many debate about the rising expense of healthcare, universal health coverage may be a step in the right direction. Linda and Terry highlight the use of information technology in healthcare as a successful technique for lowering healthcare expenses in the United States in their article. To supplement and enhance healthcare spending and quality in the United States, an Evidence-Based Medicine (EBM) approach is also being advocated. It advises doctors to consult original research in order to utilise effective and efficient medical treatment techniques across the spectrum of care, in order to increase healthcare efficiency.

VI. THEORETICAL AND PRACTICAL IMPLICATION

The Data Envelopment Analysis (DEA) was used to compare India to BRICS and OECD countries in this study. India is operating inside the efficiency frontier, but there is potential for improvement, as it ranks 5th among its peers and 13th among OECD countries. It also shows that many developed countries, with significant healthcare expenditures, function at a lower efficiency level than some underdeveloped countries. It also adds to the body of literature on DEA and health system efficiency from a theoretical standpoint.

While India has the lowest healthcare spending among the BRICS and OECD countries, it operates on the efficiency frontier. Any increase in health-care spending, physician and nurse density, and hospital bed density

will all contribute to enhance health outcomes such as life expectancy, infant survival, and maternal survival ratios.

India has to strengthen its public sector in order to provide effective and affordable healthcare. There are significant obstacles posed by insufficient and misallocated resources, as well as an issue of dispersed distribution that makes early medical intervention difficult. The public system also suffers from a lack of capacity, as well as a shortage of skilled medical and paramedical personnel and inferior services. Because of the this, people are forced to seek medical care in private facilities, which creates the issue of affordability.

Canada, Spain, South Korea, Japan, and China are five countries that India may learn from and apply. It can take advantage of Universal Health Coverage by boosting government spending while also enacting stricter rules on generics and prescriptions to prevent overprescribing. Both Japan and South Korea have demonstrated that healthcare efficiency can be improved by adequate monitoring, regulations, and price setting rather than increasing the share of generics.

Countries such as Japan and Korea are at the forefront of healthcare system efficiency. When measured on the same efficiency standards, countries like India perform fairly well, even better than the United States, but other BRICS members outperform India. Increased physician, nurse, and bed density will put India on par with its peers. While the healthcare delivery structure cannot be changed overnight, adopting best practises from South Korea, Japan, and China, could help India climb the rankings. India can also benefit from the United States' laxity in terms of reimbursement management and having a unified healthcare system with universal health coverage, which appears to be a common factor among the world's best performers. To increase healthcare efficiency, Evidence-Based Medicine (EBM) is also advised.

VII. LIMITATIONS AND RECOMMENDATIONS

This current study only includes and considers OECD and BRICS countries and that could be extended to include a greater number of nations. This study includes and considers only four input variables and three output variables. The input variables include total number of nurses (per thousand inhabitants), total number of doctors (per thousand inhabitants), total number of hospital beds (per thousand inhabitants) and the total health expenditure per capita. The three output variables include infant and maternal survival rates as well as the life expectancy at birth. This study could be extended to include a greater number of input and output variables such as lifestyle, disease burden, income levels as well as nutrition.

VIII. CONCLUSION

The objective of the research paper was to use operation research to compare the efficiency of India's healthcare system to that of its BRICS and OECD rivals. After scrutinizing the findings, we see that among the BRICS countries, India has the lowest health spending (208.77), the lowest bed density (0.53) and doctors (0.78) and nurses (1.5) have the lowest density. These have a strong correlation with life expectancy, maternal survival rate and infant survival rate. Although all countries are efficient, the model ranks India and South Africa at the bottom of the health outcomes. While India has the lowest healthcare spending among the BRICS and OECD countries, it still operates on the efficiency frontier, meaning it makes efficient use of its resources. While the healthcare delivery structure cannot be changed overnight, adopting best practises from South Korea, Japan, and China, could help India climb the rankings.

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