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## Appendix A.

**Table A1:** Evaluation of the global illuminance from original efficacy model.

Sky condition	Littlefair		Muneer and Kinghorn		Ruiz E and Robledo L		Robledo L and Soler A		Chung	
	MBD	RMSD	MBD	RMSD	MBD	RMSD	MBD	RMSD	MBD	RMSD
All	-	-	2.51	3.96	3.81	5.03	-	-	-	-
Clear	2.89	4.72	5.94	7.14	3.99	5.17	14.79	16.93	-	-
Overcast	-4.37	5.41	0.70	0.94	2.66	3.29	6.36	8.89	-	-
Intermediate	-	-	1.63	3.11	3.31	4.99	-	-	-3.32	4.66

**Table A2:** Evaluation of the global illuminance from local coefficients of efficacy model.

Sky condition	Littlefair		Muneer and Kinghorn		Ruiz E and Robledo L		Robledo L and Soler A		Chung	
	MBD	RMSD	MBD	RMSD	MBD	RMSD	MBD	RMSD	MBD	RMSD
All	-	-	0.45	1.99	1.42	2.83	-	-	-	-
Clear	-0.28	1.70	0.31	2.37	3.42	4.61	-0.09	1.58	-	-
Overcast	-1.00	2.88	0.005	0.45	0.12	0.44	-1.27	3.42	-	-
Intermediate	-	-	0.49	2.27	0.98	2.56	-	-	-0.01	1.76

**Table A3:** Evaluation of the diffuse illuminance from original efficacy model.

Sky condition	Muneer and Kinghorn		Robledo L and Soler A		Chung	
	MBD	RMSD	MBD	RMSD	MBD	RMSD
All	-1.13	2.40	-1.31	3.22	-	-
Clear	-1.98	2.32	0.90	1.85	-1.99	2.70
	0.08	0.49	1.41	1.87	-	-
	-1.87	2.68	-2.91	3.68	-	-

**Table A4:** Evaluation of the diffuse illuminance from local coefficients of efficacy model.

Sky condition	Muneer and Kinghorn		Robledo L and Soler A		Chung	
	MBD	RMSD	MBD	RMSD	MBD	RMSD
All	0.82	2.79	0.03	2.22	-	-
Clear	-0.24	1.41	-0.46	1.35	0.62	2.21
	-0.04	0.52	1.05	1.31	-	-
	0.06	2.43	-0.67	2.01	-	-

**Table A5:** Evaluation of the beam illuminance from original efficacy model.

Sky condition	Ullah MB		Chung	
	MBD	RMSD	MBD	RMSD
Clear	-80.16	80.95	-48.42	49.17

**Table A6:** Evaluation of the diffuse illuminance from local coefficients of efficacy model.

Sky condition	Ullah MB		Chung	
	MBD	RMSD	MBD	RMSD
Clear	-0.08	5.25	-0.10	5.37

**Table A7:** Performance evaluation of the illuminance from proposed efficacy model for tropical climate

Sky condition	Global efficacy		Diffuse efficacy	
	MBD	RMSD	MBD	RMSD
All	0.02	1.46	0.11	1.78
Overcast	0.15	1.17	0.17	1.58
Intermediate	-0.22	1.71	0.05	2.10
Clear	0.36	1.16	0.07	1.09

## Appendix B.

**Table B1 :** Mean values of global irradiance (W/m<sup>2</sup>).

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			45.92	65.15	76.76	62.36	56.57	61.67	52.01	47.37	53.23	43.70
7-8	86.88	80.87	137.05	222.55	220.00	176.56	161.54	192.33	163.55	153.49	169.22	126.88
8-9	231.57	246.03	322.40	443.96	426.10	363.67	325.93	379.17	357.13	348.30	363.00	320.38
9-10	416.13	438.98	514.60	604.92	580.82	546.31	485.02	559.06	513.02	519.94	581.12	501.79
10-11	585.93	585.53	664.67	747.74	720.28	616.58	611.42	735.48	584.17	666.34	706.70	662.88
11-12	653.72	667.23	729.80	757.86	707.47	756.32	659.41	778.53	688.91	698.17	758.61	753.57
12-13	670.11	676.23	777.18	735.37	716.36	698.50	682.55	745.10	691.21	699.58	773.45	747.97
13-14	643.84	636.84	649.84	706.15	676.37	609.21	650.06	716.39	665.20	594.11	678.71	659.10
14-15	543.07	544.72	592.49	622.51	600.26	564.76	587.06	600.33	508.94	432.26	556.91	536.99
14-16	383.09	408.01	433.30	466.97	480.40	425.40	467.37	421.14	346.97	313.82	377.84	358.57
16-17	218.87	237.53	246.14	305.94	283.50	262.69	287.95	246.79	174.34	166.39	182.65	175.54
17-18	76.43	79.66	88.08	123.70	111.87	120.23	129.96	96.67	72.62	52.76	53.56	51.11
18-19			23.80	35.24	37.58	43.28	46.13	34.94	36.18			

**Table B2 :** Standard Deviation of global irradiance.

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			19.44	13.44	24.92	21.34	19.94	19.24	15.00	15.04	18.99	13.49
7-8	23.04	18.52	60.49	33.83	71.11	63.04	56.36	78.45	57.84	61.49	60.53	34.81
8-9	73.92	50.96	96.72	52.44	94.24	107.99	106.21	134.52	105.51	112.42	112.40	67.51
9-10	99.54	90.60	162.36	101.04	138.62	162.97	137.05	178.30	159.31	154.10	119.40	97.60
10-11	111.08	150.02	229.00	124.74	161.23	184.23	185.24	188.03	204.63	155.16	156.17	116.73
11-12	123.75	167.15	236.48	214.39	268.42	188.05	210.95	217.13	228.51	168.70	211.69	106.30
12-13	181.58	191.85	264.28	263.59	249.69	235.61	254.25	229.23	244.70	172.20	209.98	124.85
13-14	159.91	186.30	309.90	222.47	251.78	242.87	237.60	220.51	186.21	192.13	170.17	142.70
14-15	151.50	128.37	227.93	224.76	230.76	215.50	219.54	203.89	196.63	163.88	132.44	116.80
14-16	119.46	96.12	155.40	151.69	168.47	150.51	184.88	189.61	182.93	144.04	94.31	91.80
16-17	67.09	72.24	93.30	95.38	120.11	106.11	115.61	116.88	99.78	73.26	44.52	47.45
17-18	22.54	20.06	26.99	31.82	50.89	48.21	61.13	49.52	32.13	20.08	13.62	14.76
18-19				6.64	12.77	12.66	17.33	8.08	5.34			

**Table B3 : Mean values of diffuse irradiance (W/m<sup>2</sup>).**

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			38.46	49.30	53.36	52.01	46.67	44.66	43.42	40.60	34.17	26.99
7-8	63.39	62.81	88.50	118.02	128.15	128.80	119.07	104.93	118.95	100.39	76.82	58.38
8-9	128.52	147.90	170.00	199.34	212.89	219.91	221.62	179.18	225.07	191.42	141.20	111.11
9-10	199.70	215.63	230.14	269.96	276.75	288.38	294.44	258.27	302.27	252.52	200.55	153.32
10-11	243.40	254.04	272.95	315.87	318.04	357.73	356.72	308.85	357.82	317.70	201.27	166.17
11-12	277.86	285.65	299.34	310.71	302.82	383.59	397.84	326.00	386.60	340.50	204.64	182.80
12-13	275.93	292.15	305.02	296.40	338.96	408.37	385.55	368.50	386.18	344.37	201.37	215.26
13-14	269.15	283.76	259.99	291.76	290.94	355.78	370.97	362.29	365.56	301.04	217.78	215.12
14-15	229.59	259.73	253.43	256.53	245.76	277.00	308.87	310.32	293.98	254.68	201.22	195.05
14-16	171.08	208.92	213.09	210.65	219.66	242.27	249.39	224.68	205.20	195.18	147.46	144.94
16-17	109.11	138.52	143.86	152.46	151.51	162.30	168.46	154.61	123.08	113.62	88.55	90.39
17-18	50.18	59.50	63.99	77.11	78.82	86.93	92.61	75.96	57.11	44.41	38.14	40.20
18-19			25.30	29.52	31.64	36.05	39.40	31.86	32.53			

**Table B4 : Standard Deviation diffuse irradiance.**

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			13.56	7.71	12.41	11.76	12.36	10.34	9.66	9.75	7.11	3.83
7-8	14.01	10.99	28.18	21.45	38.36	27.98	27.93	39.12	31.36	29.12	20.34	19.92
8-9	27.45	23.86	46.16	47.07	55.65	54.70	52.55	77.24	52.04	59.53	60.31	47.96
9-10	43.89	41.92	76.48	62.76	97.23	76.95	71.99	119.45	74.46	71.80	106.13	73.81
10-11	71.05	57.58	101.63	92.28	117.92	92.57	91.49	126.53	106.78	76.73	118.44	89.32
11-12	91.13	66.61	87.43	95.29	101.05	116.60	119.98	126.79	112.56	69.88	127.90	98.42
12-13	89.42	79.04	95.48	78.77	100.94	131.09	123.29	119.73	114.13	87.11	105.80	112.41
13-14	83.42	72.95	94.31	64.40	110.13	138.38	128.29	118.30	119.10	84.76	96.32	95.60
14-15	74.15	46.82	75.81	81.40	95.75	99.38	102.93	110.06	102.12	70.80	76.22	80.86
14-16	51.45	43.41	73.98	54.07	62.36	80.90	75.61	82.93	81.97	67.91	49.83	48.58
16-17	28.28	39.94	33.46	42.22	46.21	54.78	41.38	54.03	54.73	40.09	20.58	24.02
17-18	9.34	13.77	16.30	21.72	25.45	27.39	31.33	28.34	19.69	14.22	9.56	9.02
18-19				6.51	9.31	9.14	12.21	6.74	2.23			

Table B5 : Mean values of beam irradiance (W/m<sup>2</sup>).

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			42.21	70.75	93.84	17.37	30.37	75.90	33.10	22.27	135.65	151.68
7-8	102.45	73.62	149.66	270.08	202.50	58.01	87.09	227.16	104.16	131.67	321.24	309.27
8-9	259.91	221.95	281.27	411.10	313.33	163.60	139.85	325.30	194.40	261.76	451.63	514.60
9-10	367.99	347.80	387.61	416.94	346.05	235.85	207.56	360.92	240.48	340.45	570.31	604.93
10-11	478.63	423.71	436.46	453.59	390.27	201.14	239.84	431.17	215.07	368.87	648.07	713.50
11-12	462.75	433.75	433.79	431.68	377.74	287.00	217.98	419.28	271.78	350.46	659.64	743.84
12-13	470.21	419.60	466.30	419.11	333.05	192.27	251.31	328.62	272.22	344.75	681.84	672.51
13-14	469.15	399.01	402.51	414.83	371.63	210.25	247.67	324.70	285.69	312.94	584.29	594.13
14-15	447.55	364.21	395.25	417.92	399.28	281.98	285.48	296.28	234.06	212.00	532.89	532.54
14-16	390.18	317.30	315.24	360.11	355.15	178.43	269.91	249.24	197.86	188.25	466.44	437.65
16-17	309.67	230.64	210.63	312.36	242.46	143.64	198.02	153.63	103.08	136.83	322.96	284.08
17-18	159.63	97.66	92.89	176.71	103.69	68.95	96.11	48.99	57.38	50.08	137.25	90.93
18-19			28.30	65.71	43.10	38.40	30.29	14.42	3.03			

Table B6 : Standard Deviation of beam irradiance.

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			47.23	62.76	116.12	45.98	56.44	99.64	57.83	39.74	136.89	92.88
7-8	89.25	59.52	164.43	130.81	198.85	117.64	147.53	246.81	137.35	159.64	249.50	159.48
8-9	194.86	119.69	220.53	171.35	260.77	224.84	197.70	309.15	194.24	273.23	350.31	249.72
9-10	215.55	170.65	260.77	204.44	283.91	252.90	239.94	336.77	243.06	294.54	342.05	305.53
10-11	253.45	226.15	247.87	219.86	297.12	269.04	269.14	295.40	247.75	249.20	347.80	298.35
11-12	272.43	230.34	275.57	269.06	325.88	291.62	252.79	310.73	278.22	217.76	366.00	271.91
12-13	290.02	259.08	286.25	298.05	300.86	234.76	278.28	275.88	273.23	221.58	355.27	315.96
13-14	273.46	258.49	315.08	261.50	316.63	295.04	281.80	285.24	286.79	237.59	339.72	315.22
14-15	272.76	192.12	264.88	269.93	292.96	322.67	278.26	265.83	260.16	201.36	293.16	288.28
14-16	271.21	160.85	228.70	231.32	262.13	235.33	264.79	262.08	255.45	205.67	259.51	251.57
16-17	226.07	140.06	176.92	187.34	242.59	185.70	226.37	174.27	181.09	162.82	199.55	173.88
17-18	144.42	66.79	70.18	135.15	139.24	133.46	144.23	90.63	97.33	73.90	102.99	79.75
18-19				63.07	63.72	77.62	60.45	28.45	4.28			

## Appendix C.

**Table C1 : Mean values of Global illuminance (klux).**

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			5.03	7.48	9.43	7.09	6.45	7.47	5.71	5.31	6.56	5.57
7-8	9.66	8.19	15.37	25.64	25.95	20.35	18.58	22.67	18.68	17.56	20.21	15.77
8-9	26.09	25.60	35.64	49.53	48.65	41.50	36.68	43.02	40.12	39.49	40.61	36.80
9-10	45.56	45.27	55.42	65.41	64.31	60.61	53.57	61.49	56.11	57.52	63.10	55.29
10-11	62.52	60.15	69.79	78.76	77.53	67.11	66.32	78.61	63.11	72.00	75.14	71.09
11-12	69.07	67.36	75.40	78.64	75.06	80.56	70.62	81.67	73.14	74.53	79.53	79.64
12-13	70.11	68.18	79.70	75.90	75.89	74.80	72.59	78.19	73.25	74.60	80.80	78.68
13-14	67.31	64.42	67.24	73.46	72.12	65.81	69.63	75.80	70.98	64.03	71.77	69.96
14-15	57.61	55.03	62.33	65.51	65.00	61.54	63.44	64.62	55.23	47.92	60.22	57.95
14-16	41.55	41.58	46.52	50.08	53.45	47.66	51.60	46.58	38.49	35.55	42.20	39.66
16-17	24.64	24.59	27.01	33.74	32.72	30.36	32.78	28.12	20.02	19.57	21.77	20.53
17-18	9.37	8.66	10.11	14.40	13.52	14.37	15.42	11.39	8.72	6.66	6.98	6.57
18-19			3.60	4.41	4.64	5.32	5.56	4.20	3.80			

**Table C2 : Standard Deviation of Global illuminance.**

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			2.03	1.78	3.61	2.73	2.63	2.99	1.95	1.93	2.56	1.47
7-8	2.92	1.99	7.50	4.21	8.65	7.56	7.04	9.81	6.95	7.53	7.52	4.53
8-9	8.61	5.47	11.26	5.96	10.80	12.30	11.94	15.17	11.81	12.94	12.23	8.04
9-10	10.76	9.15	17.40	10.36	14.80	17.33	14.50	18.91	16.50	16.51	12.02	10.62
10-11	11.50	14.85	23.58	12.62	16.14	18.73	18.64	18.96	20.58	15.78	15.10	11.95
11-12	12.14	16.33	22.95	20.80	26.31	18.44	20.65	20.75	22.36	16.90	20.63	10.34
12-13	17.86	18.36	25.71	25.25	24.29	23.48	24.52	21.90	23.77	17.10	20.37	11.89
13-14	15.93	17.88	30.66	21.38	25.14	24.39	23.35	21.64	18.39	19.58	16.26	14.13
14-15	15.54	12.68	23.28	22.70	23.86	22.18	22.22	20.77	20.45	17.30	13.22	12.01
14-16	12.79	9.85	16.29	16.10	18.21	16.29	19.53	20.19	19.79	15.69	9.94	9.89
16-17	7.87	7.68	9.92	10.35	13.93	12.18	12.98	13.05	11.35	8.57	5.49	5.58
17-18	3.14	2.22	3.10	3.81	6.43	6.12	7.48	5.98	4.14	2.57	1.87	1.71
18-19				0.81	1.80	1.86	2.27	1.03	0.35			

Table C3 : Mean values of Diffuse illuminance (klux).

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			4.73	6.60	7.09	6.56	5.74	5.66	5.21	4.90	4.88	4.16
7-8	8.17	7.77	11.51	16.97	16.81	16.80	15.08	13.81	15.28	12.95	10.83	8.59
8-9	17.91	21.10	23.22	28.11	27.51	27.66	27.89	23.25	29.28	24.99	18.94	15.81
9-10	27.43	30.66	31.12	36.71	34.71	37.15	36.82	32.53	38.99	32.70	26.58	21.00
10-11	33.00	35.86	36.38	42.02	39.11	43.72	43.81	38.82	44.98	40.38	26.61	22.62
11-12	36.56	39.42	39.04	40.54	36.86	46.28	48.11	40.21	47.85	43.41	26.79	24.66
12-13	36.27	39.79	39.80	38.60	42.44	53.08	46.55	45.49	47.64	43.35	26.41	28.40
13-14	35.43	38.47	34.33	38.67	35.78	44.58	45.43	44.47	45.69	37.87	28.50	28.24
14-15	31.01	35.86	34.60	34.79	30.81	36.14	38.80	38.89	37.30	32.52	26.85	26.01
14-16	23.63	29.58	29.52	29.02	28.12	31.07	32.02	28.74	26.60	25.29	20.51	20.20
16-17	15.51	19.32	19.99	21.61	19.73	20.62	21.99	20.44	16.05	15.00	12.76	12.99
17-18	7.10	7.86	8.69	10.90	10.18	11.01	12.13	9.80	7.47	5.93	5.55	5.66
18-19			3.50	4.05	4.08	4.56	5.07	4.01	3.80			

Table C4 : Standard Deviation diffuse illuminance.

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			1.70	1.13	1.81	2.17	1.64	1.29	1.21	1.31	1.14	0.48
7-8	1.75	1.63	3.75	2.31	4.63	4.01	3.52	5.06	4.10	3.72	2.30	2.09
8-9	3.91	3.83	5.33	5.46	6.12	6.45	6.12	9.32	6.32	6.72	5.77	5.00
9-10	4.67	5.08	8.95	7.55	11.04	10.51	8.24	14.35	8.57	8.19	11.55	7.62
10-11	7.15	7.40	12.38	10.99	13.25	11.21	10.47	15.09	12.58	8.65	12.84	9.18
11-12	9.04	8.32	10.34	11.11	11.56	14.23	13.60	14.75	13.03	9.05	13.83	10.33
12-13	9.63	8.54	11.68	9.67	11.79	17.11	13.88	14.30	13.12	10.23	11.37	12.03
13-14	8.94	7.92	12.21	7.98	12.67	17.55	14.59	13.63	13.67	10.01	10.23	9.82
14-15	8.15	5.29	10.72	10.44	11.08	12.55	12.08	12.89	12.50	8.68	8.28	8.63
14-16	5.57	5.75	9.26	6.94	7.37	10.33	9.18	9.88	10.41	8.60	5.18	5.39
16-17	3.27	4.94	4.77	5.67	5.76	6.71	5.20	7.38	6.82	5.20	2.06	2.86
17-18	0.91	1.52	2.19	2.53	3.34	3.32	4.17	3.76	2.58	1.88	1.09	1.11
18-19				0.63	1.29	1.13	1.63	0.84	0.28			



Table C5 : Mean values of beam illuminance (klux).

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			1.01	2.77	7.68	0.70	2.07	7.39	2.08	1.52	8.20	7.61
7-8	4.99	1.02	10.80	21.84	21.39	5.03	7.62	24.52	8.75	12.45	29.87	26.55
8-9	20.03	9.19	23.84	38.45	35.65	20.13	15.23	36.83	19.02	27.79	46.70	52.75
9-10	33.18	23.66	35.90	39.45	39.43	17.58	20.17	41.31	23.65	37.16	60.74	64.13
10-11	45.36	33.44	42.02	43.89	43.79	26.08	25.91	48.81	21.38	40.85	70.08	76.38
11-12	45.01	34.83	42.00	42.45	42.33	37.29	24.27	47.36	28.20	37.36	71.43	79.67
12-13	45.65	34.37	45.31	39.88	35.29	21.68	28.00	35.69	28.16	37.66	73.84	71.62
13-14	45.03	32.54	39.10	39.84	41.83	22.82	27.39	35.90	29.85	33.94	62.50	62.83
14-15	42.01	26.35	36.54	39.88	44.44	32.24	31.65	32.93	24.19	22.66	56.00	55.12
14-16	35.26	20.09	26.70	33.05	39.71	24.80	29.98	27.74	20.10	19.33	47.46	42.86
16-17	25.09	11.89	14.67	26.21	27.09	19.48	21.76	15.72	9.69	12.94	29.19	23.88
17-18	9.89	2.51	4.14	11.41	10.44	10.06	10.10	4.36	4.78	3.37	7.91	4.58
18-19			0.00	0.74	2.85	3.97	2.49	0.85	0.00			

Table C6 : Standard Deviation of beam illuminance.

Local time	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6-7			1.80	4.11	11.58	2.17	4.95	10.46	5.42	3.18	9.60	5.60
7-8	6.73	2.03	16.20	13.34	21.36	11.69	14.71	28.18	13.84	16.12	23.90	15.52
8-9	18.33	9.76	24.05	19.20	28.17	23.56	22.06	35.98	20.56	29.10	36.26	27.31
9-10	21.63	15.83	28.60	22.27	31.43	19.40	26.08	39.26	25.04	32.09	36.01	33.06
10-11	26.88	21.93	26.03	24.88	32.39	32.10	30.07	33.93	25.49	26.65	37.30	32.50
11-12	28.16	23.30	29.19	29.08	36.74	32.18	28.59	35.64	30.36	22.73	39.54	29.67
12-13	30.12	25.24	31.85	30.89	32.34	24.96	31.38	31.28	28.87	23.32	38.68	34.26
13-14	29.22	25.04	34.37	27.44	35.63	33.75	31.62	32.72	32.01	25.56	36.53	33.84
14-15	28.77	18.62	28.89	28.93	32.95	36.70	31.12	30.33	29.04	21.13	30.96	30.87
14-16	27.75	15.47	23.41	24.81	28.61	31.57	29.63	29.41	28.37	21.47	26.91	26.34
16-17	22.68	13.08	14.95	18.61	25.90	22.16	24.92	19.36	19.16	15.72	18.88	16.34
17-18	12.45	4.33	4.51	11.04	13.62	16.32	15.11	8.31	8.89	5.36	6.66	5.00
18-19				1.50	4.19	7.46	5.07	2.03	0.00			

