WPI

OIE 548 (Performance Analytics)
Final Project: DEA-Based Selection of Indian T20 Bowlers
By Ishan Ratnakar Deshpande

Problem Statement:

The Indian cricket team, currently the highest-ranked team in T20 cricket according to the ICC ratings, is preparing for the upcoming ICC Men's T20 Cricket World Cup scheduled to take place in the United States from June 1 to June 29, 2024. The tournament will be held across three venues: Dallas, Florida, and New York.

To optimize their performance, the team management faces a crucial decision in selecting the best combination of bowlers for the playing eleven from a talented pool of players.

In this project, the aim is to utilize Data Envelopment Analysis (DEA) models to address this selection dilemma. T20 International (T20I) statistics of 23 Indian bowlers have been collected from the ESPN Cricinfo website. The dataset includes various performance metrics categorized into inputs and outputs for the analysis. By applying DEA techniques, the objective is to identify the most efficient bowlers who can contribute effectively to the team's success in the ICC Men's T20 Cricket World Cup.

Dataset description:

The dataset comprises columns representing key performance metrics of 23 Indian bowlers in T20 International cricket matches. These columns include 'PlayerName', 'Matches', 'Overs', 'Maidens', 'Runs', 'Wickets', 'Average', 'Economy', 'StrikeRate', '4fers', and '5fers', providing comprehensive insights into the bowlers' experience, workload, control over runs, wicket-taking ability, and effectiveness in maintaining a low scoring rate.

Inputs:

Matches: The total number of matches played by the player. This represents the experience and consistency of the player over time.

Overs: The total number of overs bowled by the bowler. This indicates the workload and contribution of the player in terms of bowling opportunities.

Maidens: The total number of maidens bowled by the player. This reflects the ability of the bowler to control runs and build pressure on the opposition batsmen.

Runs: The total runs conceded by the bowler in all matches. This represents the defensive capability of the bowler and their ability to restrict runs.

4fers: The number of times a bowler takes 4 wickets in an innings. This indicates the bowler's ability to take wickets in clusters and have a significant impact on the game.

5fers: The number of times a bowler takes 5 wickets in an innings. Similar to 4fers, this also reflects the bowler's ability to take wickets in bulk and potentially change the course of the match.

Outputs:

Wickets: The total number of wickets taken by the bowler in all matches. This represents the primary objective of the bowler, which is to take wickets and dismiss the opposition batsmen.

Average: The average number of runs conceded per wicket taken. This provides an indication of the bowler's effectiveness in terms of conceding runs per wicket.

Economy: The average number of runs conceded per over bowled. This measures the bowler's ability to maintain a low scoring rate and control the flow of runs during their spell.

Strike Rate: The average number of balls bowled per wicket taken. This indicates how quickly the bowler takes wickets, with a lower strike rate implying greater effectiveness in dismissing batsmen.

Models Used:

1] Multiplier Model (Input Oriented)

2] Multiplier Model (Improved Input Oriented)

3] Multiplier Model (Output Oriented)

4] Envelopment Model (Input Oriented)

5] Envelopment Model (Output Oriented)

6] Envelopment Model (Input Oriented - Super Efficiency)

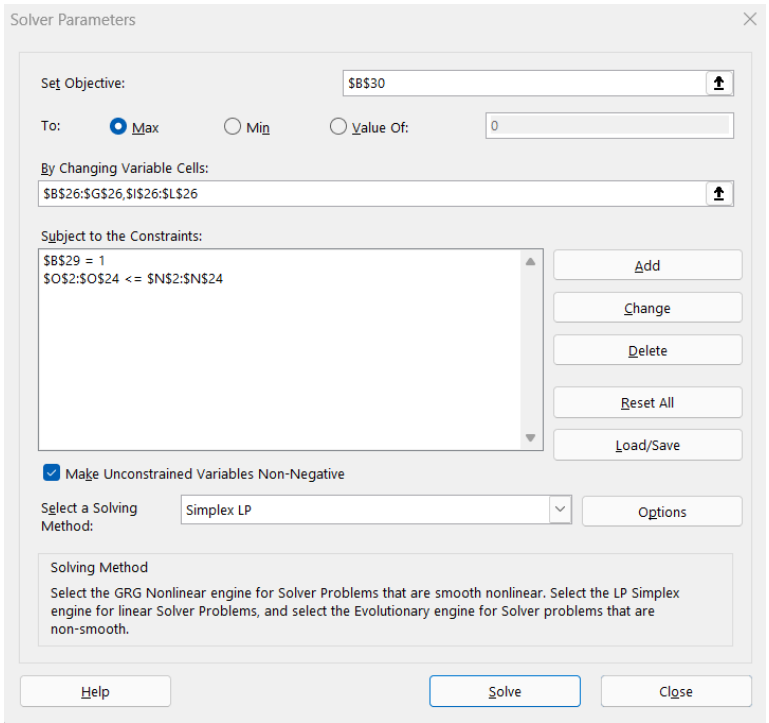
7] Envelopment Model (Output Oriented - Super Efficiency)

Multiplier Model (Input Oriented)

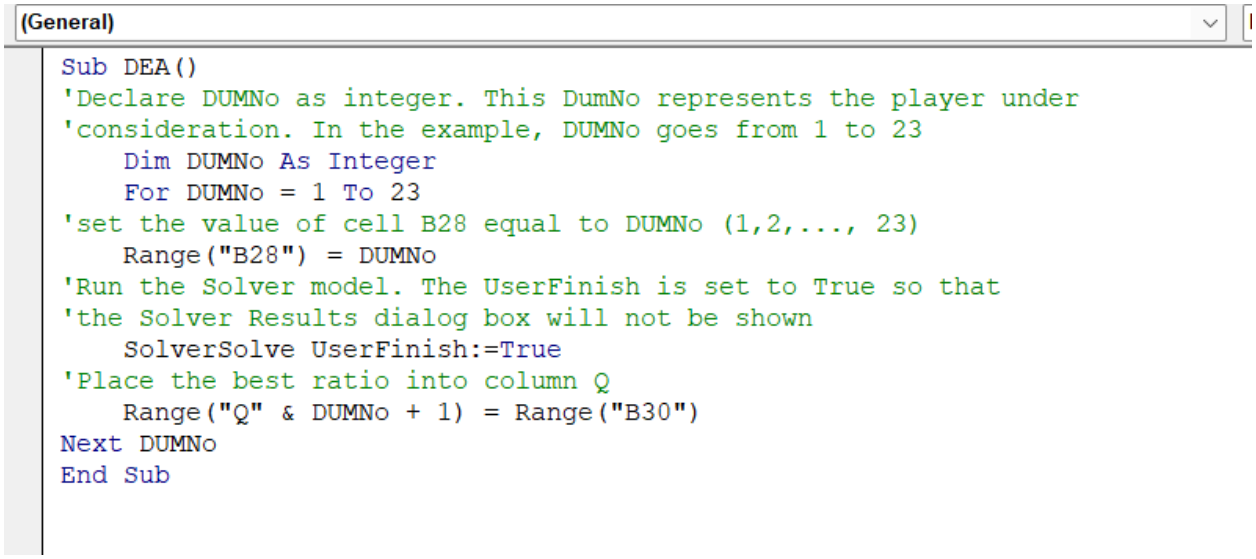
Model:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Player Name	Matches	Overs	Maidens	Runs	4(fers)	5(fers)		Wickets	Average	Economy	Strike Rate		Weighted Category I	Weighted Category II		DEA Score		
2	Jasprit Bumrah	62	221.5	10	1455	0	0		74	19.66	19.66	17.9		8.989917994	0.824318658		1		
3	Arshdeep Singh	44	149.5	2	1294	1	0		62	20.87	8.63	14.5		7.67745943	0.875052411		0.986482		
4	Kuldeep Yadav	35	123.2	2	832	1	2		59	14.1	6.74	12.5		5.12770939	0.591194969		1		
5	Bhuvneshwar Kumar	87	298.3	10	2079	3	2		90	23.1	6.96	19.9		12.80005017	0.968553459		0.722572		
6	Ravi Bishnoi	24	93.4	0	703	1	0		36	19.52	7.50	15.6		4.173717501	0.818448637		1		
7	Ravindra Jadeja	66	212	4	1506	0	0		53	28.41	7.10	24		9.357128779	1.191194969		0.715478		
8	Ravichandran Ashwin	65	242	3	1672	2	0		72	23.22	6.90	20.1		10.15252618	0.973584906		0.830587		
9	Axar Patel	52	163.1	1	1186	0	0		49	24.2	7.26	19.9		7.369575994	1.014675052		0.854583		
10	Mohammad Shami	23	79.3	1	711	0	0		24	29.62	8.94	19.8		4.184904466	1.241928721		0.754021		
11	Mohammad Siraj	10	38	2	334	1	0		12	27.83	8.78	19		1.942960215	1.16687631		0.848282		
12	Umran Malik	8	23.1	0	243	0	0		11	22.09	10.48	12.6		1.434254929	0.926205451		1		
13	Avesh Khan	20	66.2	1	618	1	0		19	32.52	9.31	20.9		3.637752573	1.363522013		0.673821		
14	Deepak Chahar	25	90	2	747	0	1		31	24.09	8.30	17.4		4.420625108	1.010062893		0.910428		
15	Yuzvendra Chahal	80	294	2	2409	2	1		96	25.09	8.19	18.3		14.23831879	1.051991614		0.785963		
16	Hardik Pandya	92	238.5	1	1950	3	0		73	26.71	8.16	19.6		12.30237656	1.119916143		0.716751		
17	Shardul Thakur	25	84.2	0	772	1	0		33	23.29	9.15	15.3		4.544709037	0.976519916		0.916167		
18	Shivam Dube	21	36.3	0	360	0	0		8	45	9.86	27.3		2.385726317	1.886792453		0.828372		
19	Washington Sundar	43	134.3	1	968	0	0		34	28.47	7.19	23.7		6.030885102	1.193710692		0.723072		
20	Prasidh Krishna	5	20	0	220	0	0		8	27.5	11.00	15		1.234538037	1.153039832		1		
21	Mukesh Kumar	14	43.5	0	412	0	0		12	34.33	9.39	21.9		2.444181643	1.439412998		0.688216		
22	Krunal Pandya	19	68.2	1	554	1	0		15	36.93	8.10	27.3		3.291577822	1.548427673		0.613353		
23	Venkatesh Iyer	9	9.1	0	75	0	0		5	15	8.18	11		0.628930818	0.628930818		1		
24	Rahul Chahar	6	22	0	167	0	0		7	23.85	7.59	18.8		1	1		1		
25																			
26	Weights/Multipliers	0.02852	0	0	0.004963	0	0		0	0.041929	0	0							
27																			
28	Player Under Consideration	23																	
29	Weighted Category I	1																	
30	Weighted Category II	1																	
31																			

Solver:



VBA Code:



Results and Analysis:

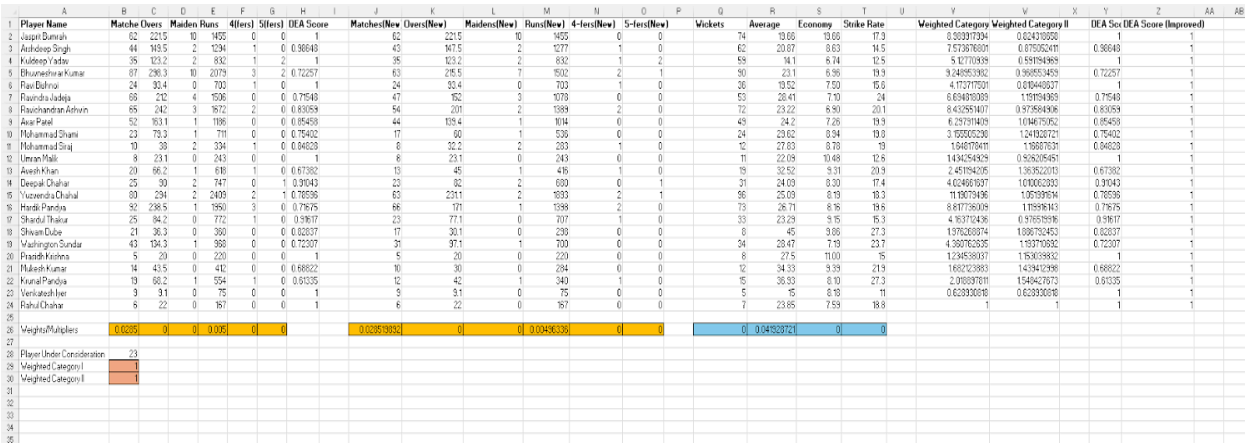
This model, known as the Multiplier Input Oriented Model, maximizes output with the input set to 1. By analyzing the DEA score, we identify optimal practices. Among 23 players, 7 demonstrate optimal practices with a DEA score of 1. These players are Jasprit Bumrah, Kuldeep Yadav, Ravi Bishnoi, Umran Malik, Prasidh Krishna, Venkatesh Iyer, and Rahul Chahar.

The weights or multiplier values obtained from the Data Envelopment Analysis (DEA) model provide valuable insights into the relative significance of input and output variables within a unified framework for evaluating cricket player performance efficiency. Among the input variables, "Matches" emerges as the most influential, indicating its pivotal role in determining overall efficiency, while "Runs" also contributes significantly. Conversely, variables such as "Overs," "Maidens," "4(fers)," and "5(fers)" display minimal impact on efficiency. Within the output variables, "Average" exhibits the highest weight, followed by "Strike Rate," suggesting their critical importance in evaluating player effectiveness. These findings offer actionable insights for optimizing player performance and strategic decision-making in cricket.

Multiplier Model (Improvement in the Input Oriented Model)

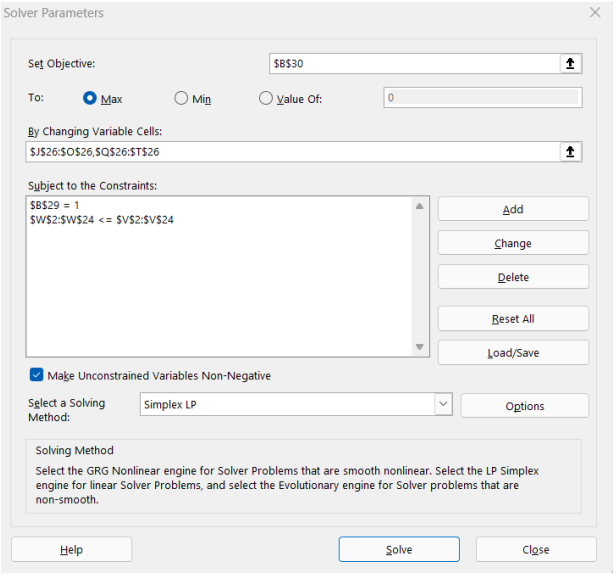
The previous model pinpointed 7 out of 23 players as embodying best practices. This updated version provides clarity on the inputs necessary to identify such practices. By multiplying the original input with the DEA score, new inputs were derived for model preparation. Achieving a flawless DEA score of 1 using this method offers insight into setting inputs to reach the frontier effectively.

Model:



Player Name	Matche	Overs	Maiden	Runs	4(fers)	5(fers)	DEA Score	Matches(New	Overs(New)	Maidens(New)	Runs(New)	4-fers(New)	5-fers(New)	Wickets	Average	Economy	Strike Rate	Weighted Category	Weighted Category II	DEA Sco	DEA Score (Improved)
Jasprit Bumrah	62	221.5	10	1455	0	0	1	62	221.5	10	1455	0	0	74	19.66	19.66	17.9	8.393917334	0.624316858	1	1
Arshdeep Singh	44	149.5	2	1094	1	0	0.96949	43	147.5	2	1077	1	0	62	20.07	8.63	14.5	7.573876691	0.675352411	0.96949	1
Kuldeep Yadav	35	123.2	2	832	1	2	1	35	123.2	2	832	1	2	59	14.1	6.74	12.5	5.12770939	0.59194969	1	1
Bhuvneshwar Kumar	87	298.3	10	2079	3	2	0.72257	63	215.5	7	1502	2	1	90	23.1	6.96	19.9	9.248853982	0.968553459	0.72257	1
Ravi Bishnoi	24	90.4	0	703	1	0	1	24	90.4	0	703	1	0	36	19.52	7.50	15.6	4.173717501	0.810448637	1	1
Ravindra Jadeja	66	212	4	1506	0	0	0.71548	47	152	3	1078	0	0	53	28.41	7.10	24	6.694818389	1.151194369	0.71548	1
Ravichandran Ashwin	65	242	3	1672	2	0	0.83059	54	201	2	1389	2	0	72	23.22	6.90	20.1	8.432551407	0.973584906	0.83059	1
Axar Patel	52	163.1	1	1196	0	0	0.85458	44	139.4	1	1014	0	0	49	24.2	7.26	19.9	6.257311409	1.074675052	0.85458	1
Mohammad Shami	23	79.3	1	711	0	0	0.75402	17	60	1	536	0	0	24	29.62	8.94	19.8	3.155065236	1.241320721	0.75402	1
Mohammad Siraj	10	39	2	334	1	0	0.84628	8	32.2	2	283	1	0	12	27.83	8.78	19	1.946179411	1.15867531	0.84628	1
Umran Malik	8	23.1	0	243	0	0	1	8	23.1	0	243	0	0	11	22.09	10.48	12.6	1.434254929	0.926205451	1	1
Avesh Khan	20	66.2	1	618	1	0	0.67382	13	45	1	416	1	0	19	32.52	9.31	20.9	2.451194205	1.363522013	0.67382	1
Deepak Chahar	25	90	2	747	0	1	0.91043	23	82	2	680	0	1	31	24.09	8.30	17.4	4.024661937	1.010062333	0.91043	1
Yuzvendra Chahal	80	294	2	2409	2	1	0.78596	69	231.1	2	1933	2	1	96	25.09	8.19	18.3	11.19079496	1.051391614	0.78596	1
Hardik Pandya	92	238.5	1	1650	3	0	0.71675	66	171	1	1398	2	0	73	26.71	8.16	19.6	8.817736009	1.119916143	0.71675	1
Shardul Thakur	25	84.2	0	772	1	0	0.91617	23	77.1	0	707	1	0	33	23.29	9.15	15.3	4.163704396	0.976515916	0.91617	1
Shivam Dube	21	36.3	0	360	0	0	0.82837	17	30.1	0	298	0	0	8	45	9.86	27.3	1.976268374	1.086782453	0.82837	1
Washington Sundar	43	134.3	1	980	0	0	0.72307	31	97.1	1	700	0	0	34	28.47	7.19	23.7	4.380762935	1.193710932	0.72307	1
Prasidh Krishna	5	29	0	220	0	0	1	5	20	0	220	0	0	8	27.5	11.00	15	1.234538937	1.150338832	1	1
Mukesh Kumar	14	43.5	0	412	0	0	0.68822	10	30	0	284	0	0	12	34.33	9.39	21.9	1.682123883	1.439412998	0.68822	1
Krunal Pandya	19	68.2	1	554	1	0	0.61335	12	42	1	340	1	0	15	36.93	8.10	27.3	2.018897611	1.540427673	0.61335	1
Venkatesh Iyer	9	9.1	0	75	0	0	1	9	9.1	0	75	0	0	5	15	8.18	11	0.623330818	0.623330818	1	1
Rahul Chahar	6	22	0	167	0	0	1	6	22	0	167	0	0	7	23.85	7.59	18.8	1	1	1	1
Weights/Multipliers	0.0285	0	0	0.005	0	0		0.029519093	0	0	0.00496336	0	0	0	0.041928724	0	0				
Player Under Consideration	23																				
Weighted Category I	1																				
Weighted Category II	1																				

Solver:



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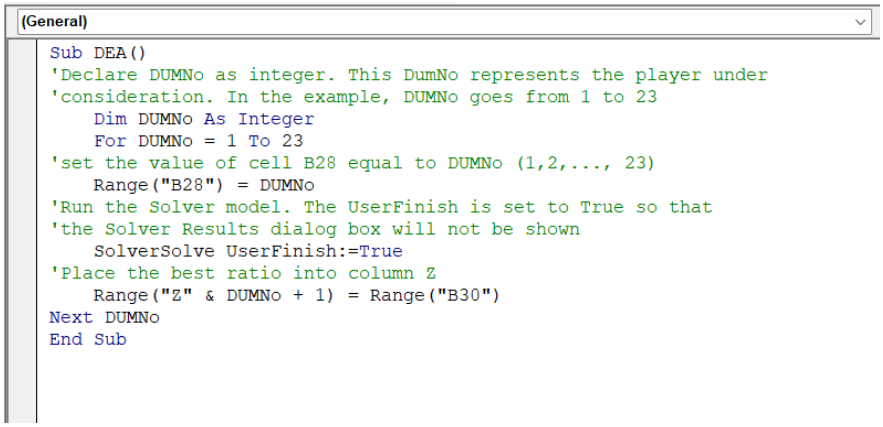


```
(General)
Sub DEA()
'Declare DUMNo as integer. This DumNo represents the player under
'consideration. In the example, DUMNo goes from 1 to 23
    Dim DUMNo As Integer
    For DUMNo = 1 To 23
'set the value of cell B28 equal to DUMNo (1,2,..., 23)
    Range("B28") = DUMNo
'Run the Solver model. The UserFinish is set to True so that
'the Solver Results dialog box will not be shown
    SolverSolve UserFinish:=True
'Place the best ratio into column Z
    Range("Z" & DUMNo + 1) = Range("B30")
Next DUMNo
End Sub
```

Results and Analysis:

Let's examine the case of Player Avesh Khan:

His original input values and DEA score are:
Matches: 20
Overs: 66.2
Maidens: 1
Runs: 618
4-fers: 1
5-fers: 0
DEA score: 0.67382

After multiplying these values by the DEA score, we get updated input values and an improved DEA score:

Matches (New): 13
Overs (New): 45
Maidens (New): 1
Runs (New): 416
4-fers (New): 1
5-fers (New): 0
Improved DEA score: 1

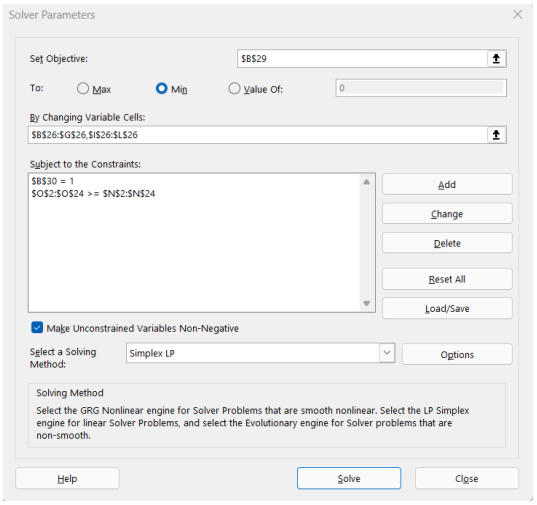
The original DEA score of 0.67382 indicates that the player has the potential to reduce their current input levels by 32.62% in order to reach the frontier.

Multiplier Model (Output Oriented)

Model:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Player Name	Matches	Overs	Maidens	Runs	4(fers)	5(fers)		Wickets	Average	Economy	Strike Rate		Weighted Category I	Weighted Category II		DEA Score		
2	Jasprit Bumrah	62	221.5	10	1455	0	0		74	19.66	19.66	17.9		0.916996047	2.590250329		1		
3	Arshdeep Singh	44	149.5	2	1294	1	0		62	20.87	8.63	14.5		0.183399209	1.137022398		1		
4	Kuldeep Yadav	35	123.2	2	832	1	2		59	14.1	6.74	12.5		0.183399209	0.88801054		1		
5	Bhuvneshwar Kumar	87	298.3	10	2079	3	2		90	23.1	6.96	19.9		0.916996047	0.916996047		1		
6	Ravi Bishnoi	24	93.4	0	703	1	0		36	19.52	7.50	15.6		0	0.988142292		1		
7	Ravindra Jadeja	66	212	4	1506	0	0		53	28.41	7.10	24		0.366798419	0.93544137		1		
8	Ravichandran Ashwin	65	242	3	1672	2	0		72	23.22	6.90	20.1		0.275098814	0.909090909		1		
9	Axar Patel	52	163.1	1	1186	0	0		49	24.2	7.26	19.9		0.091699605	0.956521739		1		
10	Mohammad Shami	23	79.3	1	711	0	0		24	29.62	8.94	19.8		0.091699605	1.177865613		1		
11	Mohammad Siraj	10	38	2	334	1	0		12	27.83	8.78	19		0.183399209	1.156785244		1		
12	Umran Malik	8	23.1	0	243	0	0		11	22.09	10.48	12.6		0	1.380764163		1		
13	Avesh Khan	20	66.2	1	618	1	0		19	32.52	9.31	20.9		0.091699605	1.226613966		1		
14	Deepak Chahar	25	90	2	747	0	1		31	24.09	8.30	17.4		0.183399209	1.093544137		1		
15	Yuzvendra Chahal	80	294	2	2409	2	1		96	25.09	8.19	18.3		0.183399209	1.079051383		1		
16	Hardik Pandya	92	238.5	1	1950	3	0		73	26.71	8.16	19.6		0.091699605	1.075098814		1		
17	Shardul Thakur	25	84.2	0	772	1	0		33	23.29	9.15	15.3		0	1.205533597		1		
18	Shivam Dube	21	36.3	0	360	0	0		8	45	9.86	27.3		0	1.299077734		1		
19	Washington Sundar	43	134.3	1	968	0	0		34	28.47	7.19	23.7		0.091699605	0.947299078		1		
20	Prasidh Krishna	5	20	0	220	0	0		8	27.5	11.00	15		0	1.449275362		1		
21	Mukesh Kumar	14	43.5	0	412	0	0		12	34.33	9.39	21.9		0	1.23715415		1		
22	Krunal Pandya	19	68.2	1	554	1	0		15	36.93	8.10	27.3		0.091699605	1.067193676		1		
23	Venkatesh Iyer	9	9.1	0	75	0	0		5	15	8.18	11		0	1.07773386		1		
24	Rahul Chahar	6	22	0	167	0	0		7	23.85	7.59	18.8		0	1		1		
25																			
26	Weights/Multipliers	0	0	0.0917	0	0	0		0	0	0	0							
27																			
28	Player Under Consideration	23																	
29	Weighted Category I	0																	
30	Weighted Category II	1																	
31																			
32																			
33																			

Solver:



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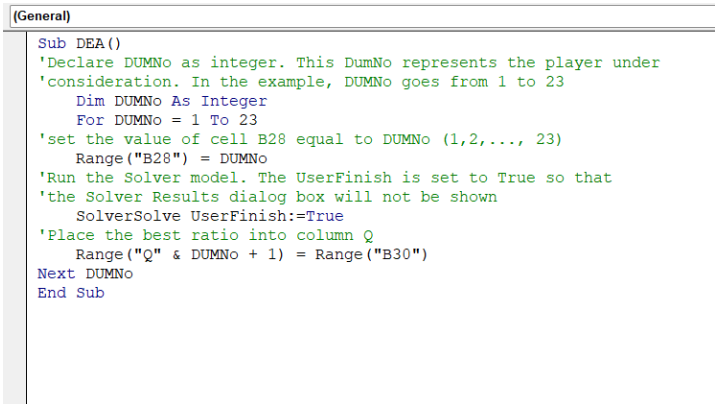


(General)

```
Sub DEA()
'Declare DUMNo as integer. This DumNo represents the player under
'consideration. In the example, DUMNo goes from 1 to 23
    Dim DUMNo As Integer
    For DUMNo = 1 To 23
'set the value of cell B28 equal to DUMNo (1,2,..., 23)
    Range("B28") = DUMNo
'Run the Solver model. The UserFinish is set to True so that
'the Solver Results dialog box will not be shown
    SolverSolve UserFinish:=True
'Place the best ratio into column Q
    Range("Q" & DUMNo + 1) = Range("B30")
Next DUMNo
End Sub
```

Results and Analysis:

In an output-oriented multiplier model, the objective is to minimize inputs while setting the output to 1. Achieving a DEA score of 1 for each player indicates that they are operating at maximum efficiency within this framework.

The weights derived from the DEA model represent the relative importance assigned to different performance metrics for evaluating a player's efficiency and effectiveness. In this specific case, the weights indicate that Maidens hold a significant emphasis, with a weight of 0.0917, suggesting that the ability to prevent scoring opportunities is highly valued. Conversely, other metrics such as Matches, Overs, Runs, 4-fers, 5-fers, Wickets, Average, Economy, and Strike Rate are assigned a weight of 0, indicating they are not considered as influential in determining efficiency according to this model. These weights provide valuable insight into the factors that contribute most significantly to a player's performance evaluation within the context of the DEA analysis.

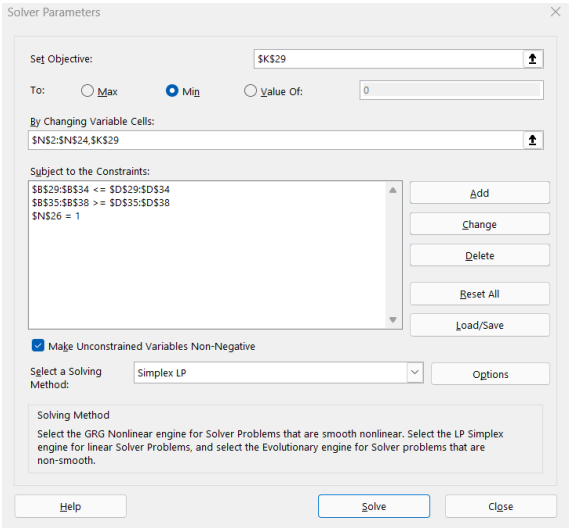
Envelopment Model (Input Oriented)

In this model, a virtual DMU is created by leveraging existing DMUs. It operates as an input-oriented model, employing the concept of weight share. Each DMU contributes a specific percentage to the overall efficiency score, with the sum of these weight shares totaling 1 or 100%. When assessing a particular DMU, the weight share column indicates the percentage contribution of other DMUs. This model serves as a valuable tool for benchmarking purposes.

Model:

Player Name	Matches	Overs	Maidens	Runs	4(fers)	5(fers)	Wickets	Average	Economy	Strike Rate	Weight Share	DEA Efficiency
Jasprit Bumrah	62	221.5	10	1455	0	0	74	19.66	19.66	17.9	0%	1
Arshdeep Singh	44	149.5	2	1294	1	0	62	20.87	8.63	14.5	14%	1
Kuldeep Yadav	35	123.2	2	832	1	2	59	14.1	6.74	12.5	0%	1
Bhuvneshwar Kumar	87	298.3	10	2079	3	2	90	23.1	6.96	19.9	0%	1
Ravi Bishnoi	24	93.4	0	703	1	0	36	19.52	7.50	15.6	0%	1
Ravindra Jadeja	66	212	4	1506	0	0	53	28.41	7.10	24	0%	1
Ravichandran Ashwin	65	242	3	1672	2	0	72	23.22	6.90	20.1	0%	1
Axar Patel	52	163.1	1	1186	0	0	49	24.2	7.26	19.9	0%	1
Mohammad Shami	23	79.3	1	711	0	0	24	29.62	8.94	19.8	0%	1
Mohammad Siraj	10	38	2	334	1	0	12	27.83	8.78	19	0%	1
Umran Malik	8	23.1	0	243	0	0	11	22.09	10.48	12.6	0%	1
Avesh Khan	20	66.2	1	618	1	0	19	32.52	9.31	20.9	0%	0.914524725
Deepak Chahar	25	90	2	747	0	1	31	24.09	8.30	17.4	0%	1
Yuzvendra Chahal	80	294	2	2409	2	1	96	25.09	8.19	18.3	0%	1
Hardik Pandya	92	238.5	1	1950	3	0	73	26.71	8.16	19.6	0%	1
Shardul Thakur	25	84.2	0	772	1	0	33	23.29	9.15	15.3	0%	1
Shivam Dube	21	36.3	0	360	0	0	8	45	9.86	27.3	1%	1
Washington Sundar	43	134.3	1	968	0	0	34	28.47	7.19	23.7	0%	1
Prasidh Krishna	5	20	0	220	0	0	8	27.5	11.00	15	0%	1
Mukesh Kumar	14	43.5	0	412	0	0	12	34.33	9.39	21.9	85%	1
Krunal Pandya	19	68.2	1	554	1	0	15	36.93	8.10	27.3	0%	1
Venkatesh Iyer	9	9.1	0	75	0	0	5	15	8.18	11	0%	1
Rahul Chahar	6	22	0	167	0	0	7	23.85	7.59	18.8	0%	1
Sum of Weight Shares											100%	
DMU Under Evaluation	12								Performance			
Virtual DMU									Score			
Matches	18.2905	<=	18.2905						0.914524725			
Overs	58.3952	<=	60.5415									
Maidens	0.29457	<=	0.91452									
Runs	535.282	<=	565.176									
4(fers)	0.13884	<=	0.91452									
5(fers)	0	<=	0									
Wickets	19	>=	19									
Average	32.52	>=	32.52									
Economy	9.31	>=	9.31									
Strike Rate	20.9	>=	20.9									

Solver:



VBA Code:

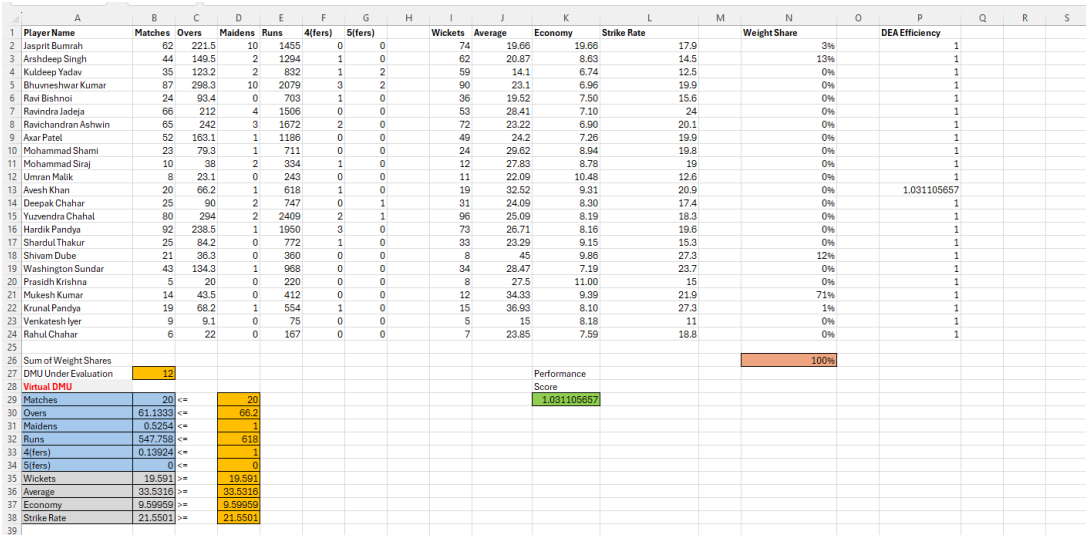
```
Sub DEA()
'Declare DUMNo as integer. This DumNo represents the Player under
'consideration. In the example, DUMNo goes from 1 to 23
    Dim DUMNo As Integer
    For DUMNo = 1 To 23
'set the value of cell B27 equal to DUMNo (1,2,..., 23)
    Range("B27") = DUMNo
'Run the Solver model. The UserFinish is set to True so that
'the Solver Results dialog box will not be shown
    SolverSolve UserFinish:=True
'Place the best ratio into column P
    Range("P" & DUMNo + 1) = Range("K29")
Next DUMNo
End Sub
```

Results and Analysis:

Analyzing the DEA score reveals that among the 23 players, 22 are considered best practices. When evaluating DMU 12 (Avesh Khan), the weight share column indicates that DMU 20 holds the highest weight share at 85%, followed by DMU 2 with a weight share of 14%, and DMU 19 with a weight share of 1%. Therefore, DMU 12 can use DMU 20 as a benchmarking model, followed by DMU 2 and DMU 19, based on their respective percentage weight shares.

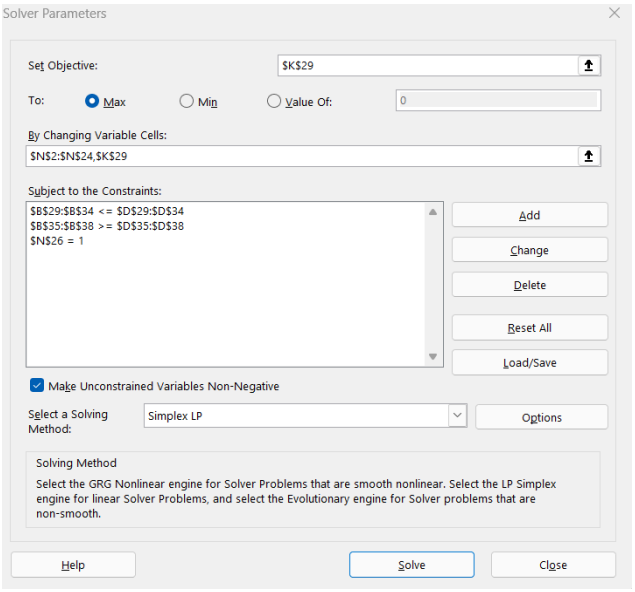
Envelopment Model (Output Oriented)

Model:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Player Name	Matches	Overs	Maidens	Runs	4(fers)	5(fers)		Wickets	Average	Economy	Strike Rate		Weight Share		DEA Efficiency			
2	Jasprit Bumrah	62	221.5	10	1455	0	0		74	19.66	19.66	17.9		3%		1			
3	Arshdeep Singh	44	149.5	2	1294	1	0		62	20.87	8.63	14.5		13%		1			
4	Kuldeep Yadav	35	123.2	2	832	1	2		59	14.1	6.74	12.5		0%		1			
5	Bhuvneshwar Kumar	87	298.3	10	2079	3	2		90	23.1	6.96	19.9		0%		1			
6	Ravi Bishnoi	24	93.4	0	703	1	0		36	19.52	7.50	15.6		0%		1			
7	Ravindra Jadeja	66	212	4	1506	0	0		53	28.41	7.10	24		0%		1			
8	Ravichandran Ashwin	65	242	3	1672	2	0		72	23.22	6.90	20.1		0%		1			
9	Axar Patel	52	163.1	1	1186	0	0		49	24.2	7.26	19.9		0%		1			
10	Mohammad Shami	23	79.3	1	711	0	0		24	29.62	8.94	19.8		0%		1			
11	Mohammad Siraj	10	38	2	334	1	0		12	27.83	8.78	19		0%		1			
12	Umran Malik	8	23.1	0	243	0	0		11	22.09	10.48	12.6		0%		1			
13	Avesh Khan	20	66.2	1	618	1	0		19	32.52	9.31	20.9		0%		1.031105657			
14	Deepak Chahar	25	90	2	747	0	1		31	24.09	8.30	17.4		0%		1			
15	Yuzvendra Chahal	80	294	2	2409	2	1		96	25.09	8.19	18.3		0%		1			
16	Hardik Pandya	92	238.5	1	1950	3	0		73	26.71	8.16	19.6		0%		1			
17	Shardul Thakur	25	84.2	0	772	1	0		33	23.29	9.15	15.3		0%		1			
18	Shivam Dube	21	36.3	0	360	0	0		8	45	9.86	27.3		12%		1			
19	Washington Sundar	43	134.3	1	968	0	0		34	28.47	7.19	23.7		0%		1			
20	Prasidh Krishna	5	20	0	220	0	0		8	27.5	11.00	15		0%		1			
21	Mukesh Kumar	14	43.5	0	412	0	0		12	34.33	9.39	21.9		71%		1			
22	Krunal Pandya	19	68.2	1	554	1	0		15	36.93	8.10	27.3		1%		1			
23	Venkatesh Iyer	9	9.1	0	75	0	0		5	15	8.18	11		0%		1			
24	Rahul Chahar	6	22	0	167	0	0		7	23.85	7.59	18.8		0%		1			
25																			
26	Sum of Weight Shares													100%					
27	DMU Under Evaluation	12									Performance								
28	Virtual DMU										Score								
29	Matches	20	<=	20							1.031105657								
30	Overs	61.1333	<=	66.2															
31	Maidens	0.5254	<=	1															
32	Runs	547.758	<=	618															
33	4(fers)	0.13924	<=	1															
34	5(fers)	0	<=	0															
35	Wickets	19.591	>=	19.591															
36	Average	33.5316	>=	33.5316															
37	Economy	9.59959	>=	9.59959															
38	Strike Rate	21.5501	>=	21.5501															
39																			

Solver:



VBA Code:

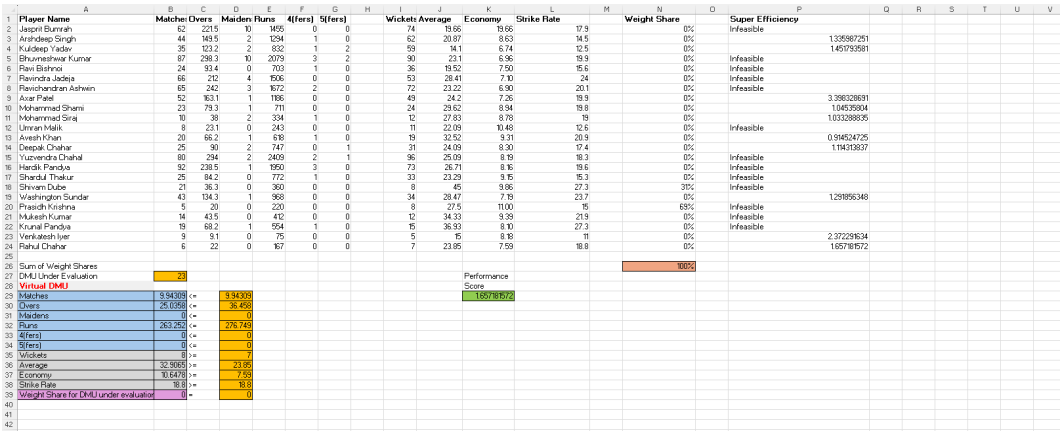
```
Sub DEA()
'Declare DUMNo as integer. This DumNo represents the Player under
'consideration. In the example, DUMNo goes from 1 to 23
    Dim DUMNo As Integer
    For DUMNo = 1 To 23
'set the value of cell B27 equal to DUMNo (1,2,..., 23)
    Range("B27") = DUMNo
'Run the Solver model. The UserFinish is set to True so that
'the Solver Results dialog box will not be shown
    SolverSolve UserFinish:=True
'Place the best ratio into column P
    Range("P" & DUMNo + 1) = Range("K29")
Next DUMNo
End Sub
```

Results and Analysis:

In the output-oriented envelopment model, 22 out of 23 decision-making units (DMUs) have a DEA score of 1. When DMU 12 (Avesh Khan) is being evaluated, DMU 20 contributes the most with a weight share of 71%, followed by DMU 2 with 13%, and DMU 17 with 12%. This means that DMU 12 can use DMU 20 as its primary benchmark, with DMU 2 and DMU 17 as secondary benchmarks based on their respective weight shares.

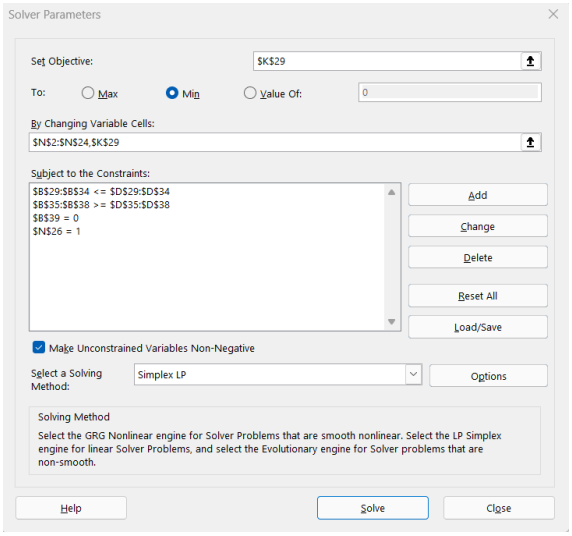
Envelopment Model (Input Oriented - Super Efficiency)

Model:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	Player Name	Matches	Overs	Maidens	Runs	4(fers)	5(fers)		Wickets	Average	Economy	Strike Rate		Weight Share		Super Efficiency						
2	Jasprit Bumrah	62	221.5	10	1455	0	0		74	19.66	11.66	17.9		0%		Infeasible						
3	Arshdeep Singh	44	149.5	2	1294	1	0		62	20.87	8.63	14.5		0%		1.395987251						
4	Kuldeep Yadav	35	123.2	2	832	1	2		59	14.1	6.74	12.5		0%		1.457933581						
5	Bhuvneshwar Kumar	87	298.3	10	2079	3	2		90	23.1	6.96	19.9		0%		Infeasible						
6	Ravi Bishnoi	24	93.4	0	703	1	0		36	19.52	7.50	15.6		0%		Infeasible						
7	Ravindra Jadeja	66	212	4	1506	0	0		53	28.41	7.10	24		0%		Infeasible						
8	Ravichandran Ashwin	65	242	3	1672	2	0		72	23.22	6.90	20.1		0%		Infeasible						
9	Axar Patel	52	163.1	1	1186	0	0		49	24.2	7.26	19.9		0%		3.398328691						
10	Mohammad Shami	23	79.3	1	711	0	0		24	29.62	8.94	19.8		0%		1.04535804						
11	Mohammad Siraj	10	38	2	334	1	0		12	27.83	8.78	19		0%		1.033288835						
12	Umran Malik	8	23.1	0	243	0	0		11	22.09	10.49	12.6		0%		Infeasible						
13	Avesh Khan	20	66.2	1	618	1	0		19	32.52	9.31	20.9		0%		0.914524725						
14	Deepak Chahar	25	90	2	747	0	1		31	24.09	8.30	17.4		0%		1.114313837						
15	Yuzvendra Chahal	80	294	2	2409	2	1		96	25.09	8.19	18.3		0%		Infeasible						
16	Hardik Pandya	92	238.5	1	1950	3	0		73	26.71	8.16	19.6		0%		Infeasible						
17	Shardul Thakur	25	84.2	0	772	1	0		33	23.39	9.15	15.3		0%		Infeasible						
18	Shivam Dube	21	36.3	0	360	0	0		8	45	9.86	27.3		31%		Infeasible						
19	Washington Sundar	43	134.3	1	968	0	0		34	28.47	7.19	23.7		0%		1.291856348						
20	Prasidh Krishna	5	20	0	220	0	0		8	27.5	11.00	15		69%		Infeasible						
21	Mukesh Kumar	14	43.5	0	412	0	0		12	34.33	9.39	21.9		0%		Infeasible						
22	Krunal Pandya	19	68.2	1	554	1	0		15	36.93	8.10	27.3		0%		Infeasible						
23	Venkatesh Iyer	9	9.1	0	75	0	0		5	15	8.18	11		0%		2.372291634						
24	Rahul Chahar	6	22	0	167	0	0		7	23.85	7.59	18.8		0%		1.657181572						
25																						
26	Sum of Weight Shares													100%								
27	DMU Under Evaluation	23									Performance											
28	Virtual DMU										Score											
29	Matches	9.94309	<=	9.94309							1.657181572											
30	Overs	25.0356	<=	36.459																		
31	Maidens	0	<=	0																		
32	Runs	263.252	<=	276.749																		
33	4(fers)	0	<=	0																		
34	5(fers)	0	<=	0																		
35	Wickets	8	>=	7																		
36	Average	32.9085	>=	23.85																		
37	Economy	10.6478	>=	7.59																		
38	Strike Rate	18.8	>=	18.8																		
39	Weight Share for DMU under evaluation	0	=	0																		
40																						
41																						
42																						

Solver:



VBA Code:

```
Sub SuperEfficiency()
'Declare DMUNo as integer.This DMUNo represents the player under
'evaluation.In the example, DMUNo goes from 1 to 23
    Dim DMUNo As Integer
    For DMUNo = 1 To 23
'set the value of cell B27 equal to DMUNo (1,2,...,23)
    Range("B27") = DMUNo
'Run the Solver model.The UserFinish is set to True so that
'the Solver Results dialog box will not be shown
    SolverSolve UserFinish:=True
'Place the best ratio into column P
    If SolverSolve(UserFinish:=True) = 5 Then
        Range("P" & DMUNo + 1) = "Infeasible"
    Else
        Range("P" & DMUNo + 1) = Range("K29")
    End If
Next DMUNo

End Sub
```

Results and Analysis:

Given the super-efficiency values for the DMUs (players) and their weight shares when evaluating DMU 23 (Rahul Chahar), along with the names of the DMUs from 1 to 23, here are some conclusions:

Super-Efficiency Scores:

Some players, such as Axar Patel (DMU 8) and Venkatesh Iyer (DMU 22), have high super-efficiency scores, suggesting they are performing exceptionally well and are highly efficient.

The infeasible scores for many players may indicate data or model issues, or these players might be outliers in terms of performance.

Weight Shares for DMU 23:

When Rahul Chahar (DMU 23) is evaluated, 31% of his performance is attributed to Shivam Dube (DMU 17), and 69% is attributed to Prasidh Krishna (DMU 19).

This reliance on Prasidh Krishna and Shivam Dube indicates they are the top performers in the data set and serve as important benchmarks for Rahul Chahar.

Improvement Opportunities:

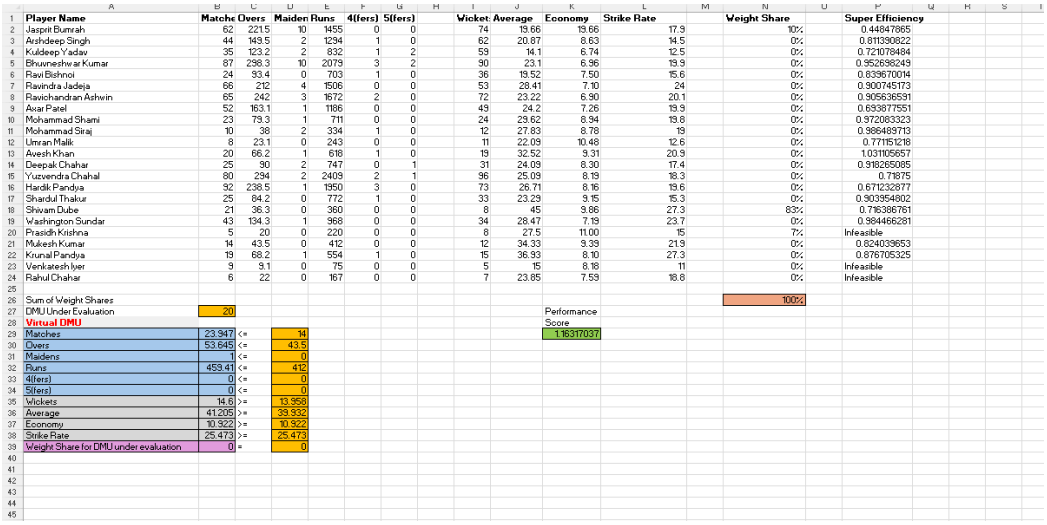
Players with infeasible super-efficiency scores could benefit from studying the performance of Prasidh Krishna and Shivam Dube to enhance their efficiency and improve their own performance.

Learning from the strategies and techniques of these top players can help other players become more efficient and effective.

In summary, players like Axar Patel and Venkatesh Iyer stand out for their high super-efficiency scores, while many others have infeasible scores. DMU 23 (Rahul Chahar) should focus on using the high-performing players Prasidh Krishna and Shivam Dube as benchmarks to improve his performance.

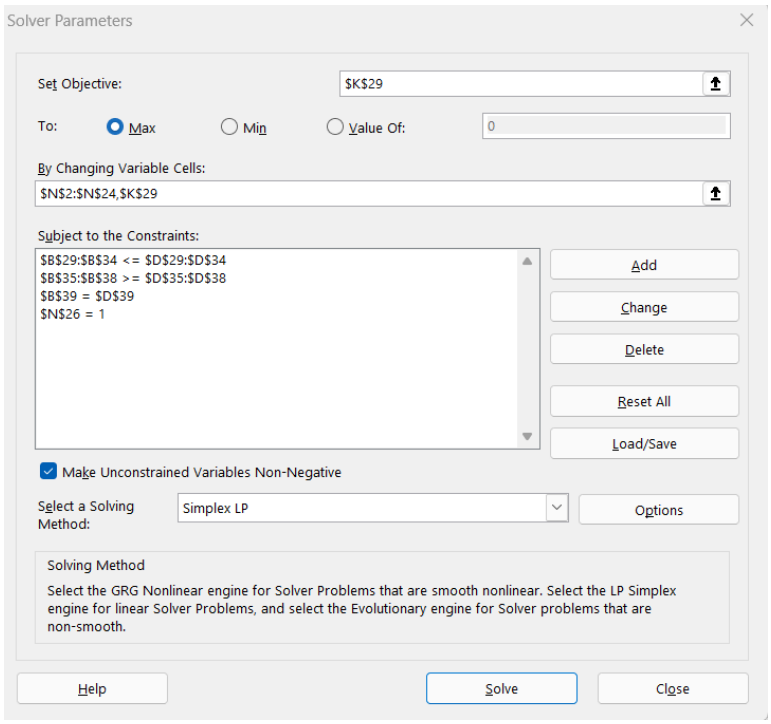
Envelopment Model (Output Oriented - Super Efficiency)

Model:

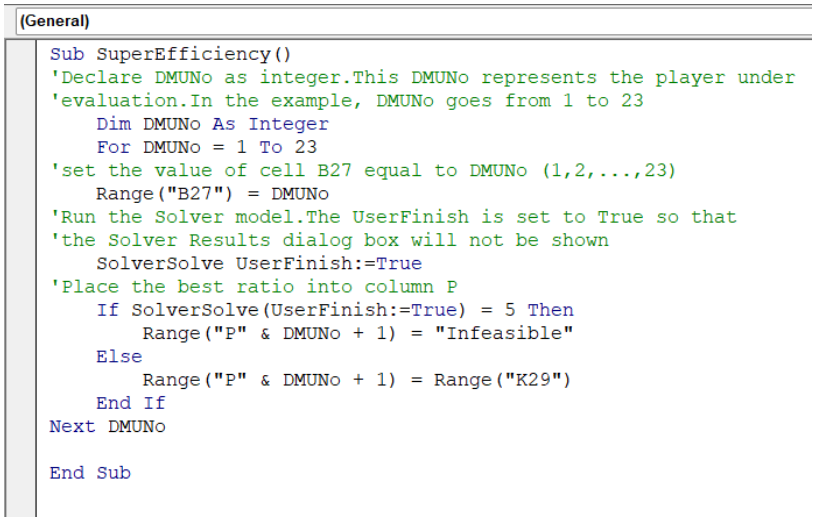


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**Player Name**	**Matche**	**Overs**	**Maiden**	**Runs**	**4(fers)**	**5(fers)**		**Wicket**	**Average**	**Economy**	**Strike Rate**		**Weight Share**		**Super Efficiency**
2	Jasprit Bumrah	62	221.5	10	1455	0	0		74	19.66	19.66	17.9		10%		0.44847885
3	Arshdeep Singh	44	149.5	2	1294	1	0		62	20.87	8.63	14.5		0%		0.811390822
4	Kuldeep Yadav	35	123.2	2	832	1	2		59	14.1	6.74	12.5		0%		0.721078484
5	Bhuvneshwar Kumar	87	298.3	10	2079	3	2		90	23.1	6.96	19.9		0%		0.952698249
6	Ravi Bishnoi	24	93.4	0	703	1	0		36	19.52	7.50	15.6		0%		0.839670014
7	Ravindra Jadeja	66	212	4	1506	0	0		53	28.41	7.10	24		0%		0.900745173
8	Ravichandran Ashwin	65	242	3	1672	2	0		72	23.22	6.90	20.1		0%		0.905636591
9	Axar Patel	52	163.1	1	1186	0	0		49	24.2	7.26	19.9		0%		0.893877551
10	Mohammad Shami	23	73.3	1	711	0	0		24	29.62	8.94	19.8		0%		0.972083323
11	Mohammad Siraj	10	38	2	334	1	0		12	27.83	8.78	19		0%		0.986489713
12	Umran Malik	8	23.1	0	243	0	0		11	22.09	10.48	12.6		0%		0.771151218
13	Avesh Khan	20	66.2	1	618	1	0		19	32.52	9.31	20.9		0%		1.031105657
14	Deepak Chahar	25	90	2	747	0	1		31	24.09	8.30	17.4		0%		0.918265085
15	Yuzvendra Chahal	80	294	2	2409	2	1		96	25.09	8.19	18.3		0%		0.71875
16	Hardik Pandya	92	238.5	1	1950	3	0		73	26.71	8.16	19.6		0%		0.671232877
17	Shardul Thakur	25	84.2	0	772	1	0		33	23.29	9.15	15.3		0%		0.903354802
18	Shivam Dube	21	36.3	0	360	0	0		8	45	9.86	27.3		83%		0.776386761
19	Washington Sundar	43	134.3	1	968	0	0		34	28.47	7.19	23.7		0%		0.984466281
20	Prasidh Krishna	5	20	0	220	0	0		8	27.5	11.00	15		7%		Infeasible
21	Mukesh Kumar	14	43.5	0	412	0	0		12	34.33	9.39	21.9		0%		0.824039653
22	Krunal Pandya	19	68.2	1	554	1	0		15	36.93	8.10	27.3		0%		0.876705325
23	Venkatesh Iyer	9	9.1	0	75	0	0		5	15	8.18	11		0%		Infeasible
24	Rahul Chahar	6	22	0	167	0	0		7	23.85	7.59	18.8		0%		Infeasible
25																
26	Sum of Weight Shares													100%		
27	DMU Under Evaluation	20									Performance					
28	**Virtual DMU**										Score					
29	Matches	23.947	<=	14							1.183170137					
30	Overs	53.645	<=	43.5												
31	Maidens	1	<=	0												
32	Runs	459.41	<=	412												
33	4(fers)	0	<=	0												
34	5(fers)	0	<=	0												
35	Wickets	14.6	>=	13.958												
36	Average	41.205	>=	33.932												
37	Economy	10.922	>=	10.922												
38	Strike Rate	25.473	>=	25.473												
39	Weight Share for DMU under evaluation	0	=	0												
40																
41																
42																
43																
44																
45																

Solver:



VBA Code:



```
(General)
Sub SuperEfficiency()
'Declare DMUNo as integer.This DMUNo represents the player under
'evaluation.In the example, DMUNo goes from 1 to 23
    Dim DMUNo As Integer
    For DMUNo = 1 To 23
'set the value of cell B27 equal to DMUNo (1,2,...,23)
    Range("B27") = DMUNo
'Run the Solver model.The UserFinish is set to True so that
'the Solver Results dialog box will not be shown
    SolverSolve UserFinish:=True
'Place the best ratio into column P
    If SolverSolve(UserFinish:=True) = 5 Then
        Range("P" & DMUNo + 1) = "Infeasible"
    Else
        Range("P" & DMUNo + 1) = Range("K29")
    End If
Next DMUNo

End Sub
```

Results and Analysis:

When DMU 20 (Mukesh Kumar) is under evaluation in an output-oriented envelopment model, here are the observations and conclusions:

Observations

Super-Efficiency Scores:

The super-efficiency values range from 0.4485 to 1.0311.

Most DMUs have scores below 1, indicating potential for improvement in their output performance while maintaining the same input levels.

DMU 12 (Avesh Khan) has the highest super-efficiency score of 1.0311, showing exceptional efficiency and suggesting that this DMU achieves higher output with the same level of inputs or uses fewer inputs to produce the same level of output.

DMUs 19, 22, and 23 have infeasible super-efficiency scores, which might indicate data or model constraints, or these DMUs could be extreme outliers.

Weight Shares for DMU 20:

When DMU 20 (Mukesh Kumar) is under evaluation, the weight shares indicate a strong focus on DMU 17 (Shivam Dube), which holds 83% of the weight share.

DMU 1 (Jasprit Bumrah) contributes 10% to the weight share, while DMU 19 (Prasidh Krishna) holds 7%.

This suggests that Mukesh Kumar's performance is closely tied to the efficiency and practices of DMU 17, which serves as the primary benchmark.

Conclusion

DMU 20 (Mukesh Kumar) Performance:

The reliance on DMU 17 (Shivam Dube) as a benchmark suggests Mukesh Kumar could benefit from studying and emulating the practices and strategies of Shivam Dube to improve its efficiency and output.

DMU 20 may also benefit from considering the practices of DMU 1 (Jasprit Bumrah) and DMU 19 (Prasidh Krishna), given their significant contributions to its evaluation.

Improvement Opportunities:

DMUs with scores below 1, particularly those close to 1, may benefit from examining the strategies of high-performing DMUs such as DMU 12 (Avesh Khan) and DMU 17 (Shivam Dube).

By learning from these top performers, other DMUs could work towards enhancing their output levels and overall performance.

In summary, DMU 20 (Mukesh Kumar) can leverage the practices of DMUs 17, 1, and 19 to improve its efficiency and output performance. Other DMUs can similarly look to the top-performing units for opportunities to enhance their own productivity.

Conclusion:

The Indian cricket team's performance can be optimized by selecting bowlers based on efficiency and productivity as measured by Data Envelopment Analysis (DEA) models. The DEA scores from different models provide insights into the relative efficiency of each bowler, helping the team management to make informed decisions.

Efficiency Analysis:

Input-oriented Multiplier Model: Shows that the majority of DMUs (bowlers) have a DEA score close to 1, indicating a high level of efficiency in terms of input usage. However, there is still room for improvement for bowlers with lower scores.

Output-oriented Multiplier Model: All DMUs (bowlers) have a DEA score of 1, demonstrating high output efficiency. This model focuses on maximizing output given a set of inputs.

Input-oriented Envelopment Model: The DEA scores are all 1, except for Avesh Khan (0.9145), which suggests that almost all bowlers are efficient in input usage.

Output-oriented Envelopment Model: Similar to the output-oriented multiplier model, all bowlers are highly efficient in terms of output, with Avesh Khan scoring slightly above 1 (1.0311), showing exceptional performance.

Super Efficiency Analysis:

Input-oriented Envelopment Model: A few DMUs, such as Arshdeep Singh (1.3359), Kuldeep Yadav (1.4518), and Avesh Khan (1.1143), exhibit super efficiency, indicating they can further improve their performance beyond the basic efficiency measures.

Output-oriented Envelopment Model: DMUs like Avesh Khan (1.0311), Mohammad Shami (0.9865), and Prasidh Krishna (0.9845) are notable for their high super-efficiency scores, indicating potential candidates for the team.

Recommendations:

The team management should focus on bowlers with the highest efficiency and super-efficiency scores to form the optimal playing eleven. Based on the DEA results:

Highly Efficient Bowlers: Bowlers such as Jasprit Bumrah, Arshdeep Singh, Kuldeep Yadav, and Avesh Khan consistently rank high in both efficiency and super-efficiency scores across different DEA models, making them strong candidates for the playing eleven.

Potential Star Performers: Avesh Khan, Mohammad Shami, and Prasidh Krishna stand out in the super-efficiency analysis, showing exceptional performance and the potential to be game-changers.

Optimization Strategy: The team management should leverage the insights from DEA to select bowlers who are both efficient and have high potential to contribute significantly to the team's success. This approach would maximize the team's overall performance in the ICC Men's T20 Cricket World Cup.

By making strategic decisions based on the DEA models, the Indian cricket team can optimize their performance and increase their chances of success in the upcoming tournament.

References:

An IRJET paper was used as a reference for this project.

TITLE - DEA MODEL FOR SELECTION OF CRICKET TEAM PLAYERS

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