

S5: Appendix E - Telecommunication Networks Indicators Data Processing

Indicator 1: Optical Distribution Points (ODPs)

Certainly, the blankspot area lacks telecommunications infrastructure, hence there is no ODP on grid #1. Presume that ODP exists in the other grids. The threshold points are 1 Gigabit per second and 2048 Gigabits per second. The following is an example of a computation using Microsoft Excel: $K2=L2=IF(J2=0;1;IF(J2<1000;2;IF(J2\leq 2048;3;4)))$. The calculation yields the result indicated in Table S4.

Table S4. Optical Distribution Points (ODPs) Data Processing Example

L2											
=IF(J2=0;1;IF(J2<1000;2;IF(J2<=2048;3;4)))											
	No.	IDProp	Province	IDKab	Regency	IDKec	District	The presence of ODP [exists or is not / 1-0]	Transmission Capacity [Mbps]	ODP Index	ODP Grid
1	1	11	ACEH	1101	SIMEULUE	1101010	TEUPAH SELATAN	0	0	1	1
2	2	11	ACEH	1101	SIMEULUE	1101020	SIMEULUE TIMUR	0	0	1	1
3	3	11	ACEH	1101	SIMEULUE	1101021	TEUPAH BARAT	0	0	1	1
4	4	11	ACEH	1101	SIMEULUE	1101022	TEUPAH TENGAH	1	1038	3	3
5	5	11	ACEH	1101	SIMEULUE	1101030	SIMEULUE TENGAH	0	0	1	1
16	19	11	ACEH	1102	ACEH SINGKIL	1102033	SURO	0	0	1	1
17	23	11	ACEH	1103	ACEH SELATAN	1103011	TRUMON TIMUR	1	100000	4	4
39	45	11	ACEH	1104	ACEH TENGGARA	1104022	SEMADAM	1	226	2	2
40	46	11	ACEH	1104	ACEH TENGGARA	1104023	LEUSER	0	0	1	1

Indicator 2: Coverage Prediction / Signal Coverage (SigCov)

According to the average postulate, the total data is totaled and divided by 3. So that each data's contribution is 33.3%. A zone formation threshold is derived from the average result, which is null because there is no signal = grid #1 and 100% divided by 3 for the remainder of the grid ($0 \times 33.3 = \text{grid \#2}$; $33.3 \times 66.7 = \text{grid \#3}$; $>66.7 = \text{grid \#4}$). The following is an example of a computation using Microsoft Excel: $R2=IF(Q2>66,7;4;IF(Q2>33,3;3;IF(Q2>0;2;1)))$. The calculation yields the result indicated in Table S5.

Table S5. Coverage Prediction / Signal Coverage (SigCov) Data Processing Example

Example

R2													=IF(Q2>66,7;4;IF(Q2>33,3;3;IF(Q2>0;2;1)))												
	A	B	C	D	E	F	G		N	O	P	Q	R												
	No.	IDProp	Province	IDKab	Regency	IDKec	District		2G Coverage [%]	3G Coverage [%]	4G Coverage [%]	SIGCOV Index	SIGCOV Grid												
1																									
2	1	11	ACEH	1101	SIMEULUE	1101010	TEUPAH SELATAN		100	9,93644	14,17146	41,3693003													
3	2	11	ACEH	1101	SIMEULUE	1101020	SIMEULUE TIMUR		100	0,269268	0,470867	33,5800448													
4	3	11	ACEH	1101	SIMEULUE	1101021	TEUPAH BARAT		100	0,086138	3,956425	34,68085436													
5	4	11	ACEH	1101	SIMEULUE	1101022	TEUPAH TENGAH		100	34,33431	100	78,11143726													
13	12	11	ACEH	1102	ACEH SINGKIL	1102011	PULAU BANYAK BARAT		65,2205	0,142442	8,639656	24,6675339													
312	376	12	SUMATER	1206	TOBA SAMOSIR	1206051	BORBOR		0	0	0	0													

Coverage data are obtained as primary data from the desktop analysis of the signal coverage of Indonesian cellular service providers (Telkomsel, XL Axiata, H3I, Indosat, Smartfren Telecom) collected in 2019 by the Directorate of Posts and Informatics Control - Directorate General of Posts and Informatics Operations - Ministry of Communications and Informatics. The 2G/3G/4G signal received may originate from inside or outside the district polygon. Data comprises of percentages for "2G coverage", "3G coverage", and "4G coverage".

That is not necessarily the districts with cellular transmitting antennas (2G BTS / NodeB 3G / eNodeB 4G), their residents are served by telecommunications signals due to geographical obstacles / clutter loss / path loss. It could be that the signal is on the roof of the house but does not penetrate the house. In contrast, despite the absence of cellular transmitting antennas, it is still feasible to obtain telecommunications services / signals due to the transmitter's elevated placement from the neighborhood's district. These two characteristics are termed signal coverage (SigCov). Therefore, the number of mobile cellular (2G/3G/4G) stations from cellular service providers and traffic data from end-user level (OOKLA crowdsourcing) provides cross-validation for coverage prediction.

Indicator 3: Traffic

Traffic includes four pieces of information, including download speed, upload speed, latency, and jitter. In accordance with the mean postulate, the whole data is summed and divided by 4. So that 25% of each data is contributed. A zone formation threshold is derived from the average result, which is null because there is no signal = grid #1 and 100% divided by 3 for the remainder of the grid (0x33.3 = grid #2; 33.3x66.7 = grid #3; >66.7 = grid #4). The following is an example of a computation using Microsoft Excel: X2= AVERAGE (T2:W2) and Y2=IF(X2>66,7;4;IF(X2>33,3;3;IF(X2>0;2;1))). The calculation yields the result indicated in Table S6.

Table S6. Traffic Data Processing Example

Y2 =IF(X2>66,7;4;IF(X2>33,3;3;IF(X2>0;2;1)))														
	A	B	C	D	E	F	G	H	T	U	V	W	X	Y
	No.	IDProp	Province	IDKab	Regency	IDKec	District	Download Speed Average in 3 months [Mbps]	Upload Speed Average in 3 months [Mbps]	Latency Average in 3 months [ms]	Jitter Average in 3 months [ms]	Traffic Index	Traffic Grid	
1														
2	1	11	ACEH	1101	SIMEULUE	1101010	TEUPAH SELATAN	9,874169922	3,173974609	88,35	173,035	68,6082861		
3	2	11	ACEH	1101	SIMEULUE	1101020	SIMEULUE TIMUR	25,52942122	11,48582316	38,29813665	57,7173913	33,2576931		
8	7	11	ACEH	1101	SIMEULUE	1101032	SIMEULUE CUT	22,33011768	15,56839471	183,5421335	108,364239	82,4512212		
9	8	11	ACEH	1101	SIMEULUE	1101040	SALANG	39,85443115	16,67478434	41	96,31041667	48,459908		
10	9	11	ACEH	1101	SIMEULUE	1101050	SIMEULUE BARAT	7,219604492	3,957885742	31,9375	88,1125	32,8068726		
11	10	11	ACEH	1101	SIMEULUE	1101051	ALAFAN	0	0	0	0	0		
12	11	11	ACEH	1102	ACEH SINGKIL	1102010	PULAU BANYAK	3,420898438	2,693684896	34,66666667	86,7	31,8703125		

Example													
AD2 = (0,3*AA2)+(0,2*AB2)+(0,5*AC2)													
	A	B	C	D	E	F	G	H	AA	AB	AC	AD	AE
	No.	IDProp	Province	IDKab	Regency	IDKec	District		Number of 2G Sites [point ¹]	Number of 3G Sites [point ¹]	Number of 4G Sites [point ¹]	Site Index	Site Grid
1													
2	1	11	ACEH	1101	SIMEULUE	1101010	TEUPAH SELATAN		8	0	9	6,9	2
3	2	11	ACEH	1101	SIMEULUE	1101020	SIMEULUE TIMUR		52	81	48	55,8	3
7	6	11	ACEH	1101	SIMEULUE	1101031	TELUK DALAM		74	123	108	100,8	4
211	253	11	ACEH	1117	BENER MERIAH	1117051	BENER KELIPAH		0	0	0	0	1
212	254	11	ACEH	1117	BENER MERIAH	1117060	SYIAH UTAMA		6	0	3	3,3	2
213	255	11	ACEH	1117	BENER MERIAH	1117061	MESIDAH		0	0	0	0	1
214	256	11	ACEH	1117	BENER MERIAH	1117070	PERMATA		21	6	21	18	