Appendix – A

Table A.1: Energy productivity data related to five SM models in varied coal tensile strengths at Bhubaneswari opencast coal mine.

SM model	Tensile strength (MPa)	Cutting depth (m)	Drum radius (m)	No. of picks in contact with coal (n)	Cutting force (kN)	Total cutting power (kW)	Drum width (m)	Drum speed (rpm)	Cutting speed (m/min)	Theoretical coal production (bcm)	Energy productivity (bcm/MJ)
A	3.7304	0.1	0.575	10	36.24	368.75	3	70	20.8	374.5	0.2821
	2.6237	0.1		10	25.49	259.35			20.8	374.5	0.4011
		0.15		12	24.94	304.18			20.7	560	0.5114
		0.2		15	24.4	371.56			20.7	744.1	0.5563
		0.25		16	24.26	394.03			20.6	929.4	0.6552
	1.5171	0.1		10	14.74	150			20.8	374.5	0.6937
		0.15		12	14.42	175.9			20.7	560	0.8843
		0.2		15	14.12	214.85			20.7	744.1	0.9621
		0.25		16	14.03	227.84			20.6	929.4	1.1331
		0.3		18	13.9	253.84			20.6	1113.6	1.2186
B	3.7304	0.1	0.675	9	35.27	334.82	3	70	16	288.7	0.2395
		0.15		11	34.6	401.33			16	432.3	0.2992
		0.2		13	34.15	467.91			16	575.6	0.3417
		0.25		15	33.82	534.55			16	718.9	0.3736
	2.6237	0.1		9	24.81	235.49			16	288.7	0.3405
		0.15		11	24.34	282.27			16	432.3	0.4254
		0.2		13	24.02	329.1			16	575.6	0.4859
		0.25		15	23.79	375.96			16	718.9	0.5311
		0.3		17	23.61	422.82			16	862	0.5663
		0.35		18	23.53	446.27			16	1005.4	0.6258
		0.4		19	23.47	469.69			16	1148.7	0.6794
	1.5171	0.1		9	14.34	136.16			16	288.7	0.5889
		0.15		11	14.07	163.22			16	432.3	0.7357
		0.2		13	13.89	190.29			16	575.6	0.8403
		0.25		15	13.75	217.39			16	718.9	0.9185
		0.3		17	13.65	244.49			16	862	0.9794
		0.35		18	13.61	258.05			16	1005.4	1.0823
		0.4		19	13.57	271.59			16	1148.7	1.1749

Table A.2: Energy productivity data related to five SM models in varied coal tensile strengths at Bhubaneswari opencast coal mine.

SM model	Tensile strength (MPa)	Cutting depth (m)	Drum radius (m)	No. of picks in contact with coal (n)	Cutting force (kN)	Total cutting power (kW)	Drum width (m)	Drum speed (rpm)	Cutting speed (m/min)	Theoretical coal production (bcm)	Energy productivity (bcm/MJ)
C	3.7304	0.1	0.575	13	34.65	438.06	4	70	18.1	434.3	0.2754
	2.6237	0.1		13	24.37	308.1			18.1	434.3	0.3916
		0.15		16	23.98	372.77			18.1	650	0.4844
		0.2		19	23.70	437.48			18	865.3	0.5494
	1.5171	0.1		13	14.09	178.15			18.1	434.3	0.6772
		0.15		16	13.86	215.55			18.1	650	0.8376
		0.2		19	13.71	252.96			18	865.3	0.9502
		0.25		21	13.63	277.93			18	1080.8	1.0802
		0.3		23	13.56	302.89			18	1296.1	1.1887
D	3.7304	0.1	0.555	7	37.4	260.62	2.2	70	20.9	275.62	0.2938
		0.15		9	35.91	321.05			20.8	411	0.3556
		0.2		11	34.98	381.7			20.8	545.8	0.3972
		0.25		12	34.63	412.06			20.7	681.2	0.4592
	2.6237	0.1		7	26.30	183.3			20.9	275.62	0.4177
		0.15		9	25.26	225.8			20.8	411	0.5056
		0.2		11	24.60	268.46			20.8	545.8	0.5647
		0.25		12	24.36	289.82			20.7	681.2	0.6529
	1.5171	0.1		7	14.1	106			20.9	275.62	0.7223
		0.15		9	13.86	130.57			20.8	411	0.8743
		0.2		11	13.71	155.23			20.8	545.8	0.9767
		0.25		12	13.63	167.58			20.7	681.2	1.1291

Table A.3: Energy productivity data related to five SM models in varied coal tensile strengths at Bhubaneswari opencast coal mine.

SM model	Tensile strength (MPa)	Cutting depth (m)	Drum radius (m)	No. of picks in contact with coal (n)	Cutting force (kN)	Total cutting power (kW)	Drum width (m)	Drum speed (rpm)	Cutting speed (m/min)	Theoretical coal production (bcm)	Energy productivity (bcm/MJ)
E	3.7304	0.1	0.65	9	36.76	367.88	3.8	70	21.2	483.6	0.3652
		0.15		11	35.81	437.46			21.1	722.8	0.4589
	2.6237	0.1		9	25.86	258.74			21.2	483.6	0.5192
		0.15		11	25.19	307.68			21.1	722.8	0.6525
		0.2		13	24.73	356.73			21.1	961.2	0.7484
		0.25		14	24.55	381.26			21.1	1200.2	0.8483
		0.3		16	24.26	430.37			21	1437.7	0.928
		0.35		17	24.14	454.94			21	1676.1	1.0234
	1.5171	0.1		9	14.95	149.61			21.2	483.6	0.898
		0.15		11	14.56	177.91			21.1	722.8	1.1285
		0.2		13	14.3	206.27			21.1	961.2	1.2944
		0.25		14	14.2	220.45			21.1	1200.2	1.4661
		0.3		16	14.1	248.85			21	1437.7	1.6048
		0.35		17	14	263.06			21	1676.1	1.7699

Appendix – B

Table B.1: Field measurement data related to surface miner in Indian opencast coal mines.

Name of coal mine	Location name	SM code	Time in 10 m distance (sec)	Cutting depth (m)	Face length (m)	Scheduled shift time (h)	Machine shift time (h)	Coal production achieved (t)	Pick loss (n)	Diesel loss (l)
Nigahi opencast coal mine (NOCM)	P1-a	C	30	0.30	150	744	250	171892.5	111	18510
			28	0.30	146	744	301.5	181872	96	18650
			30	0.28	154	744	298	178904	102	18872
			32	0.30	150	744	278	153005	131	17888
			30	0.30	150	744	270	173789	120	18902
	P1-b		40	0.18	142	720	180	37710	33	6785
			38	0.18	138	720	204	42460	42	7815
			42	0.18	140	720	156	38630	39	7378
	P1-c		38	0.18	117	720	184	39170.6	42	8147
			40	0.18	125	720	120.3	32333	31	7169.4
			42	0.18	118	720	171	36842	35	7978
	P2-a		26.5	0.30	128	744	225	141423	95	14069
			28	0.28	134	648	255	131037.2	77	12470
			28.4	0.30	135	576	197	131149	72	10750
			26	0.28	126	672	209	133951	80	12174
			27.4	0.30	127	720	243	135098	91	13363.5
	P2-b		33.3	0.10	127	720	197	33934.2	25	5982.2
			32	0.11	128	720	224.5	40234	28	6469
			34.6	0.10	135	720	151	30581	22	5178

Table B.2: Field measurement data related to surface miner in Indian opencast coal mines.

Name of coal mine	Location name	SM code	Time in 10 m distance (sec)	Cutting depth (m)	Face length (m)	Scheduled shift time (h)	Machine shift time (h)	Coal production achieved (t)	Pick loss (n)	Diesel loss (l)
Jayant opencast coal mine (JOCM)	T3-a	C	25	0.20	200	744	260	199889	98	22614
			26	0.18	190	744	349	229572	107	23265
			29.5	0.18	180	744	444	289582	146	27728
			28	0.22	190	744	361.5	249941.5	115	26043
	T3-b		28	0.22	200	744	371	278722.9	134	27616
			31	0.18	200	744	286	138186	65	14926
			32	0.20	200	744	335	142567	74	15565.5
			34.5	0.22	180	744	441	220967	108	20082
			36	0.20	220	744	375	178136.5	87	18342.5
	T3-c		33	0.20	200	744	386	191537.5	91	19966
			36	0.14	135	744	180	62126	61	8839.6
			34	0.15	150	744	301.8	76039	77	12176
			36	0.16	165	744	210	65916	66	10617
Samleswari opencast coal mine (SOCM)	L1-a	A	25	0.26	100	744	375	187340	105	20523
			33	0.27	130	744	538	231775.5	137	24279
			27	0.28	120	744	383	192375	123	22278
			28	0.29	120	744	340	150383	92	19737
			30	0.30	130	744	298.5	141538	83	18882
	L1-b		33	0.15	100	720	343	73114	82	16960
			34	0.16	110	720	284	65162	51	13374
			33	0.14	90	720	237	56124	32	8934.8
	L1-c		42.3	0.13	100	720	184	39784	23	6104
			45	0.14	120	720	313	56564	74	13935
			41.5	0.18	80	720	259	48804	41	11313.7

Table B.3: Field measurement data related to surface miner in Indian opencast coal mines.

Name of coal mine	Location name	SM code	Time in 10 m distance (sec)	Cutting depth (m)	Face length (m)	Scheduled shift time (h)	Machine shift time (h)	Coal production achieved (t)	Pick loss (n)	Diesel loss (l)
Bhubaneswari opencast coal mine (BOCM)	B_m2-a	E	28	0.27	190	744	452	259025	142	24059
			27	0.26	180	744	377	236781	127	19880
			29	0.28	195	744	492	283796	202	26041
			26.5	0.22	170	744	237.5	218632	114	17802
			26	0.22	165	744	227	198497.4	75	13940
	B_m3-b		28	0.22	140	720	161	138079	49	11426
			30	0.25	150	720	207	183263	104	18262
			32	0.26	160	720	297	169614	78	14475.5
			31	0.27	150	720	373	195010	142	20243
			29	0.25	150	720	402	239378	172	23501
	B_m4-c		33.5	0.35	135	672	243	287320	NA	NA
			31	0.37	110	648	211	259086	NA	NA
			34	0.35	140	672	333	315716	NA	NA
			33	0.33	120	696	402	360084	NA	NA
			35	0.35	145	672	323	305670	NA	NA
			42	0.25	150	720	313.2	173785.6	103	16262.1
	B_m4-d		38	0.25	150	720	401	216341	139	24501
			40	0.25	150	720	193	93411	73	12426
			62	0.35	190	744	415	368712	NA	NA
	B_m5-a		58	0.34	185	720	339	328518	NA	NA
			56	0.36	160	672	228	276711	NA	NA
			64	0.38	195	720	349	311271	NA	NA
			60	0.32	170	744	253	300372	NA	NA
			69	0.25	170	744	319	173288	101	22422
	B_m5-b		67	0.23	150	744	187.5	90371	53	16230.5
			64	0.27	130	744	431	223841	140	28135
			103	0.16	100	720	385	61088	75	12239
	B_m5-c		98	0.15	80	720	139	22971	19	4113
			99	0.14	90	720	232	40681	32	8097.1

Table B.4: Field measurement data related to surface miner in Indian opencast coal mines.

Name of coal mine	Location name	SM code	Time in 10 m distance (sec)	Cutting depth (m)	Face length (m)	Scheduled shift time (h)	Machine shift time (h)	Coal production achieved (t)	Pick loss (n)	Diesel loss (l)
Parsa East and Kanta Basan (PEKB)	H_m4-a	E	24	0.29	140	744	250	184714	89	15603.8
			25	0.30	160	744	472	305720	138	26308
			26	0.31	180	744	304	243585	115	24150
	H_m4-b		23	0.28	165	720	374	367885	142	27560.4
			24	0.27	175	696	288.4	309008.6	119	23308
			25	0.29	185	744	504	430020	171	32150
	H_m4-c		35	0.17	150	720	310	67841	51	12085
			39	0.22	150	720	269	58920	38	7497
			38.5	0.21	150	720	133.8	47875	22	2247.5
	H_m5-a		30.8	0.25	110	744	329.4	143235	72	18269.4
			31	0.23	110	744	254	111462	48	15045
			33	0.27	140	744	421	202305	108	23811
	H_m5-b		60	0.25	120	720	224	62861.6	51	10302
			58	0.25	100	720	312.2	93780	76	15079
			62	0.25	140	720	371	154528	122	18182.6
	H_m5-c		51	0.14	80	744	304	28481	30	6073
			47	0.11	70	696	110	17281.8	11	2372.1
			52	0.14	90	720	190.8	21370	19	4310
	H_m5-d		62	0.20	110	672	212	25429.5	23	5690
			62	0.20	110	672	288	36108	42	7382.8
			56	0.20	80	672	125	29073	31	3690
	H_m6-a		21.3	0.28	150	720	332	254960	95	18579
			25	0.32	180	720	512	388063	174	29588.5
			23	0.30	150	720	365.5	305303.4	139	25802
	H_m6-b		24	0.28	160	744	378.2	352638	139	28997
			25	0.29	170	744	484	407300	181	31823
			23	0.27	150	744	276	287206	100	19810
	H_m6-c		36.5	0.20	150	720	226	46200	39	7497
			37	0.18	115	696	105	43808	30	4577
			39	0.22	155	744	317	52552	51	9310

Appendix – B.5

Table B.5: Field measurement data related to surface miner in Indian opencast coal mines.

Name of coal mine	Location name	SM code	Time in 10 m distance (sec)	Cutting depth (m)	Face length (m)	Scheduled shift time (h)	Machine shift time (h)	Coal production achieved (t)	Pick loss (n)	Diesel loss (l)
Rajmahal opencast coal mine (ROCM)	R_m3-a	E	30	0.31	150	744	460	264178	111	25287
			28	0.27	125	720	215	197526	74	18012
			33	0.32	160	744	543	283730	125	29060
			27	0.27	120	672	120	183545	68	16873
			32	0.32	145	720	372	233821	87	21234
	R_m3-b		50	0.15	100	744	108	34453	21	4035.2
			53	0.17	130	744	289.2	47336	39	10240
	R_m2-a		47	0.13	100	744	183	40053	30	6438
			31	0.30	135	720	382	272621	113	23126
			32	0.32	145	744	227	236425	100	18795
			29	0.28	120	672	131	223041	92	17282
			33	0.32	160	720	472	303120	141	26205
			33	0.28	150	744	552	323073	154	30046
	R_m2-b		44	0.25	160	720	329.8	79356	58	13366
			42.7	0.25	130	720	232	71574.8	42	10035
			42	0.25	130	720	151	66473.2	35	7035.5
Lakhanpur (LOCM)	L2-a	A	25.5	0.18	140	744	492	212921	107	23252
			27	0.23	150	744	253	176724	89	19029.5
			30	0.24	160	744	158	159341	80	17402
			26	0.18	150	744	586	283203	144	30176
			28	0.22	150	744	408	243410	130	26305
			41	0.15	135	720	245	79468	45	9350
	L2-b		42	0.16	135	720	422.6	92306.8	85	16436
			37	0.14	120	720	326	84574	62	12153.5

Table B.6: Field measurement data related to surface miner in Indian opencast coal mines.

Name of coal mine	Location name	SM code	Time in 10 m distance (sec)	Cutting depth (m)	Face length (m)	Scheduled shift time (h)	Machine shift time (h)	Coal production achieved (t)	Pick loss (n)	Diesel loss (l)
Gevra opencast coal mine (GOCM)	UK1-a	D	30	0.18	110	744	324	120375.5	36	11910
			28	0.20	120	744	233.7	98438	53	10730
			32	0.22	130	744	402	150671	103	18003.4
	UK1-b	B	36	0.26	155	720	284	120214.8	68	11064.5
			34	0.23	140	696	207	98313	50	7487
			36	0.26	155	744	351.4	149601	113	17525
	UK1-c	B	34	0.25	160	720	257	118528.2	62	12260
			32	0.25	140	720	216.4	98313	44	8220.4
	UK1-d	D	34	0.25	180	720	369	147918	107	16725
			40	0.13	100	744	343	71186	63	6632
			39	0.15	90	696	161	15620	18	5462
			41	0.17	110	720	252	38690	39	6102.8
	LK2-a	D	27	0.19	130	744	371	183209	72	15310
			28	0.20	145	744	464	205715	111	20901
			27	0.21	130	744	281	162380	33	13406.3
			25	0.28	160	744	431.7	253215	135	22678.5
	LK2-b	E	24.5	0.29	155	744	210	209830	56	13986.7
			22.5	0.27	135	744	318	232737.5	88	16910
			38	0.15	70	744	105	8620	15	6005
	LK2-c	D	41	0.16	85	744	257.5	30190	25	5254.7
			41	0.17	85	744	374	62606.05	53	4967
	UK3-a	D	22	0.16	130	720	298	239830	87	19035.1
			26	0.18	170	720	537	283257	167	28030
			24	0.20	150	720	461	262937	109	22105
			28	0.24	130	696	327.8	213927	104	17110
	UK3-b	E	26	0.25	150	744	435	229245	158	22848
			28	0.26	140	720	220	185820	77	14135.3
	UK3-c	D	49	0.17	125	744	371	63086	54	6652
			52	0.14	110	744	123	9750	13	7296.5
			49	0.17	125	744	265	31906	32	6162
	LK4-a	B	41	0.25	105	696	137	64820	34	11200
			44.7	0.32	135	720	255.6	92740	52	13010
			43	0.27	120	744	385	141816	103	18601
	LK4-b	D	26	0.22	155	720	417	151718	115	17003.5
			25	0.15	135	720	327.4	129029	64	12610
			24	0.17	130	720	206	109392.2	43	8620
	LK4-c	E	49.5	0.13	110	744	192.7	32315	23	5954.8
			52	0.15	120	744	302	63482.2	55	6658
			48.5	0.17	100	744	108	10278	15	5632

Table C.1: Machine shift cost in varied production trials for SM in Indian opencast coal mines

Particular	Case - 01 P1-a	Case - 02 P1-b	Case - 03 P1-c	Case - 04 P2-a	Case - 05 P2-b	Case - 06 T3-a	Case - 07 T3-b	Case - 08 T3-c	Case - 09 B_m2-a
Unit price of SM	38400000	38400000	38400000	38400000	38400000	38400000	38400000	38400000	65000000
Loan amount (debt: equity 2:1) (₹)	25600000	25600000	25600000	25600000	25600000	25600000	25600000	25600000	43333333
Life of machine/cutting drum (h)	35000	35000	35000	35000	35000	35000	35000	35000	35000
Annual operating time (h/yr)	3360	2160	1896	2712	2292	4284	4380	2772	4284
Life of machine (yr)	10.4	16.2	18.5	12.9	15.3	8.2	8	12.6	8.2
Salvage Value (₹)	7680000	7680000	7680000	7680000	7680000	7680000	7680000	7680000	13000000
Depreciation (₹/h)	877.71	877.71	877.71	877.71	877.71	877.71	877.71	877.71	1485.71
Annual interest rate, insurance, and tax rate (%)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Average annual investment (₹/yr)	24516923	23988148	23870270	24230698	24043922	24913171	24960000	24259048	42170732
Annual Depreciation cost (₹/yr)	2953846	1896296	1660540	2381395	2007843	3746342	3840000	2438095	6341463
Machine productivity (t/h)	615	220	228	595.8	183	698.8	478	295	670.25
Wage cost (₹/t)	0.72	2.00	1.93	0.74	2.41	0.63	0.92	1.49	0.66
Diesel consumption rate (l/1000t)	108	185	215	93.4	168.3	102	102	155	85
Price of diesel (₹/l)	94.03	94.03	94.03	94.03	94.03	94.03	94.03	94.03	96.05
Diesel cost (₹/t)	10.16	17.4	20.22	8.78	15.83	9.59	9.59	14.57	8.16
filter, lubrication & grease cost (₹/t)	4.95	23.72	26.60	4.42	25.94	4.12	6.02	14.82	3.65
Total number of picks (n)	126	126	126	106	106	126	126	126	96
Price of pick (₹/n)	1300	1300	1300	1300	1300	1300	1300	1300	1600
Pick consumption rate (n/1000t)	0.65	0.95	1	0.62	0.73	0.48	0.49	1	0.55
Pick replacement cost (₹/t)	0.85	1.24	1.30	0.81	0.95	0.62	0.64	1.30	0.88
Holder cost (₹/t)	0.38	0.55	0.58	0.36	0.43	0.28	0.29	0.58	0.32
Routine maintenance cost (₹/t)	0.29	0.80	0.77	0.29	0.96	0.25	0.37	0.60	0.44
Administrative overhead (₹/t)	0.46	2.02	2.22	0.59	2.29	0.32	0.46	1.17	0.57
Major breakdown repair cost (₹/t)	0.37	1.62	1.78	0.48	1.83	0.26	0.37	0.94	0.45
Total operating cost (₹/t)	18.18	49.35	55.41	16.47	50.64	16.07	18.65	35.48	15.13
Total ownership cost (₹/t)	2.91	10.30	10.74	3.35	11.95	2.29	3.32	6.69	4.04
Ownership and operating costs (₹/t)	21.09	59.65	66.15	19.82	62.59	18.36	21.97	42.17	19.18
Machine shift cost (lac ₹/month)	36.25	23.62	23.89	26.66	21.85	45.82	38.29	28.69	45.91

Table C.2: Machine shift cost in varied production trials for SM in Indian opencast coal mines

Particular	Case - 10 B_m3-b	Case - 12 B_m4-d	Case - 14 B_m5-b	Case - 15 B_m5-c	Case - 16 R_m3-a	Case - 17 R_m3-b	Case - 18 R_m2-a	Case - 19 R_m2-b	Case - 20 H_m4-a
Unit price of SM	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000
Loan amount (debt: equity 2:1) (₹)	43333333	43333333	43333333	43333333	43333333	43333333	43333333	43333333	43333333
Life of machine/cutting drum (h)	35000	35000	35000	35000	35000	35000	35000	35000	35000
Annual operating time (h/yr)	3456	3624	3750	3024	4104	2316	4236	2856	4104
Life of machine (yr)	10.1	9.7	9.3	11.6	8.5	15.1	8.3	12.3	8.5
Salvage Value (₹)	13000000	13000000	13000000	13000000	13000000	13000000	13000000	13000000	13000000
Depreciation (₹/h)	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71
Annual interest rate, insurance, and tax rate (%)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Average annual investment (₹/yr)	41574257	41680412	41795699	41241379	42058824	40721854	42132530	41113821	42058824
Annual Depreciation cost (₹/yr)	5148515	5360825	5591398	4482759	6117647	3443709	6265060	4227642	6117647
Machine productivity (t/h)	642.6	533	520	165	680	210	770	305	715
Wage cost (₹/t)	0.69	0.83	0.85	2.67	0.65	2.10	0.57	1.45	0.62
Diesel consumption rate (l/1000t)	95	110	137	196	95	170	85	140	90
Price of diesel (₹/l)	96.05	96.05	96.05	96.05	94.93	94.93	94.93	94.93	96.67
Diesel cost (₹/t)	9.12	10.57	13.16	18.83	9.02	16.14	8.07	13.29	8.7
filter, lubrication & grease cost (₹/t)	4.26	5.95	7.59	34.23	3.98	23.05	3.14	13.07	3.65
Total number of picks (n)	96	96	96	96	100	100	100	100	100
Price of pick (₹/n)	1600	1600	1600	1600	1600	1600	1600	1600	1600
Pick consumption rate (n/1000t)	0.59	0.65	0.6	1	0.4	0.75	0.44	0.62	0.47
Pick replacement cost (₹/t)	0.94	1.04	0.96	1.60	0.64	1.20	0.70	0.99	0.75
Holder cost (₹/t)	0.34	0.38	0.35	0.58	0.23	0.44	0.26	0.36	0.27
Routine maintenance cost (₹/t)	0.46	0.56	0.57	1.80	0.44	1.41	0.39	0.97	0.42
Administrative overhead (₹/t)	0.73	0.84	0.83	3.26	0.58	3.34	0.50	1.87	0.55
Major breakdown repair cost (₹/t)	0.59	0.67	0.67	2.61	0.47	2.67	0.40	1.49	0.44
Total operating cost (₹/t)	17.13	20.84	24.98	65.58	16.01	50.36	14.03	33.49	15.41
Total ownership cost (₹/t)	4.66	5.47	5.55	19.32	4.08	17.55	3.54	10.75	3.88
Ownership and operating costs (₹/t)	21.79	26.31	30.53	84.89	20.08	67.91	17.57	44.25	19.28
Machine shift cost (lac ₹/month)	40.33	42.41	49.61	35.3	46.7	27.58	47.73	32.07	47.17

Table C.3: Machine shift cost in varied production trials for SM in Indian opencast coal mines

Particular	Case - 21 H_m4-b	Case - 22 H_m4-c	Case - 23 H_m5-a	Case - 24 H_m5-b	Case - 25 H_m5-c	Case - 26 H_m5-d	Case - 27 H_m6-a	Case - 28 H_m6-b	Case - 29 H_m6-c
Unit price of SM	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000	65000000
Loan amount (debt: equity 2:1) (₹)	43333333	43333333	43333333	43333333	43333333	43333333	43333333	43333333	43333333
Life of machine/cutting drum (h)	35000	35000	35000	35000	35000	35000	35000	35000	35000
Annual operating time (h/yr)	4668	2856	4020	3624	2424	2496	4836	4548	2592
Life of machine (yr)	7.5	12.3	8.7	9.7	14.4	14	7.2	7.7	13.5
Salvage Value (₹)	13000000	13000000	13000000	13000000	13000000	13000000	13000000	13000000	13000000
Depreciation (₹/h)	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71	1485.71
Annual interest rate, insurance, and tax rate (%)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Average annual investment (₹/yr)	42466667	41113821	41988506	41680412	40805556	40857143	42611111	42376623	40925926
Annual Depreciation cost (₹/yr)	6933333	4227642	5977012	5360825	3611111	3714286	7222222	6753247	3851852
Machine productivity (t/h)	949	245	455	343	111	145	784	920	220
Wage cost (₹/t)	0.46	1.80	0.97	1.29	3.97	3.04	0.56	0.48	2.00
Diesel consumption rate (l/1000t)	75	125	125	140	190	185	78	77	150
Price of diesel (₹/l)	96.67	96.67	96.67	96.67	96.67	96.67	96.67	96.67	96.67
Diesel cost (₹/t)	7.25	12.08	12.08	13.53	18.37	17.88	7.54	7.44	14.5
filter, lubrication & grease cost (₹/t)	2.29	14.80	7.97	11.84	49.64	37.00	2.89	2.43	19.77
Total number of picks (n)	100	100	76	100	76	100	100	100	100
Price of pick (₹/n)	1600	1600	1600	1600	1600	1600	1600	1600	1600
Pick consumption rate (n/1000t)	0.39	0.63	0.5	0.8	0.88	1.05	0.43	0.4	0.85
Pick replacement cost (₹/t)	0.62	1.01	0.80	1.28	1.41	1.68	0.69	0.64	1.36
Holder cost (₹/t)	0.23	0.37	0.29	0.47	0.51	0.61	0.25	0.23	0.50
Routine maintenance cost (₹/t)	0.31	1.21	0.65	0.87	2.68	2.05	0.38	0.32	1.35
Administrative overhead (₹/t)	0.37	2.32	0.89	1.31	6.04	4.49	0.43	0.39	2.85
Major breakdown repair cost (₹/t)	0.29	1.86	0.71	1.05	4.83	3.59	0.34	0.31	2.28
Total operating cost (₹/t)	11.83	35.44	24.36	31.62	87.45	70.35	13.08	12.24	44.61
Total ownership cost (₹/t)	2.76	13.39	6.14	8.50	32.38	24.37	3.31	2.88	15.73
Ownership and operating costs (₹/t)	14.59	48.83	30.50	40.12	119.83	94.72	16.39	15.12	60.34
Machine shift cost (lac ₹/month)	53.83	28.42	46.46	41.61	26.82	28.61	51.81	52.78	28.67

Table C.4: Machine shift cost in varied production trials for SM in Indian opencast coal mines

Particular	Case - 30 L1-a	Case - 31 L1-b	Case - 32 L1-c	Case - 33 L2-a	Case - 34 L2-b	Case - 35 UK1-a	Case - 36 UK1-b	Case - 37 UK1-c	Case - 38 UK1-d
Unit price of SM	30000000	30000000	30000000	30000000	30000000	62500000	44000000	44000000	62500000
Loan amount (debt: equity 2:1) (₹)	20000000	20000000	20000000	20000000	20000000	41666667	29333333	29333333	41666667
Life of machine/cutting drum (h)	35000	35000	35000	35000	35000	35000	35000	35000	35000
Annual operating time (h/yr)	4644	3456	3024	4548	3972	3840	3372	3372	3024
Life of machine (yr)	7.5	10.1	11.6	7.7	8.8	9.1	10.4	10.4	11.6
Salvage Value (₹)	6000000	6000000	6000000	6000000	6000000	12500000	8800000	8800000	12500000
Depreciation (₹/h)	685.71	685.71	685.71	685.71	685.71	1428.57	1005.71	1005.71	1428.57
Annual interest rate, insurance, and tax rate (%)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Average annual investment (₹/yr)	19600000	19188119	19034483	19558442	19363636	40247253	28092308	28092308	39655172
Annual Depreciation cost (₹/yr)	3200000	2376238	2068966	3116883	2727273	5494506	3384615	3384615	4310345
Machine productivity (t/h)	467	225	192	567	258	385	437	433	166
Wage cost (₹/t)	0.94	1.96	2.30	0.78	1.71	1.15	1.01	1.02	2.66
Diesel consumption rate (l/1000t)	117	202	216	108	148	110	98	102	145
Price of diesel (₹/l)	95.15	95.15	95.15	94.85	94.85	95.15	95.15	95.15	95.15
Diesel cost (₹/t)	11.13	19.22	20.55	10.24	14.04	10.47	9.32	9.71	13.8
filter, lubrication & grease cost (₹/t)	7.15	25.63	32.11	5.42	16.32	8.16	6.40	6.72	24.93
Total number of picks (n)	106	106	106	106	106	76	106	106	76
Price of pick (₹/n)	1300	1300	1300	1300	1300	1600	1300	1300	1600
Pick consumption rate (n/1000t)	0.6	0.85	0.95	0.51	0.75	0.52	0.63	0.58	0.95
Pick replacement cost (₹/t)	0.78	1.11	1.24	0.66	0.98	0.83	0.82	0.75	1.52
Holder cost (₹/t)	0.35	0.50	0.55	0.30	0.44	0.30	0.37	0.34	0.55
Routine maintenance cost (₹/t)	0.29	0.61	0.71	0.24	0.53	0.74	0.46	0.46	1.72
Administrative overhead (₹/t)	0.35	0.96	1.29	0.29	0.73	1.06	0.75	0.75	3.11
Major breakdown repair cost (₹/t)	0.28	0.77	1.03	0.23	0.59	0.85	0.60	0.60	2.49
Total operating cost (₹/t)	21.27	50.75	59.79	18.16	35.33	23.55	19.72	20.37	50.79
Total ownership cost (₹/t)	2.61	6.14	7.66	2.16	5.02	7.12	4.68	4.72	18.46
Ownership and operating costs (₹/t)	23.88	56.89	67.45	20.32	40.36	30.67	24.40	25.09	69.25
Machine shift cost (lac ₹/month)	43.15	36.86	32.64	43.71	34.49	37.77	29.94	30.51	28.97

Table C.5: Machine shift cost in varied production trials for SM in Indian opencast coal mines

Particular	Case - 39 LK2-a	Case - 40 LK2-b	Case - 41 LK2-c	Case - 42 UK3-a	Case - 43 UK3-b	Case - 44 UK3-c	Case - 45 LK4-a	Case - 46 LK4-b	Case - 47 LK4-c
Unit price of SM	62500000	65000000	62500000	62500000	65000000	62500000	44000000	62500000	65000000
Loan amount (debt: equity 2:1) (₹)	41666667	43333333	41666667	41666667	43333333	41666667	29333333	41666667	43333333
Life of machine/cutting drum (h)	35000	35000	35000	35000	35000	35000	35000	35000	35000
Annual operating time (h/yr)	4464	3840	2946	5184	3936	3036	3108	3804	2412
Life of machine (yr)	7.8	9.1	11.9	6.8	8.9	11.5	11.3	9.2	14.5
Salvage Value (₹)	12500000	13000000	12500000	12500000	13000000	12500000	8800000	12500000	13000000
Depreciation (₹/h)	1428.57	1485.71	1428.57	1428.57	1485.71	1428.57	1005.71	1428.57	1485.71
Annual interest rate, insurance, and tax rate (%)	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
Average annual investment (₹/yr)	40705128	41857143	39600840	41176471	41921348	39673913	27957522	40217391	40793103
Annual Depreciation cost (₹/yr)	6410256	5714286	4201681	7352941	5842697	4347826	3115044	5434783	3586207
Machine productivity (t/h)	494	725	137.7	606.5	640	138	385	410.5	176
Wage cost (₹/t)	0.89	0.61	3.20	0.73	0.69	3.20	1.15	1.07	2.51
Diesel consumption rate (l/1000t)	90	77	160	88	86	192	143	98	172
Price of diesel (₹/l)	95.15	95.15	95.15	95.15	95.15	95.15	95.15	95.15	95.15
Diesel cost (₹/t)	8.56	7.33	15.22	8.37	8.18	18.27	13.61	9.32	16.37
filter, lubrication & grease cost (₹/t)	5.20	3.03	33.17	4.14	3.84	39.71	10.60	6.81	27.90
Total number of picks (n)	76	100	76	76	100	76	106	76	100
Price of pick (₹/n)	1600	1600	1600	1600	1600	1600	1300	1600	1600
Pick consumption rate (n/1000t)	0.39	0.4	0.92	0.46	0.54	0.94	0.63	0.57	0.88
Pick replacement cost (₹/t)	0.62	0.64	1.47	0.74	0.86	1.50	0.82	0.91	1.41
Holder cost (₹/t)	0.23	0.23	0.54	0.27	0.31	0.55	0.37	0.33	0.51
Routine maintenance cost (₹/t)	0.58	0.41	2.07	0.47	0.46	2.07	0.52	0.70	1.69
Administrative overhead (₹/t)	0.71	0.58	3.85	0.50	0.65	3.73	0.92	1.00	3.83
Major breakdown repair cost (₹/t)	0.57	0.47	3.08	0.40	0.52	2.98	0.74	0.80	3.06
Total operating cost (₹/t)	17.36	13.30	62.61	15.61	15.51	72.02	28.72	20.95	57.27
Total ownership cost (₹/t)	5.21	3.93	22.56	3.98	4.40	22.21	5.52	6.70	20.46
Ownership and operating costs (₹/t)	22.57	17.24	85.17	19.58	19.91	94.23	34.25	27.65	77.73
Machine shift cost (lac ₹/month)	41.48	39.98	28.79	51.3	41.74	32.9	34.18	35.96	27.48

List of Publications

Journals:

1. Singh NP, Seervi V, Kishore N, Verma AK (2024). Impact of Surface Miner Utilisation on Production Efficiency in Opencast Coal Mines Using Least Squares Method: A Case Study. *J. Inst. Eng. India Ser. D*; 105(1):567–580. (**SCOPUS**)
2. Singh NP, Seervi V, Kishore N, Verma AK (2023). An Investigation into Statistical Correlations Between Coal Production and Key Productivity Indicators of Surface Miners in Indian Opencast Mines. *Min Meta & Exp*; 40(1):389–402. (**IF: 2.0**)
3. Singh NP, Seervi V, Meena SK, Jamal A, Kishore N (2023). Development of Multiple Regression Model for Assessment of Coal Calorific Value in Indian Opencast Mines. *J. Inst. Eng. India Ser. D*; 104(2):503–514. (**SCOPUS**)

Conference Papers:

1. Singh NP and Kishore N (2023). Investigations on energy productivity of surface miner during coal cutting and its optimisation by specified control factors using Taguchi method. In: *6th International conference on opencast mining technology and sustainability (ICOMS-2023), NCL, Singrauli, India*; 103–110.
2. Singh NP, Seervi V, Kishore N, Verma AK (2023). A study on energy-saving effect by selecting optimum parameters of surface miner in opencast coal mines –An approach. In: *26th World Mining Congress (WMC 2023), Brisbane, Australia*; 3823–3834. (**ISBN: 978-0-646-87565-1**)
3. Singh NP, Kishore N, Verma AK (2023). A critical analysis of production and productivity by selecting optimum operating parameters of surface miner in opencast coal mines. In: *5th International conference on opencast mining technology and sustainability (ICOMS-2022), NCL, Singrauli, India*; 142–149.

4. Singh N P, Jamal A, Kishore N (2017). Impact of coal quality on longevity of picks of Surface Miner – A case study. In: *International conference on deep excavation, energy resources and production (DEEP 2016), IIT KGP, Kharagpur, India*; 48–59.

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