

Estimation of Technical Efficiency of District Hospitals of Madhya Pradesh with reference to MMR and IMR

Manish Sharma¹, Sufia Aziz², Smita Verma³

¹Research Scholar, ²Associate Professor, Department of Applied Sciences (Mathematics), IET, DAVV, Indore, M.P.,

³Professor, Department of Applied Mathematics and Computational Science, SGSITS, Indore, M.P.

ABSTRACT

Data Envelopment Analysis (DEA) is a non-parametric method used to evaluate the efficiency of decision-making units (DMUs) such as district hospitals. Ensuring the effective allocation of sustainable healthcare resources is crucial for hospitals to provide high-quality care to patients, so it is essential to closely monitor efficiency. This research focuses on assessing the efficiency of 51 district hospitals in Madhya Pradesh, India with reference to the Maternal Mortality Rate (MMR) and Infant Mortality Rate (IMR). Using DEA, input and output data from various hospitals is analyzed to determine their relative efficiency. Results show that while most district hospitals' efficiency scores fluctuated, a few had an increased trend during the period. The study identifies best practices and areas for improvement, providing valuable insights for healthcare management and policy-making.

Keywords: Data Envelopment Analysis (DEA), Decision making unit (DMU), Efficiency, District Hospital M.P.

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1. INTRODUCTION

Data Envelopment Analysis (DEA) has emerged as a promising method for evaluating efficiency across diverse domains. While efficiency, defined as the ratio of outputs to inputs, is straightforward to measure with a single input and output, the challenge escalates with multiple inputs and outputs.

Introduced by Charnes et al. [6] in 1978, DEA assesses the relative efficiency of decision-making units (DMUs) using multiple inputs and outputs. Efficiency is calculated as the weighted sum of outputs divided by the weighted sum of inputs, with a mathematical model provided to support this evaluation, which will be discussed later in this paper. Cooper et al.[7] expanded on a range of DEA models, including the foundational Charnes, Cooper, and Rhodes (CCR) [7] model and the Banker, Charnes, and Cooper (BCC) [4] model, highlighting their applications and enhancements.

The efficiency of healthcare services is critical for ensuring optimal resource utilization and improved patient outcomes [1, 3, 10, 14, 17, 18, 21]. In developing regions like Madhya Pradesh, efficient hospital management can significantly impact public health. This study employs DEA to measure the relative efficiency of district hospitals in Madhya Pradesh with reference to the MMR and IMR. DEA is chosen for its ability to handle multiple inputs and

outputs without requiring a predefined functional form.

Objectives of the Study:

- Evaluate efficiency of district hospitals in Madhya Pradesh with reference to MMR and IMR
- Identify efficient and inefficient hospitals
- Provide recommendations for improving hospital efficiency

2. AN OVERVIEW OF DISTRICT HOSPITALS OF MP

Among the biggest states in India is Madhya Pradesh (MP), which has a network of district hospitals for the purpose of offering the general public basic medical services. With a range of services from primary care to specialty treatments, these hospitals play a critical role in the public healthcare system. Total 10,111 Sub-Health Centers, 1415 Primary Health Centers, 353 Community Health Centers, 135 Civil Hospitals, and 52 District Hospitals are providing health services to the population of Madhya Pradesh.

3. METHODOLOGY

3.1 DEA Model Used

The study uses the **CCR (Charnes, Cooper, Rhodes) model**, assuming constant returns to scale. DEA evaluates efficiency using multiple inputs and outputs without requiring a predefined functional form. The efficiency of each DMU is calculated using a fractional programming model and converted into a linear programming model.

3.2 Mathematical Formulation

Efficiency of DMU_o:

$$\max \sum_s v_s y_{so} \quad Z_o = \quad (1)$$

Subject to the constraints

$$\sum_k w_k x_{ko} = 1$$

$$\sum_s v_s y_s - \sum_k w_k x_{ko} \leq 0$$

$$v_s, w_k \geq 0$$

Dual model:

$$\min e_o \quad (2)$$

Subject to the constraints

$$\sum_p \rho_p x_{kp} - e_o x_{ko} \leq 0$$

$$\sum_p \rho_p y_{sp} - y_{so} \geq 0$$

$$\rho_p \geq 0$$

Efficient DMUs have efficiency score = 1.

4. CASE STUDY: EFFICIENCY OF DISTRICT HOSPITALS IN MADHYA PRADESH

4.1. Data Collection and Input–Output Variables

In selecting the input and output variables, due consideration was given to the intensity of hospital operations and service delivery. Previous studies have shown that variations in case-mix significantly influence resource utilization [5], and that output measures are meaningful only when such variations are adequately accounted for. A total of six variables were identified for the analysis, comprising three inputs (denoted as X₁–X₃) and three outputs (denoted as Y₁–Y₃).

The measurements of input are:

1. Number of Beds
2. Number of Doctors
3. Number of Health Personnel’s (likes: nurses, Lab technician, etc.)

The measurements of output are:

1. Number of Deliveries
2. Number of Maternal Deaths
3. Number of Infant Deaths

The study sample consists of 51 district hospitals located in the state of Madhya Pradesh, India. The data utilized in this study were obtained from the Annual Statistical Reports and Bulletins published by the Public Health and Family Welfare Department, covering the period from 2019 to 2023 (see Tables 1 and 2).

Table-1: Input values for District Hospitals in 2019-23

S. No.	Year →	For 2019-20			For 2020-21			For 2021-22			For 2022-23		
	District Hospitals Name ↓	Inputs			Inputs			Inputs			Inputs		
		X ₁	X ₂	X ₃	X ₁	X ₂	X ₃	X ₁	X ₂	X ₃	X ₁	X ₂	X ₃
1	AGAR MALWA	100	14	42	100	13	40	100	13	42	100	15	42
2	ALIRAJPUR	100	13	38	100	13	38	100	15	40	100	16	40
3	ANUPPUR	200	15	72	200	16	72	200	16	77	200	18	75
4	ASHOKNAGAR	100	16	46	100	14	46	100	14	45	100	16	45
5	BALAGHAT	300	24	96	300	18	96	300	22	96	300	21	94
6	BARWANI	300	22	80	300	26	80	300	26	82	300	27	82
7	BETUL	300	21	72	300	21	72	300	24	72	300	22	72

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8	BHIND	300	18	65	300	19	66	300	19	66	300	18	66
9	BHOPAL	300	28	112	300	28	114	300	30	114	300	34	114
10	BURHANPUR	200	16	72	200	16	72	200	16	72	200	18	74
11	CHHATARPUR	300	23	81	300	26	81	300	26	81	300	27	85
12	CHHINDWARA	400	25	124	400	25	124	400	22	125	400	26	120
13	DAMOH	300	23	78	300	23	78	300	20	78	300	22	82
14	DATIA	200	12	56	200	13	56	200	13	56	200	15	56
15	DEWAS	400	24	117	400	22	114	400	22	116	400	21	116
16	DHAR	300	17	76	300	18	76	300	18	78	300	15	78
17	DINDORI	100	14	32	100	15	32	100	14	31	100	16	31
18	GUNA	400	26	88	400	26	88	400	24	88	400	24	92
19	GWALIOR	200	19	71	200	19	71	200	19	71	200	22	69
20	HARDA	100	11	44	100	11	44	100	13	44	100	12	45
21	HOSHANGABAD	300	21	89	300	22	89	300	22	90	300	26	91
22	INDORE	300	24	116	300	23	116	300	23	115	300	27	116
23	JABALPUR	500	28	105	500	28	102	500	30	98	500	31	105
24	JHABUA	200	12	42	200	12	42	200	15	45	200	17	42
25	KATNI	200	14	51	200	15	51	200	15	48	200	18	50
26	KHANDWA	400	22	82	400	22	82	400	24	82	400	25	82
27	KHARGONE	300	21	85	300	21	84	300	20	84	300	24	84
28	MANDLA	300	18	56	300	18	56	300	20	60	300	23	58
29	MANDSAUR	500	24	92	500	25	92	500	28	96	500	28	96
30	MORENA	300	21	63	300	21	62	300	20	68	300	22	63
31	NARSINGHPUR	300	25	76	300	25	76	300	23	76	300	23	82
32	NEEMUCH	200	16	69	200	16	69	200	14	75	200	15	75
33	PANNA	200	15	47	200	12	47	200	14	45	200	14	47
34	RAISEN	200	18	42	200	18	42	200	20	40	200	18	41
35	RAJGARH	300	25	78	300	24	78	300	24	80	300	21	85
36	RATLAM	500	26	129	500	22	125	500	22	122	500	24	128
37	REWA	100	16	44	100	16	45	100	18	45	100	20	45
38	SAGAR	300	26	79	300	26	79	300	28	82	300	26	82
39	SATNA	400	22	83	400	22	83	400	20	83	400	23	78
40	SEHORE	200	19	58	200	20	58	200	20	58	200	21	55
41	SEONI	400	26	94	400	23	92	400	24	95	400	22	95
42	SHAHDOL	300	24	88	300	25	90	300	25	90	300	21	90
43	SHAJAPUR	200	16	50	200	16	51	200	18	51	200	16	51
44	SHEOPUR	100	15	42	100	15	42	100	17	43	100	18	43
45	SHIVPURI	300	23	102	300	23	102	300	25	102	300	25	98
46	SIDHI	300	20	54	300	20	54	300	19	54	300	18	57
47	SINGROLI	200	16	55	200	16	55	200	18	52	200	19	55
48	TIKAMGARH	200	14	58	200	14	58	200	17	60	200	17	61
49	UJJAIN	700	32	152	700	30	143	700	30	140	700	31	151

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50	UMARIA	100	12	32	100	12	32	100	11	30	100	12	32
51	VIDISHA	300	24	87	300	24	87	300	22	82	300	25	85

Table-2: Output values for District Hospitals in 2019-23

S. No.	Year → District Hospitals Name ↓	For 2019-20			For 2020-21			For 2021-22			For 2022-23		
		Outputs			Outputs			Outputs			Outputs		
		Y ₁	Y ₂	Y ₃	Y ₁	Y ₂	Y ₃	Y ₁	Y ₂	Y ₃	Y ₁	Y ₂	Y ₃
1	AGAR MALWA	11105	5	21	10259	2	42	9721	2	61	10288	2	54
2	ALIRAJPUR	17913	23	211	16900	29	297	17044	27	309	18639	31	385
3	ANUPPUR	10954	17	181	10302	12	246	10618	34	360	11022	33	363
4	ASHOKNAGAR	17463	29	185	17228	11	245	15954	21	276	15996	55	602
5	BALAGHAT	27371	45	529	24715	48	485	27564	33	724	26427	31	499
6	BARWANI	38082	59	1231	36805	47	959	39624	60	943	40544	55	1151
7	BETUL	26203	31	660	24926	29	657	24299	37	663	25300	26	752
8	BHIND	31216	48	461	28990	19	360	28863	34	633	27293	28	296
9	BHOPAL	48579	128	1230	49913	108	1398	51163	135	1029	51411	177	1818
10	BURHANPUR	15288	14	170	14876	8	160	15088	38	417	15884	22	505
11	CHHATARPUR	41579	22	575	39551	18	606	40873	29	721	40786	38	960
12	CHHINDWARA	32868	43	502	32754	49	669	32657	58	701	33971	48	924
13	DAMOH	24665	16	318	24804	28	436	23704	35	572	25060	34	323
14	DATIA	12355	16	267	12173	19	457	10972	10	312	11261	17	378
15	DEWAS	26876	22	463	27295	22	338	24778	23	336	26774	21	446
16	DHAR	38931	59	550	39671	31	768	38558	51	727	40479	25	954
17	DINDORI	13026	24	323	11322	24	308	11263	16	436	12774	13	390
18	GUNA	28230	21	725	27265	15	532	25630	26	769	27536	24	1019
19	GWALIOR	40954	106	604	42670	68	819	37502	16	329	41375	94	398
20	HARDA	10790	11	214	10419	12	189	10030	11	219	10144	7	285
21	HOSHANGABAD	22779	23	455	24418	27	348	23314	21	360	21589	20	370
22	INDORE	63379	41	115	66387	24	77	66316	44	16	66193	89	1048
23	JABALPUR	38184	94	793	36351	99	745	36358	144	1251	37713	131	1006
24	JHABUA	28944	79	441	33822	21	398	31548	35	299	34124	19	529
25	KATNI	24378	22	502	22418	40	459	22494	60	790	23864	51	880
26	KHANDWA	24573	22	469	24230	34	487	23944	26	502	25121	21	567
27	KHARGONE	35800	25	345	33681	52	333	34060	30	696	35428	58	920
28	MANDLA	16197	23	314	16395	17	219	15626	45	354	17099	24	464
29	MANDSAUR	24178	17	473	22672	11	494	21667	11	481	22374	16	463
30	MORENA	41652	39	641	42325	20	553	41170	34	600	39696	37	474
31	NARSINGHPUR	17716	19	257	18957	21	317	17969	41	383	18575	109	441
32	NEEMUCH	13754	11	496	13649	18	313	12102	18	319	12932	12	402
33	PANNA	20750	22	368	19273	19	319	19298	28	582	20150	37	967
34	RAISEN	21206	14	452	21570	13	398	19716	15	442	20448	40	416
35	RAJGARH	25895	11	360	24302	18	421	23964	25	591	24872	14	746

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36	RATLAM	29515	10	323	29891	19	338	29613	28	333	31372	14	923
37	REWA	45612	28	164	47141	39	148	41353	70	484	44737	62	544
38	SAGAR	44552	33	423	39847	9	289	37588	79	585	37117	64	551
39	SATNA	41566	46	823	40383	55	870	39652	59	1140	40235	49	1180
40	SEHORE	24309	27	691	24813	8	480	21691	13	588	22975	8	585
41	SEONI	21804	29	537	22188	22	504	21735	40	591	22361	38	490
42	SHAHDOL	22123	44	542	20710	61	477	21043	73	717	21882	37	682
43	SHAJAPUR	16876	13	316	16666	16	238	14512	13	218	14613	19	327
44	SHEOPUR	14478	14	371	13752	19	400	13374	12	460	14526	20	656
45	SHIVPURI	38561	22	634	35998	23	500	34272	28	360	37799	27	644
46	SIDHI	25855	26	114	25684	25	211	25900	32	366	25387	70	503
47	SINGROLI	28238	7	64	25962	0	41	29894	40	388	31435	38	486
48	TIKAMGARH	27271	12	176	25823	4	174	26917	25	383	26226	15	413
49	UJJAIN	37433	44	811	34154	17	510	33496	27	517	34394	17	546
50	UMARIA	12078	12	485	11189	14	404	10620	33	556	11173	13	547
51	VIDISHA	29705	44	777	27118	27	567	26954	52	1671	26004	53	672

4.2. DEA Model Formulation

Inputs:

X_1 = Number of Beds

X_2 = Number of Doctors

X_3 = Number of Health Personnel's (likes: nurses, Lab technician, etc.)

Outputs:

Y_1 = Number of Deliveries

Y_2 = Number of Maternal Deaths

Y_3 = Number of Infant Deaths

For DMU₁ (Agar Malwa) in 2019-20.

Maximise $DMU_1 = 100X_1 + 14X_2 + 42X_3$

Subject to: $11105Y_1 + 5Y_2 + 21Y_3 = 1$

$$100X_1 + 14X_2 + 42X_3 \leq 11105Y_1 + 5Y_2 + 21Y_3$$

$$100X_1 + 13X_2 + 38X_3 \leq 17913Y_1 + 23Y_2 + 211Y_3$$

$$200X_1 + 15X_2 + 72X_3 \leq 10954Y_1 + 17Y_2 + 181Y_3$$

$$100X_1 + 16X_2 + 46X_3 \leq 17463Y_1 + 29Y_2 + 185Y_3$$

$$300X_1 + 24X_2 + 96X_3 \leq 27371Y_1 + 45Y_2 + 529Y_3$$

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$$200X_1 + 14X_2 + 58X_3 \leq 27271Y_1 + 12Y_2 + 176Y_3$$

$$700X_1 + 32X_2 + 152X_3 \leq 37433Y_1 + 44Y_2 + 811Y_3$$

$$100X_1 + 12X_2 + 32X_3 \leq 12078Y_1 + 12Y_2 + 485Y_3$$

$$300X_1 + 24X_2 + 87X_3 \leq 29705Y_1 + 44Y_2 + 777Y_3$$

and $X_1, X_2, X_3, Y_1, Y_2, Y_3 \geq 0$

There will be 204 formulas for all district hospitals.

M.P. district hospitals are vital to the state's healthcare system since they offer the populace access to necessary medical care. As the main healthcare facilities for the district, district hospitals provide a variety of services such as emergency care, inpatient and outpatient care, surgery, maternity care, and specialty therapies. Anesthesia rooms, intensive care units (ICUs), neonatal intensive care units (NICUs), diagnostic labs, and pharmacies are among the

basic medical facilities that these institutions usually have. Nevertheless, there can be large regional differences in the standard and accessibility of these amenities.

5. RESULTS AND INTERPRETATION

Efficiency analysis was performed using **deaR programming language** and **Microsoft Excel Solver**. Throughout the 2019–2023 period, the DEA results shown in Table 3 determined which district hospitals followed best practices that were generally effective (value = 1) and which were relatively inefficient (value < 1).

5.1 Key Findings

During the period 2019–20, six hospitals—Barwani, Bhopal, Gwalior, Jhabua, Rewa, and Umari—were found to be efficient, while Agar Malwa recorded the lowest efficiency score (0.27825).

In 2020–21, the number of efficient hospitals remained six, with Jabalpur newly achieving efficiency, although Agar Malwa continued to rank lowest.

In 2021–22, efficiency improved overall, with eight hospitals becoming efficient, including notable improvements in Indore, Katni, and Vidisha, yet Agar Malwa again recorded the lowest efficiency.

In 2022–23, seven hospitals were efficient, with Dhar, Gwalior, Panna, and Sheopur showing improvement, while Agar Malwa remained the least efficient for the fourth consecutive year.

Table-3: Efficiency values for District Hospitals in 2019-23.

S. No.	District Hospitals	2019-20	2020-21	2021-22	2022-23
1	AGAR MALWA	0.27825	0.26919	0.30341	0.29883
2	ALIRAJPUR	0.67192	0.81119	0.60073	0.67032
3	ANUPPUR	0.32125	0.3263	0.4991	0.37549
4	ASHOKNAGAR	0.6546	0.66401	0.54401	0.98661
5	BALAGHAT	0.53688	0.7085	0.64962	0.50873
6	BARWANI	1	0.98759	0.78517	0.81775
7	BETUL	0.66181	0.7505	0.57156	0.61751
8	BHIND	0.71455	0.56169	0.73003	0.61899
9	BHOPAL	1	1	1	1
10	BURHANPUR	0.3779	0.3421	0.57654	0.50433
11	CHHATARPUR	0.75443	0.70501	0.72338	0.74
12	CHHINDWARA	0.54906	0.60456	0.73726	0.59565
13	DAMOH	0.43864	0.49992	0.58478	0.47641
14	DATIA	0.4895	0.70408	0.44444	0.41693
15	DEWAS	0.48556	0.4582	0.47353	0.48337
16	DHAR	0.93553	0.98615	0.97262	1
17	DINDORI	0.81482	0.79061	0.79749	0.73743
18	GUNA	0.58963	0.52247	0.57813	0.6373
19	GWALIOR	1	1	0.79958	1
20	HARDA	0.5479	0.46543	0.41811	0.4947
21	HOSHANGABAD	0.50538	0.43927	0.46574	0.34135
22	INDORE	0.92898	0.97966	1	1
23	JABALPUR	0.64849	1	1	0.81174
24	JHABUA	1	1	0.87686	0.93247
25	KATNI	0.82069	0.81755	1	0.95883
26	KHANDWA	0.50412	0.51049	0.47377	0.47338
27	KHARGONE	0.65446	0.70314	0.79509	0.7418
28	MANDLA	0.46088	0.39927	0.50189	0.46002
29	MANDSAUR	0.45927	0.45504	0.37557	0.35464
30	MORENA	0.94612	0.8981	0.9045	0.77344
31	NARSINGHPUR	0.32581	0.38	0.43114	0.91034
32	NEEMUCH	0.58907	0.42171	0.44573	0.45387
33	PANNA	0.67273	0.66345	0.78601	1
34	RAISEN	0.84084	0.83288	0.74156	0.69934

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35	RAJGARH	0.45556	0.4853	0.51205	0.59364
36	RATLAM	0.44393	0.48129	0.5487	0.58596
37	REWA	1	1	1	1
38	SAGAR	0.67682	0.55055	0.67556	0.67037
39	SATNA	0.86561	0.89	1	0.91626
40	SEHORE	0.83585	0.71639	0.6308	0.62593
41	SEONI	0.42286	0.47414	0.48393	0.46798
42	SHAHDOL	0.4846	0.70534	0.67505	0.53464
43	SHAJAPUR	0.52752	0.45324	0.36295	0.43601
44	SHEOPUR	0.85212	0.85837	0.84584	1
45	SHIVPURI	0.73847	0.60892	0.56569	0.61422
46	SIDHI	0.505	0.55374	0.60542	0.82845
47	SINGROLI	0.61909	0.55073	0.72622	0.71483
48	TIKAMGARH	0.71382	0.63788	0.69095	0.63088
49	UJJAIN	0.55677	0.44783	0.481	0.41913
50	UMARIA	1	1	1	0.97907
51	VIDISHA	0.65945	0.55625	1	0.54495

5.2 Average Efficiency (2019–23)

The analysis of average efficiency scores for the period 2019–2023 reveals notable variations among district hospitals in Madhya Pradesh. Umariya emerged as the highest-performing hospital in terms of average efficiency over these years, indicating consistently optimal utilization of available resources. Bhopal and Rewa stand out as the only district hospitals that remained fully efficient throughout the entire study period, consistently achieving efficiency score of one in each year. In contrast, Agar Malwa recorded the lowest average efficiency, reflecting significant inefficiencies in resource utilization and indicating substantial scope for improvement.

Table-4: Average Efficiency Score of District Hospitals for 2019-23.

S. No.	District Hospitals	Average Efficiency Score
1	AGAR MALWA	0.28742
2	ALIRAJPUR	0.68854
3	ANUPPUR	0.38054
4	ASHOKNAGAR	0.71231
5	BALAGHAT	0.60093
6	BARWANI	0.89763
7	BETUL	0.65035
8	BHIND	0.65632
9	BHOPAL	1
10	BURHANPUR	0.45022
11	CHHATARPUR	0.73071
12	CHHINDWARA	0.62163
13	DAMOH	0.49994
14	DATIA	0.51374
15	DEWAS	0.47517
16	DHAR	0.97358
17	DINDORI	0.78509
18	GUNA	0.58188
19	GWALIOR	0.9499
20	HARDA	0.48154
21	HOSHANGABAD	0.43794
22	INDORE	0.97716
23	JABALPUR	0.86506
24	JHABUA	0.95233
25	KATNI	0.89927

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26	KHANDWA	0.49044
27	KHARGONE	0.72362
28	MANDLA	0.45552
29	MANDSAUR	0.41113
30	MORENA	0.88054
31	NARSINGHPUR	0.51182
32	NEEMUCH	0.4776
33	PANNA	0.78055
34	RAISEN	0.77866
35	RAJGARH	0.51164
36	RATLAM	0.51497
37	REWA	1
38	SAGAR	0.64333
39	SATNA	0.91797
40	SEHORE	0.70224
41	SEONI	0.46223
42	SHAHDOL	0.59991
43	SHAJAPUR	0.44493
44	SHEOPUR	0.88908
45	SHIVPURI	0.63183
46	SIDHI	0.62315
47	SINGROLI	0.65272
48	TIKAMGARH	0.66838
49	UJJAIN	0.47618
50	UMARIA	0.99477
51	VIDISHA	0.69016

5.2 Benchmark Analysis

The benchmark analysis indicates that efficient hospitals form the efficiency frontier and serve as reference units for improving the performance of inefficient hospitals. Among them, Rewa emerged as the most significant benchmark, acting as a reference for 36 hospitals, while Barwani, Jhabua, and Bhopal also played important benchmarking roles.

5.3 Analytical Insights

(a) Efficiency Distribution

Around 15–20% of hospitals operate near or on the efficiency frontier. Nearly 50% fall in the moderate efficiency range (0.5–0.8). The remaining hospitals exhibit serious inefficiencies (<0.5).

(b) Scale vs. Efficiency

Larger hospitals (e.g., with more beds) are not always more efficient. Efficiency depends more on management and utilization than size alone.

5.4 Health Indicators Insight

From a health indicators perspective, Madhya Pradesh continues to face challenges, with a relatively high Infant Mortality Rate (IMR) of 48 per 1000 live births and a Neonatal Mortality Rate (NMR) of 32 per 1000 live births, highlighting the need for improved healthcare efficiency and outcomes.

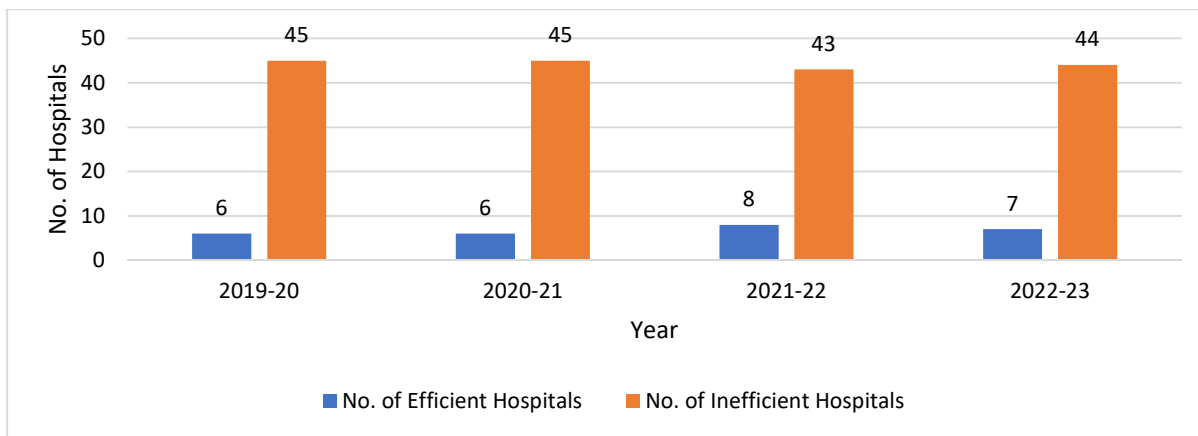


Figure 1: Number of Efficient and Inefficient hospitals during 2019-23.

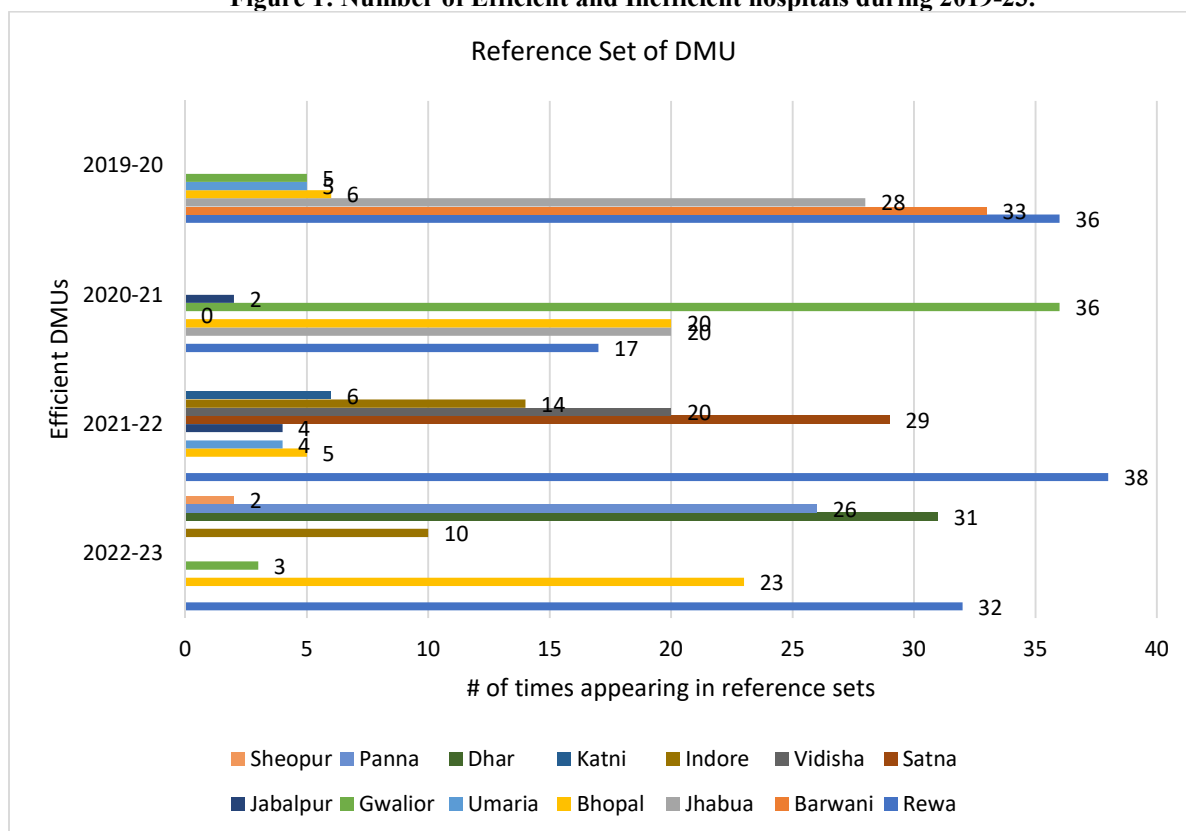


Figure 2: Reference Chart for Efficient hospitals during 2019-23

6. CONCLUSION AND RECOMMENDATIONS

This study examines relative efficiencies using an input-oriented DEA approach to evaluate the performance of 51 district hospitals in Madhya Pradesh. The findings provide an initial assessment of productivity and efficiency among these hospitals, enabling inefficient units to move toward the efficiency frontier while maintaining constant output levels. The DEA results highlight relative efficiency differences, showing that districts such as Agar

Malwa, Anuppur, and Mandsaur, despite offering comparatively poorer healthcare with fewer inputs, serve as reference hospitals for others with significantly higher outputs.

Although DEA does not directly reveal the exact resource requirements of hospitals, it indicates a relationship between resource allocation and utilization. The results offer valuable insights for policymakers and officials at the directorate of hospitals, helping them make informed decisions regarding optimal distribution of healthcare

resources. Overall, the study identifies substantial variations in technical efficiency across district hospitals in Madhya Pradesh, with Dhar, Gwalior, Indore, Jabua, Rewa, Satna, and Umari demonstrating consistently effective performance based on average efficiency scores.

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