Direktorat Riset dan Pengabdian Masyarakat Direktorat Jenderal Riset dan Pengembangan
Kementerian Riset, Teknologi, dan Pendidikan Tinggi
Gedung BPPT II Lantai 19, Jl. MH. Thamrin No. 8 Jakarta Pusat
http://simlitabmas.ristekdikti.go.id/

LAPORAN AKHIR PENELITIAN MULTI TAHUN

ID Proposal: e4fb2a2d-30b3-412c-bdd6-db2e80ea6422
Laporan Akhir Penelitian: tahun ke-2 dari 2 tahun

1. IDENTITAS PENELITIAN

A. JUDUL PENELITIAN

TEORI BARU IMPROVED INSENTIF INTERNET MENURUT JARINGAN MULTIPLE QOS

B. BIDANG, TEMA, TOPIK, DAN RUMPUN BIDANG ILMU

Bidang Fokus RIRN / Bidang Unggulan Perguruan Tinggi	Tema	Topik (jika ada)	Rumpun Bidang Ilmu
Teknologi Informasi dan Komunikasi	Pengembangan Infrastruktur TIK	Network, data and information security	Matematika

C. KATEGORI, SKEMA, SBK, TARGET TKT DAN LAMA PENELITIAN

Kategori (Kompetitif Nasional/ Desentralisasi/ Penugasan)	Skema Penelitian	Strata (Dasar/ Terapan/ Pengembangan)	SBK (Dasar, Terapan, Pengembangan)	Target Akhir TKT	Lama Penelitian (Tahun)
Penelitian Kompetitif Nasional	Penelitian Dasar	SBK Riset Dasar	SBK Riset Dasar	3	2

2. IDENTITAS PENGUSUL

Nama, Peran	Perguruan Tinggi/ Institusi	Program Studi/ Bagian	Bidang Tugas	ID Sinta	H-Index
FITRI MAYA PUSPITA Ketua Pengusul	Universitas Sriwijaya	Matematika		5976544	4
Dr Dr. Drs YUSUF HARTONO M.Sc., M.Sc. Anggota Pengusul 1	Universitas Sriwijaya	Pendidikan Matematika	Pemodelan matematika dan pengujian hipotesis	6082895	7

3. MITRA KERJASAMA PENELITIAN (JIKA ADA)

Pelaksanaan penelitian dapat melibatkan mitra kerjasama, yaitu mitra kerjasama dalam melaksanakan penelitian, mitra sebagai calon pengguna hasil penelitian, atau mitra investor

Mitra	Nama Mitra

4. LUARAN DAN TARGET CAPAIAN

Luaran Wajib

Tahun Luaran	Jenis Luaran	Status target capaian (*accepted, published, terdaftar atau granted, atau status lainnya*)	Keterangan (*url dan nama jurnal, penerbit, url paten, keterangan sejenis lainnya*)
2	Publikasi Ilmiah Jurnal Internasional	accepted/published	International Journal of Electrical and Computer Engineering

Luaran Tambahan

Tahun Luaran	Jenis Luaran	Status target capaian (*accepted, published, terdaftar atau granted, atau status lainnya*)	Keterangan (*url dan nama jurnal, penerbit, url paten, keterangan sejenis lainnya*)
2	Prosiding dalam pertemuan ilmiah Internasional	sudah terbit/sudah dilaksanakan	ICECOS 2020

5. ANGGARAN

Rencana anggaran biaya penelitian mengacu pada PMK yang berlaku dengan besaran minimum dan maksimum sebagaimana diatur pada buku Panduan Penelitian dan Pengabdian kepada Masyarakat Edisi 12.

Total RAB 2 Tahun Rp. 58,335,000

Tahun 1 Total Rp. 0

Tahun 2 Total Rp. 58,335,000

Jenis Pembelanjaan	Item	Satuan	Vol.	Biaya Satuan	Total
Analisis Data	Transport Lokal	OK (kali)	60	150,000	9,000,000
Analisis Data	Biaya konsumsi rapat	OH	60	63,000	3,780,000
Bahan	ATK	Paket	1	1,005,000	1,005,000
Bahan	Bahan Penelitian (Habis Pakai)	Unit	3	150,000	450,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Biaya seminar internasional	Paket	1	3,000,000	3,000,000
Pelaporan, Luaran Wajib, dan Luaran Tambahan	Publikasi artikel di Jurnal Internasional	Paket	1	5,900,000	5,900,000
Pengumpulan Data	FGD persiapan penelitian	Paket	1	1,250,000	1,250,000
Pengumpulan Data	Transport	OK (kali)	150	150,000	22,500,000
Pengumpulan Data	Biaya konsumsi	OH	150	63,000	9,450,000
Sewa Peralatan	Peralatan penelitian	Unit	1	2,000,000	2,000,000

6. HASIL PENELITIAN

A. RINGKASAN: Tuliskan secara ringkas latar belakang penelitian, tujuan dan tahapan metode penelitian, luaran yang ditargetkan, serta uraian TKT penelitian.

Harga telah menjadi isu penting dalam kehidupan, Penyedia Layanan Internet (ISP) sekarang menghadapi permintaan tinggi untuk mempromosikan bandwidth yang baik untuk menghindari masalah kongesti. Namun, pengetahuan untuk mengembangkan rencana penetapan harga baru jarang dibahas. Pilihan untuk mengurangi kongesti dalam penetapan harga adalah dengan menawarkan insentif internet. Riset sebelumnya pada rencana penetapan harga internet difokuskan pada jaringan QoS berkabel. Arsitektur internet saat ini juga membutuhkan rencana harga internet pada jaringan nirkabel agar bisa bersaing dalam persaingan pasar. Skema improved penetapan harga nirkabel yang diusulkan didasarkan atas jaringan nirkabel dan keuntungan dari skema penetapan harga baru berada di bawah perspektif telcos untuk memaksimalkan keuntungan mereka. Fokus penelitian sebelumnya pada penetapan harga pada jaringan kabel dan nirkabel melayani pemasok dan konsumen [1]. Yang et al.[2] menggambarkan skema penetapan harga lelang untuk mengalokasikan QoS dan memaksimalkan pendapatan ISP. Riset terkini pada skema harga internet kabel pada beberapa jaringan QoS dibahas di [3-4] sedangkan di jaringan nirkabel dibahas di [5] dan [6]. Penelitian ini mencoba memperluas penelitian yang sebelumnya dilakukan oleh Tim yang berfokus pada jaringan nirkabel dengan melibatkan mekanisme insentif. Tujuan utama dari penelitian ini adalah untuk mengoptimalkan skema penetapan harga internet dengan jaringan QoS multipel yang melibatkan insentif dengan merumuskan skema penetapan harga optimal yang baru, menganalisis skema harga optimal dengan membandingkan dengan skema harga internet saat ini dan menentukan apakah skema harga tersebut Skema mana yang menawarkan harga lebih baik yang memberi keuntungan pada Telcos. Langkah-langkah yang dilakukan dalam penelitian ini adalah dengan menurunkan skema penetapan harga untuk jaringan QoS, kemudian mulai menggeneralisasi skema, menciptakan masalah optimasi, membuat flow chart, menjalankan masalah optimasi, menguji program, menganalisis hasil pengujian dan menyimpulkan hasilnya. Hasil yang diharapkan dari penelitian ini adalah berupa model improved skema penetapan harga internet yang baru di jaringan QoS. Luaran yang ditargetkan adalah berupa luaran Wajib berupa pengiriman ke jurnal terakreditasi dan indexing SCOPUS yakni International Journal of Electrical and Computer Engineering pada Tahun 2020 dan Luaran Tambahan berupa hasil penelitian yang disampaikan pada International Conference pada tahun 2019 dan 2020. Hasil penelitian direncanakan untuk diterapkan secara pemodelan teoritis pada data lalu lintas jaringan server lokal yang mengelola bandwidth pada komunitas/masyarakat tertentu, dalam hal ini direncanakan pada pada salah satu institusi pendidikan di Palembang. Model yang diterapkan pada data lalu lintas jaringan ini, diharapkan mampu memenuhi tujuan utama penyedia layanan yang memaksimalkan keuntungan.Penelitian ini berupaya mempelajari dan menganalisis skema pembiayaan insentif. Cakupan dalam penelitian ini adalah didasarkan pada sudut pandang Telcos dan keuntungan skema pembiayaan yang terbentuk menurut padangan Telcos dalam memaksimalkan keuntungan dengan tidak merugikan pengguna. Pengaplikasian skema pembiayaan Ringkasan penelitian tidak lebih dari 500 kata yang berisi latar belakang penelitian, tujuan dan tahapan metode penelitian, luaran yang ditargetkan, serta uraian TKT penelitian yang diusulkan.internet ini diharapkan dapat dimanfaatkan secara meluas oleh masyarakat karena model yang ditetapkan oleh ISP diharapkan dapat menarik minat pengguna dalam subscribe pada produk bundling ini dimana keuntungannya adalah pengguna dapat memilih paket terintegrasi yang mereka perlukan dan sesuai dengan anggaran biaya yang akan mereka keluarkan. TKT Penelitian berada pada level 3..

B. KATA KUNCI: Tuliskan maksimal 5 kata kunci.

mekanisme insentif; pembiayaan internet; optimasi; internet kabel; jaringan nirkabel

Pengisian poin C sampai dengan poin H mengikuti template berikut dan tidak dibatasi jumlah kata atau halaman namun disarankan seringkas mungkin. Dilarang menghapus/memodifikasi template ataupun menghapus penjelasan di setiap poin.

C. HASIL PELAKSANAAN PENELITIAN: Tuliskan secara ringkas hasil pelaksanaan penelitian yang telah dicapai sesuai tahun pelaksanaan penelitian. Penyajian dapat berupa data, hasil analisis, dan capaian luaran (wajib dan atau tambahan). Seluruh hasil atau capaian yang dilaporkan harus berkaitan dengan tahapan pelaksanaan penelitian sebagaimana direncanakan pada proposal. Penyajian data dapat berupa gambar, tabel, grafik, dan sejenisnya, serta analisis didukung dengan sumber pustaka primer yang relevan dan terkini.

Pengisian poin C sampai dengan poin H mengikuti template berikut dan tidak dibatasi jumlah kata atau halaman namun disarankan seringkas mungkin. Dilarang menghapus/memodifikasi template ataupun menghapus penjelasan di setiap poin.

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4.1 Pendeskripsian Data *Traffic*

Tabel 4.1 menampilkan data *traffic digilib* pada jam sibuk dan jam tidak sibuk dengan komponen pengiriman dan penerimaan, sedangkan Tabel 4.2 menampilkan data *traffic sisfo* pada jam sibuk dan jam tidak sibuk dengan komponen yang sama. Data yang digunakan diperoleh dari salah satu server lokal di Palembang.

Tabel 4.1 Data *Traffic Digilib* pada Jam Sibuk dan Jam Tidak Sibuk

No	Tanggal	*Traffic* jam sibuk (dalam bit per second)		*Traffic* jam tidak sibuk (dalam bit per second)	
		Received	Send	Received	Send
1	01 Januari 2020	12.855,31	4.916,58	24.551,13	4.093,94
2	02 Januari 2020	16.185,76	3.454,50	19.319,09	7.354,72
3	03 Januari 2020	26.957,41	7.325,17	19.593,66	9.440,70
4	04 Januari 2020	28.257,39	15.959,67	28.242,01	10.884,29
5	05 Januari 2020	18.140,12	7.144,68	19.341,74	6.813,87
6	06 Januari 2020	30.753,35	11.714,98	20.918,39	6.760,10
7	07 Januari 2020	39.645,41	7.076,86	31.304,70	7.060,81
8	08 Januari 2020	31.634,60	8.378,43	27.835,96	7.418,94
9	09 Januari 2020	21.799,30	8.128,26	29.178,38	7.375,15
10	10 Januari 2020	21.738,67	8.144,81	29.273,51	8.531,07
11	11 Januari 2020	36.080,78	11.053,33	30.864,99	10.032,82
12	12 Januari 2020	21.579,96	7.502,23	20.966,57	7.471,22
13	13 Januari 2020	29.513,91	5.440,57	19.986,24	5.086,86
14	14 Januari 2020	27.716,45	5.695,13	28.830,80	5.480,07
15	15 Januari 2020	27.903,24	5.181,81	24.188,62	9.015,15
16	16 Januari 2020	30.151,66	6.870,88	23.927,44	8.501,17
17	17 Januari 2020	20.735,63	6.086,88	30.008,89	5.237,07
18	18 Januari 2020	19.176,82	4.490,00	36.120,95	4.425,85
19	19 Januari 2020	18.965,80	3.759,73	27.114,05	4.751,56
20	20 Januari 2020	17.410,09	2.770,96	22.042,71	4.111,85
21	21 Januari 2020	48.429,72	11.924,03	40.380,17	3.467,18
22	22 Januari 2020	44.827,84	34.738,76	21.851,27	6.723,79
23	23 Januari 2020	25.602,69	2.379,24	30.100,21	2.626,19
24	24 Januari 2020	20.379,56	5.709,34	29.606,01	11.031,37
25	25 Januari 2020	40.223,00	15.767,44	31.614,23	14.806,15
26	26 Januari 2020	39.469,19	14.880,87	30.116,70	14.349,32
27	27 Januari 2020	40.009,74	15.787,96	41.193,55	19.170,73
28	28 Januari 2020	41.286,88	25.401,61	22.667,68	12.765,27
29	29 Januari 2020	26.744,09	14.127,63	31.709,91	13.431,05
30	30 Januari 2020	24.867,04	12.885,56	24.544,13	11.541,27
31	31 Januari 2020	6.968,88	3.471,33		
Demand		27.613,23	9.618,36	27.246,46	8.325,32

Demand per bulan	18.615,80	17.785,89
Demand byte per sekon (bps)	2.326,97	2.223,24
Demand kilobyte per sekon (kbps)	18,18	17,37

Tabel 4.2 Data *Traffic Sisfo* pada Jam Sibuk dan Jam Tidak Sibuk

No	Tanggal	*Traffic* jam sibuk (dalam bit per sekon)		*Traffic* jam tidak sibuk (dalam bit per sekon)	
		Received	*Send*	*Received*	*Send*
1	01 Januari 2020	33.839,26	11.204,61	20.946,50	8.632,63
2	02 Januari 2020	110.657,60	792.003,26	59.155,96	252.240,57
3	03 Januari 2020	111.453,70	714.529,04	66.974,33	132.492,39
4	04 Januari 2020	63.233,77	246.721,70	55.777,42	41.837,54
5	05 Januari 2020	42.879,35	43.194,17	49.280,49	21.284,45
6	06 Januari 2020	119.877,68	733.965,08	85.876,18	264.158,34
7	07 Januari 2020	261.926,24	4.985.402,65	325.587,46	205.641,89
8	08 Januari 2020	206.204,27	874.100,23	166.277,45	164.504,73
9	09 Januari 2020	428.590,01	16.841.892,33	549.689,60	5.995.478,47
10	10 Januari 2020	866.307,90	62.928.475,61	285.273,28	172.346,56
11	11 Januari 2020	67.603,55	222.810,08	58.138,76	27.831,29
12	12 Januari 2020	53.863,46	25.111,77	65.257,95	60.434,99
13	13 Januari 2020	252.558,09	16.526.975,61	238.771,56	303.274,98
14	14 Januari 2020	1.793.856,26	874.906,48	3.472.120,39	352.991,53
15	15 Januari 2020	2.238.886,31	80.580.628,85	679.019,79	513.944,71
16	16 Januari 2020	1.251.932,38	2.037.603,98	294.040,23	176.583,21
17	17 Januari 2020	294.754,57	908.015,60	299.125,77	93.612,97
18	18 Januari 2020	187.234,44	3.847.680,12	69.067,39	452.06,43
19	19 Januari 2020	57.839,62	20.580,19	65.544,31	47.413,38
20	20 Januari 2020	134.537,19	973.270,30	292.378,49	5.734.809,26
21	21 Januari 2020	6.515.539,18	226.590.817,06	388.885,37	713.614,82
22	22 Januari 2020	406.753,04	1.251.147,33	179.037,76	157.253,67
23	23 Januari 2020	376.962,97	2.164.346,07	324.236,58	160.850,03
24	24 Januari 2020	430.720,35	15.452.659,00	170.639,87	351.344,91
25	25 Januari 2020	67.867,12	56.181,91	72.269,76	68.201,45
25	26 Januari 2020	60.459,74	24.008,02	67.472,51	29.763,14
27	27 Januari 2020	319.353,99	2.629.668,02	10.495.222,78	2.021.234,73
28	28 Januari 2020	533.856,53	1.618.431,40	463.508,93	239.596,27
29	29 Januari 2020	728.010,00	1.540.229,68	374.545,84	175.144,81
30	30 Januari 2020	802.120,06	60.676.956,50	416.473,17	260.426,46
31	31 Januari 2020	191.290,20	322.038,28	139.850,36	57.394,87
Demand		613.257,06	16.339.211,45	654.530,52	621.175,66
Demand per bulan		8.476.234,25		637.853,09	
Demand byte per sekon (bps)		1.059.529,28		79.731,64	
Demand kilobyte per sekon (kbps)		1.034,70		77,86	

Keterangan:

Demand	: rata-rata pemakaian *traffic* per hari
Demand per bulan	: rata-rata pemakaian *traffic* dikirim dan diterima per hari
Demand per bulan (*byte*)	: *demand* per bulan dibagi 8 (1 *byte* = 8 *bit*)
Demand per bulan (*kilobyte*)	: *demand* per bulan dibagi 1024 (1 *kilobyte* = 1024 *byte*)

4.2 Parameter dan Variabel

Menentukan parameter dan variabel pada masing-masing skema pembiayaan untuk setiap konsumen merupakan langkah selanjutnya yang harus dilakukan setelah mendeskripsikan data pada *traffic digilib* dan *traffic sisfo*. Penulis membagi skema pembiayaan menjadi 4 kasus sebagai berikut:

1. α dan β sebagai parameter
2. α sebagai parameter dan β sebagai variabel
3. α sebagai variabel dan β sebagai parameter
4. α dan β sebagai variabel

Berdasarkan keempat kasus diatas diperoleh parameter dan variabel keputusan yang digunakan untuk mengoptimalkan pembiayaan internet *wireless* dalam melayani jaringan multipel QoS pada masing-masing kasus modifikasi.

Tabel 4.3 Parameter untuk Kasus Lainnya pada *Improved Reverce charging* untuk Model Pembiayaan Insentif Internet

Kasus 2: $\boldsymbol{\alpha}$ Sebagai Parameter dan $\boldsymbol{\beta}$ Sebagai Variabel	
α	Harga dasar untuk setiap layanan
β	Kualitas premium untuk setiap layanan
C	Kapasitas total yang terdapat pada jaringan
b_j	Harga dasar minimum yang diperlukan untuk layanan *j*
d_{jk}	Kapasitas yang dibutuhkan untuk layanan j pada jaringan k
I_j	Kualitas layanan *j*
m_j	Minimum QoS untuk layanan *j*
n_j	Jumlah pengguna layanan *j*
P_{jk}	Harga pngguna layanan j pada jaringan k

Kasus 3: $\boldsymbol{\alpha}$ Sebagai Variabel dan $\boldsymbol{\beta}$ Sebagai Parameter	
α	Harga dasar untuk setiap layanan
β	Kualitas premium untuk setiap layanan
C	Kapasitas total yang terdapat pada jaringan

c_j	Kualitas premium minimum untuk layanan j
d_{jk}	Kapasitas yang dibutuhkan untuk layanan j pada jaringan k
g_j	Kualitas premium maksimum untuk layanan j
I_j	Kualitas layanan j
m_j	Minimum QoS untuk layanan j
n_j	Jumlah pengguna layanan j
P_{jk}	Harga pngguna layanan j pada jaringan k

Kasus 4: α dan β Sebagai Variabel	
α	Harga dasar untuk setiap layanan
β	Kualitas premium untuk setiap layanan
C	Kapasitas total yang terdapat pada jaringan
b_j	Harga dasar minimum yang diperlukan untuk layanan j
c_j	Kualitas premium minimum untuk layanan j
d_{jk}	Kapasitas yang dibutuhkan untuk layanan j pada jaringan k
g_j	Kualitas premium maksimum untuk layanan j
I_j	Kualitas layanan j
m_j	Minimum QoS untuk layanan j
n_j	Jumlah pengguna layanan j
P_{jk}	Harga pngguna layanan j pada jaringan k

Tabel 4.4 Variabel untuk Kasus Lainnya pada *Improved Reverce Charging* untuk Model Pembiayaan Insentif Internet

Kasus 2: α Sebagai Parameter dan β Sebagai Variabel	
a_j	Faktor biaya linier layanan j
X_{jk}	Jumlah pengguna layanan j pada pada jaringan k
β_j	Kualitas premium layanan j

Kasus 3: α Sebagai Variabel dan β Sebagai Parameter	
a_j	Faktor biaya linier layanan j
X_{jk}	Jumlah pengguna layanan j pada jaringan k
α_j	Harga dasar layanan j

Kasus 4: α dan β Sebagai Variabel	
a_j	Faktor biaya linier layanan j
X_{jk}	Jumlah pengguna layanan j pada jaringan k
α_j	Harga dasar layanan j
β_j	Kualitas premium j

Tabel 4.5 Nilai-Nilai Parameter dalam Model *Improved* Pembiayaan Insentif Internet pada Data *Traffic Digilib* Menggunakan Fungsi Utilitas Quasi Linier

Parameter	Nilai	Parameter	Nilai	Parameter	Nilai
$\bar{X}_1$	48429,72	b_2	2	g_{22}	0,12
$\bar{X}_2$	34738,76	PR_{11}	0,5	h	50

$\bar{Y}_1$	41193,55	PR_{12}	0,6	k	1000
$\bar{Y}_2$	19170,73	PR_{21}	0,4	m_1	0,01
α	0,1	PR_{22}	0,7	m_2	0,01
β	0,5	P_{11}	15	n_1	10
C	350000	P_{12}	15	n_2	10
B_1	300	P_{21}	15	c_1	0
B_2	500	P_{22}	15	c_2	0
M	200	Q_{bjk}	2000	d_{11}	4,37
V_{11}	500	f_{11}	0,05	d_{12}	4,37
V_{12}	800	f_{12}	0,06	d_{21}	4,37
V_{21}	600	f_{21}	0,07	d_{22}	4,37
V_{22}	900	f_{22}	0,08	g_1	1
a_1	3	g_{11}	0,15	g_2	1
a_2	3	g_{12}	0,14		
b_1	2	g_{21}	0,13		

Tabel 4.6 Nilai-Nilai Parameter dalam Model *Improved* Pembiayaan Insentif Internet pada Data *Traffic Sisfo* Menggunakan Fungsi utilitas Cobb-Douglas

No	Parameter	Nilai	No	Parameter	Nilai
1	B_1	300	28	f_{11}	0,05
2	B_2	500	29	f_{12}	0,06
3	M	200	30	f_{21}	0,07
4	V_{11}	500	31	f_{22}	0,08
5	V_{12}	800	32	g_{11}	0,15
6	V_{21}	600	33	g_{12}	0,14
7	V_{22}	900	34	g_{21}	0,13
8	$\bar{X}_1$	28455,37	35	g_{22}	0,12
9	$\bar{X}_2$	10109,80	36	h	50
10	$\bar{Y}_1$	1527,89	37	k	1000
11	$\bar{Y}_2$	798,97	38	m_1	0,01
12	a_1	4	39	m_2	0,01
13	a_2	3	40	n_1	10
14	b_1	3	41	n_2	10
15	b_2	2	42	d_{11}	95,80
16	α	0,1	43	d_{12}	95,80
17	β	0,5	44	d_{21}	95,80
18	C	35000	45	d_{22}	95,80
19	PR_{11}	0,5	46	b_1	0,5
20	PR_{12}	0,6	47	b_2	0,5
21	PR_{21}	0,4	48	c_1	0
22	PR_{22}	0,7	49	c_2	0
23	P_{11}	15	50	g_1	1
24	P_{12}	15	51	g_2	1
25	P_{21}	15	52	I_1	0,01
26	P_{22}	15	53	I_2	0,01
27	Q_{bij}	2000			

4.3 Model *Improved* Pembiayaan Insentif Internet Wireless

Setelah menentukan nilai-nilai parameter dan variabel yang digunakan pada pembiayaan insentif internet, selanjutnya pembiayaan insentif dimodifikasi sehingga diperoleh 4 kasus yang dapat mengoptimalkan keuntungan ISP.

4.3.1 Model Skema Pembiayaan Insentif Internet pada Data *Traffic Digilib* Menggunakan Fungsi Utilitas Quasi Linier

Model Kasus 1 (α Parameter dan β Parameter)

PQ_{jk} naik, x naik

$$Maks\ R = \sum_{i=1}^{2} \sum_{j=1}^{2} \left(P_j - B_j\right) X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) + P_X X_1 + P_X X_2 + P_Y Y_1 + P_Y Y_2 +$$
$$PZ_1 + PZ_2 + \sum_{j=1}^{2} \sum_{k=1}^{2} \left((PR_{jk} + PQ_{jk}\right) + \left(\alpha + \beta I_j\right) + P_{jk} X_{jk}) \qquad (4.1a)$$

Dengan kendala:

$S_1 \geq (R_{11} - P_1)Y_1$

$S_1 \geq (R_{12} - P_2)Y_2$

$S_2 \geq (R_{21} - P_1)Y_1$

$S_2 \geq (R_{22} - P_2)Y_2$ (4.2)

Kendala (4.2) menjelaskan bahwa konsumen mendapatkan keuntungan maksimum dari harga yang telah ditetapkan untuk setiap *bundle*.

$S_1 = (R_{11} - P_1)X_{11} + (R_{12} - P_2)X_{12}$

$S_2 = (R_{21} - P_1)X_{21} + (R_{22} - P_2)X_{22}$ (4.3)

Kendala (4.3) menjelaskan bahwa keuntungan konsumen diperoleh dari harga pemesanan dan harga setiap *bundle* yang telah ditetapkan.

$(R_{11} - P_1)X_{11} \geq 0$

$(R_{12} - P_2)X_{12} \geq 0$

$(R_{21} - P_1)X_{21} \geq 0$

$(R_{22} - P_2)X_{22} \geq 0$ (4.4)

Kendala (4.4) menjelaskan bahwa konsumen akan memilih *bundle* ketika keuntungan yang diperoleh tidak negatif.

$R_{11} = V_{11}$

$R_{12} = V_{11} + V_{12}$

$R_{21} = V_{21}$

$R_{22} = V_{21} + V_{22}$ (4.5)

Kendala (4.5) menjelaskan bahwa R_{ij} menyatakan total harga pemesanan untuk setiap layanan favorit konsumen.

$(X_{11} + X_{12}) \leq 1$

$(X_{21} + X_{22}) \leq 1$ (4.6)

Kendala (4.6) menjelaskan bahwa konsumen hanya akan membeli satu paket atau tidak membeli sama sekali.

$X_{11} \leq Y_1$

$X_{21} \leq Y_1$

$X_{12} \leq Y_2$

$X_{22} \leq Y_2$ (4.7)

Kendala (4.7) menjelaskan bahwa konsumen dapat memilih *bundle* yang ditawarkan oleh ISP.

$S_1 \geq 0,1$

$S_2 \geq 0,1$ (4.8)

Kendala (4.8) menyatakan bahwa konsumen dipastikan mendapatkan keuntungan dalam pemakaian layanan *bundle*.

$P_1 \geq 0,1$

$P_2 \geq 0,1$ (4.9)

Kendala (4.9) menyatakan bahwa konsumen akan mengeluarkan biaya jika ingin menggunakan layanan.

$X_1 \leq \bar{X}_1 Z_1$

$X_2 \leq \bar{X}_2 Z_2$ (4.10)

Kendala (4.10) menjelaskan bahwa tingkat konsumsi konsumen pada layanan jam sibuk ditentukan oleh bergabung atau tidaknya konsumen dengan program.

$Y_1 \leq \bar{Y}_1 Z_1$

$Y_2 \leq \bar{Y}_2 Z_2$ (4.11)

Kendala (4.11) menjelaskan bahwa tingkat konsumsi konsumen pada layanan jam tidak sibuk ditentukan oleh bergabung atau tidaknya konsumen dengan program.

$(3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 \geq 0$ (4.12)

Kendala (4.12) menjelaskan bahwa pasti ada masalah dalam kosumen.

$Z_1 > 0,1$

$Z_2 > 0,1$ (4.13)

Kendala (4.13) menjelaskan bahwa konsumen akan memilih untuk bergabung dengan program.

Jika skema pembiayaannya *Flat fee* maka ditambahkan kendala:

$P_X = 0$

$P_Y = 0$

$P > 0$ (4.14)

Kendala (4.14) menyatakan bahwa konsumen akan mengeluarkan biaya ketika konsumen memilih bergabung dengan program.

Jika skema pembiayaannya *Usage based* maka ditambahkan kendala:

$P_X > 0$

$P_Y > 0$

$P = 0$ (4.15)

Kendala (4.15) menyatakan bahwa ada harga yang ditetapkan ISP pada layanan di jam sibuk ataupun tidak sibuk.

Jika skema pembiayaannya *Two part tariff* maka ditambahkan kendala:

$P_X > 0$

$P_Y > 0$

$P > 0$ (4.16)

Kendala (4.16) menyatakan bahwa konsumen akan mengeluarkan biaya ketika mengikuti program.

$I_1 d_{11} x_{11} \leq a_1 C$

$I_1 d_{12} x_{12} \leq a_1 C$

$I_2 d_{21} x_{21} \leq a_2 C$

$I_2 d_{22} x_{22} \leq a_2 C$ (4.17)

Kendala (4.17) menyatakan bahwa kapsitas layanan yang tersedia melebihi kapasitas jaringan yang diperlukan.

$(I_1 d_{11} x_{11}) + (I_1 d_{12} x_{12}) \leq a_1 C$

$(I_2 d_{21} x_{21}) + (I_2 d_{22} x_{22}) \leq a_2 C$ (4.18)

Kendala (4.18) menyatakan bahwa total kapasitas jaringan lebih besar dari kapasitas jaringan yang dibutuhkan.

$a_1 + a_2 = 1$ (4.19)

Kendala (4.19) menjelaskan bahwa total kapasitas jaringan sama dengan 1.

$0 \leq a_1 \leq 1$

$0 \leq a_2 \leq 1$ (4.20)

Kendala (4.20) menjelaskan bahwa alokasi kapasitas jaringan untuk setiap layanan berada di rentang 0 sampai 1.

$0 \leq m_1 \leq I_1 \leq 1$

$0 \leq m_2 \leq I_2 \leq 1$ (4.21)

Kendala (4.21) menjelaskan bahwa harga dasar minimun yang diperlukan untuk layanan bernilai positif.

$0 \leq X_{11} \leq n_1$

$0 \leq X_{12} \leq n_1$

$0 \leq X_{21} \leq n_2$

$0 \leq X_{22} \leq n_2$ (4.22)

Kendala (4.22) menyatakan bahwa jumlah pengguna layanan tidak melebihi layanan yang telah ditetapkan.

$$PQ_{11} = \left(1 + \frac{x}{2000}\right) PB_{11} L_x$$

$$PQ_{12} = \left(1 + \frac{x}{2000}\right) PB_{12} L_x$$

$$PQ_{21} = \left(1 + \frac{x}{2000}\right) PB_{21} L_x$$

$$PQ_{22} = \left(1 + \frac{x}{2000}\right) PB_{22} L_x \qquad (4.23)$$

Kendala (4.23) dan kendala (4.31) menyatakan bahwa perubahan biaya sepanjang perubahan QoS tergantung pada biaya dasar untuk suatu koneksi yang digunakan oleh konsumen, jumlah kenaikan dan penurunan nilai QoS dan nilai nominal atribut QoS dalam jaringan operator.

$$PB_{11} = a_{11}(e - e^{-xB})\ {}^{T_l}\!/_{100}$$

$$PB_{12} = a_{12}(e - e^{-xB})\ {}^{T_l}\!/_{100}$$

$$PB_{21} = a_{21}(e - e^{-xB})\ {}^{T_l}\!/_{100}$$

$$PB_{22} = a_{22}(e - e^{-xB})\ {}^{T_l}\!/_{100} \qquad (4.24)$$

Kendala (4.24) menjelaskan bahwa biaya dasar untuk suatu koneksi oleh pengguna bergantung pada faktor biaya linier yang digunakan oleh pengguna, faktor kelinieritasan dan muatan trafik.

$$L_x = (e - e^{-xB}) \qquad (4.25)$$

Kendala (4.25) menyatakan bahwa faktor kelinieritasan bergantung pada jumlah kenaikan atau penurunan nilai QoS dan parameter linier yang ditetapkan.

$$0.05 \leq a_{11} \leq 0{,}15$$

$$0.06 \leq a_{12} \leq 0{,}14$$

$$0.07 \leq a_{21} \leq 0{,}13$$

$$0.08 \leq a_{22} \leq 0{,}12 \qquad (4.26)$$

Kendala (4.26) menyatakan bahwa batasan nilai a_{ij} telah ditetapkan.

$$50 \leq T_l \leq 1000 \qquad (4.27)$$

Kendala (4.27) menyatakan bahwa nilai muatan trafik telah ditetapkan pada rentang 50 sampai 1000.

$0 \leq x \leq 1$ (4.28)

Kendala (4.28) menjelaskan bahwa pasti ada jumlah kenaikan dan penurunan nilai QoS.

$0.8 \leq B \leq 1{,}07$ (4.29)

Kendala (4.29) menyatakan bahwa nilai parameter linier telah ditetapkan.

$a = 1$ (4.30)

Kendala (4.30) menyatakan bahwa ada biaya untuk melakukan koneksi dengan QoS yang tersedia.

PQ_{jk} naik, x turun

Dengan Fungsi Tujuan (4.1a) dilanjutkan dengan Kendala (4.2) sampai Kendala (4.22) dan menambahkan kendala baru,

$PQ_{11} = \left(1 - \frac{x}{2000}\right) PB_{11} L_x$

$PQ_{12} = \left(1 - \frac{x}{2000}\right) PB_{12} L_x$

$PQ_{21} = \left(1 - \frac{x}{2000}\right) PB_{21} L_x$

$PQ_{22} = \left(1 - \frac{x}{2000}\right) PB_{22} L_x$ (4.31)

kemudian dilanjutkan dengan Kendala (4.24) sampai Kendala (4.30).

PQ_{jk}turun, x naik

Dengan fungsi tujuan:

Maks $R = \sum_{i=1}^{2} \sum_{j=1}^{2} (P_j - B_j) X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2} \sum_{k=1}^{2} \left((PR_{jk} - PQ_{jk}\right) + \left(\alpha + \beta I_j\right) + P_{jk} X_{jk})$ (4.1b)

Dilanjutkan dengan Kendala (4.2) sampai Kendala (4.30)

PQ_{jk}turun, x turun

Dengan Fungsi Tujuan (4.1b) dilanjutkan dengan Kendala (4.2) sampai Kendala (4.22), diikuti dengan Kendala (4.31) dan dilanjutkan dengan Kendala (4.24) sampai Kendala (4.30).

Model kasus 2 (α Parameter dan β Variabel)

PQ_{jk}naik, x naik

Dengan fungsi tujuan:

$$Maks\ R = \sum_{i=1}^{2} \sum_{j=1}^{2} (P_j - B_j) X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2} \sum_{k=1}^{2} \left((PR_{jk} + PQ_{jk}) + (\alpha + \beta_j I_j) + P_{jk} X_{jk} \right) \quad (4.2a)$$

Dengan Kendala (4.2) sampai dengan Kendala (4.30) dan menambahkan kendala baru:

$$\beta_2 I_2 \geq \beta_1 I_1 \quad (4.32)$$

Kendala (4.32) menjelaskan bahwa kualitas premium untuk setiap layanan memiliki tingkat layanan yang berbeda meskipun pada tingkat kualitas premium yang sama atau lebih rendah.

$$I_1 \leq \beta_1 \leq b_1$$

$$I_2 \leq \beta_2 \leq b_2 \quad (4.33)$$

Kendala (4.33) menjelaskan bahwa nilai untuk kualitas premium setiap layanan telah ditetapkan.

PQ_{jk} naik, x turun

Dengan Fungsi Tujuan (4.2a) dilanjutkan dengan Kendala (4.2) sampai dengan Kendala (4.22), dan diikuti dengan Kendala (4.31) dan diakhiri dengan Kendala (4.24) sampai dengan Kendala (4.30) dan Kendala (4.32) sampai Kendala (4.33).

PQ_{jk}turun, x naik

Dengan fungsi tujuan:

$$\text{Maks}\quad R = \sum_{i=1}^{2} \sum_{j=1}^{2} (P_j - B_j) X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2} \sum_{k=1}^{2} \left((PR_{jk} - PQ_{jk}) + (\alpha + \beta_j I_j) + P_{jk} X_{jk} \right) \quad (4.2b)$$

Dilanjutkan dengan Kendala (4.2) sampai dengan Kendala (4.30), diikuti dengan Kendala (4.32) dan (4.33).

PQ_{jk} turun, x turun

Dengan Fungsi Tujuan (4.2b), dengan Kendala (4.2) sampai dengan Kendala (4.22) dilanjutkan dengan Kendala (4.31) dan Kendala (4.24) sampai dengan Kendala (4.30) dan diakhiri dengan Kendala (4.32) sampai Kendala (4.33).

Model Kasus 3 (α Variabel dan β Variabel)

PQ_{jk} naik dan x naik

Dengan fungsi tujuan:

Maks $R = \sum_{i=1}^{2} \sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2} \left((PR_{jk} + PQ_{jk}) + (\alpha_j + \beta_j I_j) + P_{jk}X_{jk}\right)$ (4.3a)

Dengan Kendala (4.2) sampai dengan Kendala (4.30), Kendala (4.32) dan Kendala (4.33) dan dengan menambakan kendala baru yaitu:

$\alpha_2 + \beta_2 I_2 \geq \alpha_1 + \beta_1 I_1$ (4.34)

Kendala (4.34) menjelaskan bahwa tingkat layanan yang diberikan untuk kualitas premium dan harga dasar untuk setiap layanan yang berbeda juga akan berbeda.

$c_1 \leq \alpha_1 \leq g_1$

$c_2 \leq \alpha_2 \leq g_2$ (4.35)

Kendala (4.35) menjelaskan bahwa harga dasar untuk setiap layanan telah ditetapkan pada rentang tertentu.

PQ_{jk} naik dan x turun

Dengan Fungsi Tujuan (4.3a) dan dengan Kendala (4.2) sampai dengan Kendala (4.22) dilanjutkan dengan Kendala (4.24) sampai dengan Kendala (4.35).

PQ_{jk} turun dan x naik

Dengan fungsi tujuan:

Maks $R = \sum_{i=1}^{2} \sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2} \left((PR_{jk} - PQ_{jk}) + (\alpha_j + \beta_j I_j) + P_{jk}X_{jk}\right)$ (4.3b)

Dengan Kendala (4.2) sampai dengan Kendala (4.30) dilanjutkan dengan Kendala (4.32) sampai dengan Kendala (4,35).

PQ_{jk} turun dan x turun

Dengan Fungsi Tujuan (4.3b) dan dengan Kendala (4.2) sampai dengan Kendala (4.22) dilanjutkan dengan Kendala (4.24) sampai dengan Kendala (4.35).

Model Kasus 4 (α Variabel dan β Parameter)

PQ_{jk} naik dan x naik

Dengan fungsi tujuan:

Maks $R = \sum_{i=1}^{2} \sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 -$

$$PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2} \left((PR_{jk} + PQ_{jk}\right) + \left(\alpha_j + \beta I_j\right) + P_{jk}X_{jk}) \quad (4.4a)$$

Dengan Kendala (4.2) sampai dengan Kendala (4.30) dilanjutkan dengan Kendala (4.34) sampai dengan Kendala (4.35), dan dengan menambahkan kendala baru:

$$\alpha_2 I_2 \geq \alpha_1 I_1 \quad (4.36)$$

Kendala (4.36) menyatakan bahwa tingkat layanan yang diberikan akan berbeda walaupun dengan harga dasar yang sama untuk setiap layanan.

PQ_{jk} naik dan x turun

Dengan Fungsi Tujuan (4.4a) dan dengan Kendala (4.2) sampai dengan Kendala (4.22) dilanjutkan dengan Kendala (4.24) sampai dengan Kendala (4.31) dan Kendala (4.34) sampai Kendala (4.36).

PQ_{jk} turun dan x naik

Dengan fungsi tujuan:

Maks $R = \sum_{i=1}^{2} \sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 -$

$$PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2} \left((PR_{jk} - PQ_{jk}\right) + \left(\alpha_j + \beta I_j\right) + P_{jk}X_{jk}) \quad (4.4b)$$

Dengan Kendala (4.2) sampai dengan Kendala (4.30) dilanjutkan dengan Kendala (4.34) sampai dengan Kendala (4.36).

PQ_{jk} turun dan x turun

Dengan Fungsi Tujuan (4.4b) dan dengan Kendala (4.2) sampai dengan Kendala (4.22) dilanjutkan dengan Kendala (4.24) sampai dengan Kendala (4.31) dan Kendala (4.34) sampai dengan Kendala (4.36).

Tabel 4.7 Solusi Optimal Model *Improved* Pembiayaan Insentif Internet dengan Data *Traffic Digilib* pada Kasus α dan β Sebagai Parameter (Skema Pembiayaan *Two Part Tariff*)

Solver Status	**Kasus α dan β Sebagai Parameter**			
	PQ_{ij} naik x naik	PQ_{ij} naik x turun	PQ_{ij} turun x naik	PQ_{ij} turun x turun
Model Class	MINLP	MINLP	MINLP	MINLP

State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1611,86	1611,83	1581	1581
Infeasibility	$7{,}7307 \times 10^{-13}$	$9{,}0949 \times 10^{-13}$	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$
Iterations	169	171	154	154
Extended Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1611,86	1611,83	1581	1581
Steps	0	0	0	0
Update Interval	2	2	2	2
GMU (K)	49	49	49	49
ER (Sec)	1	0	1	1

Tabel 4.8 Nilai-Nilai Variabel dengan kasus α dan β sebagai parameter pada Skema Pembiayaan *Two Part Tariff*

Variabel	***PQ_{ij}* naik *x* naik**	***PQ_{ij}* naik *x* turun**	***PQ_{ij}* turun *x* naik**	***PQ_{ij}* turun *x* turun**
P_1	1,1	1,1	2,335	2,335
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,1	0,1	0,1	0,1
X_2	0,1	0,1	0,1	0,1
Y_1	0,1	0,1	0,1	0,1
Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1
Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,150	0,150	0,050	0,050
a_{12}	0,140	0,140	0,060	0,060
a_{21}	0,130	0,130	0,070	0,070
a_{22}	0,120	0,120	0,080	0,080
Tl	1000	1000	50	50
I_1	1	1	1	1
I_2	0,5	0,5	0,01	0,01

Tabel 4.9 Solusi Optimal Model *improved* Pembiayaan Insentif Internet dengan Data *Traffic Digilib* pada Kasus α Sebagai Parameter dan β Sebagai Variabel (Skema Pembiayaan *Two Part Tariff*)

Solver Status	**Kasus α Sebagai Parameter dan β Sebagai Variabel**			
	PQ_{ij} naik x naik	PQ_{ij} naik x turun	PQ_{ij} turun x naik	PQ_{ij} turun x turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1463,36	1463,33	1432,5	1432,5
Infeasibility	$1{,}3641\times 10^{-13}$	$1{,}1368\times 10^{-13}$	$3{,}4284 \times 10^{-8}$	$3{,}4284 \times 10^{-8}$
Iterations	271	271	269	269
Extended Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1463,36	1463,33	1432,5	1432,5
Steps	0	0	0	0
Update Interval	2	2	2	2
GMU (K)	51	51	51	51
ER (Sec)	1	0	1	1

Tabel 4.10 Nilai-Nilai Variabel dengan kasus α sebagai parameter dan β sebagai variabel pada Skema Pembiayaan *Two Part Tariff*

Variabel	***PQ$_{ij}$* naik *x* naik**	***PQ$_{ij}$* naik *x* turun**	***PQ$_{ij}$* turun *x* naik**	***PQ$_{ij}$* turun *x* turun**
P_1	111,38	111,38	1,1	1,1
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,1	0,1	0,1	0,1
X_2	0,1	0,1	0,1	0,1
Y_1	0,1	0,1	0,1	0,1
Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1
Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718

a_{11}	0,150	0,150	0,050	0,050
a_{12}	0,140	0,140	0,060	0,060
a_{21}	0,130	0,130	0,070	0,070
a_{22}	0,120	0,120	0,080	0,080
β_1	0,5	0,5	0,5	0,5
β_2	0,5	0,5	0,5	0,5
Tl	1000	1000	50	50
I_1	0,01	0,01	0,01	0,01
I_2	0,01	0,01	0,01	0,01

Tabel 4.11 Solusi Optimal Model *improved* Pembiayaan Insentif Internet dengan Data *Traffic Digilib* pada Kasus α dan β Sebagai Variabel (Skema Pembiayaan *Flat Fee*)

Solver Status	**Kasus α dan β Sebagai Variabel**			
	PQ_{ij} naik x naik	PQ_{ij} naik x turun	PQ_{ij} turun x naik	PQ_{ij} turun x turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1773,36	1773,33	1702,5	1702,5
Infeasibility	$9{,}0955\times 10^{-14}$	$9{,}0955\times 10^{-14}$	$7{,}8225 \times 10^{-6}$	$7{,}8225 \times 10^{-6}$
Iterations	80	80	76	76
Extended Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1773,36	1773,33	1702,5	1702,5
Steps	0	0	1	1
Update Interval	2	2	2	2
GMU (K)	53	53	53	53
ER (Sec)	0	1	1	0

Tabel 4.12 Nilai-Nilai Variabel dengan kasus α dan β sebagai variabel pada Skema Pembiayaan *Flat Fee*

Variabel	***PQ$_{ij}$* naik** ***x* naik**	***PQ$_{ij}$* naik** ***x* turun**	***PQ$_{ij}$* turun** ***x* naik**	***PQ$_{ij}$* turun** ***x* turun**
P_1	0,1	0,1	1,1	1,1
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,1	0,1	0,1	0,1

X_2	0,1	0,1	0,1	0,1
Y_1	0,1	0,1	0,1	0,1
Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1
Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,150	0,150	0,050	0,050
a_{12}	0,140	0,140	0,060	0,060
a_{21}	0,130	0,130	0,070	0,070
a_{22}	0,120	0,120	0,080	0,080
α_1	1	1	1	1
α_2	1	1	1	1
β_1	0,5	0,5	0,5	0,5
β_2	0,5	0,5	0,5	0,5
Tl	1000	1000	50	50
I_1	0,01	0,01	0,01	0,01
I_2	0,01	0,01	0,01	0,01

Tabel 4.13 Solusi Optimal Model *improved* Pembiayaan Insentif Internet dengan Data *Traffic Digilib* pada Kasus α Sebagai Variabel dan β Sebagai Parameter (Skema Pembiayaan *Two Part Tariff*)

Solver Status	**Kasus α Sebagai Variabel dan β Sebagai Parameter**			
	PQ_{ij} naik x naik	PQ_{ij} naik x turun	PQ_{ij} turun x naik	PQ_{ij} turun x turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1733,36	1733,33	1702,5	1702,5
Infeasibility	$5{,}2266\times 10^{-5}$	$5{,}2266\times 10^{-5}$	$1{,}8758 \times 10^{-12}$	$1{,}8758 \times 10^{-12}$
Iterations	79	79	42	42
Extended Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*

Best Objective	1733,36	1733,33	1702,5	1702,5
Steps	1	1	0	0
Update Interval	2	2	2	2
GMU (K)	52	52	52	52
ER (Sec)	0	1	0	1

Tabel 4.14 Nilai-Nilai Variabel dengan kasus α sebagai variabel dan β sebagai parameter pada Skema Pembiayaan *Two Part Tariff*

Variabel	PQ_{ij} naik x naik	PQ_{ij} naik x turun	PQ_{ij} turun x naik	PQ_{ij} turun x turun
P_1	0,1	0,1	20,506	20,506
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,1	0,1	0,1	0,1
X_2	0,1	0,1	0,1	0,1
Y_1	0,1	0,1	0,1	0,1
Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1
Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,150	0,150	0,050	0,050
a_{12}	0,140	0,140	0,060	0,060
a_{21}	0,130	0,130	0,070	0,070
a_{22}	0,120	0,120	0,080	0,080
α_1	0	0	0	0

α_2	1	1	1	1
Tl	1000	1000	50	50
I_1	0,01	0,01	0,01	0,01
I_2	0,01	0,01	0,01	0,01

4.3.2 Model *Improved* Pembiayaan Insentif Internet dengan Data *Traffic Sisfo* Menggunakan Fungsi Utilitas Cobb-Douglas

Model Kasus 1 (α dan β sebagai parameter)

<u>PQ_{jk}naik dan *x* naik</u>

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 +$

$$\sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} + PQ_{jk}\right) + \left(\alpha + \beta I_j\right)P_{jk}X_{jk}\right) \quad (4.1c)$$

Berdasarkan Kendala (2.2.1) :

$S_1 \geq (R_{11} - P_1)Y_1$

$S_1 \geq (R_{12} - P_2)Y_2$

$S_2 \geq (R_{21} - P_1)Y_1$

$S_2 \geq (R_{22} - P_2)Y_2$ (4.1.1)

Berdasarkan Kendala (2.2.2) :

$S_1 = (R_{11} - P_1)X_{11} + (R_{12} - P_2)X_{12}$

$S_2 = (R_{21} - P_1)X_{21} + (R_{22} - P_2)X_{22}$ (4.1.2)

Berdasarkan Kendala (2.2.3) :

$R_{11} = V_{11}$

$R_{12} = V_{11} + V_{12}$

$R_{21} = V_{21}$

$R_{22} = V_{21} + V_{22}$ (4.1.3)

Berdasarkan Kendala (2.2.4) :

$(R_{11} - P_1)X_{11} \geq 0$

$(R_{12} - P_2)X_{12} \geq 0$

$(R_{21} - P_1)X_{21} \geq 0$

$(R_{22} - P_2)X_{22} \geq 0$ (4.1.4)

Berdasarkan Kendala (2.2.5) :

$(X_{11} + X_{12}) \leq 1$

$(X_{21} + X_{22}) \leq 1$ (4.1.5)

Berdasarkan Kendala (2.2.6) :

$X_{11} \leq Y_1$

$X_{21} \leq Y_1$

$X_{12} \leq Y_2$

$X_{22} \leq Y_2$ (4.1.6)

Berdasarkan Kendala (2.2.7) :

$S_1 \geq 0$

$S_2 \geq 0$ (4.1.7)

Berdasarkan Kendala (2.2.8) :

$P_1 \geq 0$

$P_2 \geq 0$ (4.1.8)

Berdasarkan Kendala (2.2.9) :

$X_{11}, X_{12}, X_{21}, X_{22} \in \{0,1\}$ (4.1.9)

Berdasarkan Kendala (2.2.10) :

$Y_{11}, Y_{12}, Y_{21}, Y_{22} \in \{0,1\}$ (4.1.10)

Berdasarkan Kendala (2.2.11) :

$I_1 d_{11}\, x_{11} \leq a_1\, C$

$I_1 d_{12}\, x_{12} \leq a_1\, C$

$I_2 d_{21}\, x_{21} \leq a_2\, C$

$I_2 d_{22}\, x_{22} \leq a_2\, C$ (4.1.11)

Berdasarkan Kendala (2.2.12) :

$I_1 d_{11}\, x_{11} + I_1 d_{12}\, x_{12} \leq a_1\, C$

$I_2 d_{21}\, x_{21} + I_2 d_{22}\, x_{22} \leq a_2\, C$ (4.1.12)

Berdasarkan Kendala (2.2.13) :

$a_1 + a_2 = 1$ (4.1.13)

Berdasarkan Kendala (2.2.14) :

$0 \leq a_1 \leq 1$

$0 \leq a_2 \leq 1$ (4.1.14)

Berdasarkan Kendala (2.2.15) :

$m_1 \leq I_1 \leq 1$

$m_2 \leq I_2 \leq 1$ (4.1.15)

Berdasarkan Kendala (2.2.16) :

$0 \leq x_{11} \leq n_1$

$0 \leq x_{12} \leq n_1$

$0 \leq x_{21} \leq n_2$

$0 \leq x_{22} \leq n_2$ (4.1.16)

Berdasarkan Kendala (2.2.17) :

$X_1 \leq \bar{X}_1 Z_1$

$X_2 \leq \bar{X}_2 Z_2$ (4.1.17)

Berdasarkan Kendala (2.2.18) :

$Y_1 \leq \bar{Y}_1 Z_1$

$Y_2 \leq \bar{Y}_2 Z_2$ (4.1.18)

Berdasarkan Kendala (2.2.19) :

$X_1{}^4 Y_1{}^3 + X_2{}^3 Y_2{}^2 - P_x X_1 - P_x X_2 - P_y Y_1 - P_y Y_2 - PZ_1 - PZ_2 \geq 0$ (4.1.19)

Berdasarkan Kendala (2.2.20) :

$Z_1 > 0{,}1$

$Z_2 > 0{,}1$ (4.1.20)

Berdasarkan Kendala (2.2.21) :

$PB_{11} = a_{11}(e - e^{-xB})T_l/100$

$PB_{12} = a_{12}(e - e^{-xB})T_l/100$

$PB_{21} = a_{21}(e - e^{-xB})T_l/100$

$PB_{22} = a_{22}(e - e^{-xB})T_l\,/100$ (4.1.21)

Berdasarkan Kendala (2.2.22) :

$Lx = a(e - e^{-xB})$ (4.1.22)

Berdasarkan Kendala (2.2.23) :

$0{,}05 \leq a_{11} \leq 0{,}15$

$0{,}06 \leq a_{12} \leq 0{,}14$

$0{,}07 \leq a_{21} \leq 0{,}13$

$0{,}08 \leq a_{22} \leq 0{,}12$ (4.1.23)

Berdasarkan Kendala (2.2.24) :

$50 \leq T_l \leq 1000$ (4.1.24)

Berdasarkan Kendala (2.2.25) :

$0 \leq x \leq 1$ (4.1.25)

Berdasarkan Kendala (2.2.26) :

$0{,}8 \leq B \leq 1{,}07$ (4.1.26)

Berdasarkan Kendala (2.2.27) :

$a = 1$ (4.1.27)

Berdasarkan Kendala (2.2.28) :

$PQ_{11} = (1 + \frac{x}{2000})\ PB_{11}Lx$

$PQ_{12} = (1 + \frac{x}{2000})\ PB_{12}Lx$

$PQ_{21} = (1 + \frac{x}{2000})\ PB_{21}Lx$

$PQ_{22} = (1 + \frac{x}{2000})\ PB_{22}Lx$ (4.1.28)

PQ_{jk} naik dan x turun

Dengan Fungsi Tujuan (4.1c) dan mengikuti Kendala (4.1.1) sampai Kendala (4.1.27) lalu menambahkan kendala baru:

$PQ_{11} = (1 - \frac{x}{2000})\ PB_{11}Lx$

$PQ_{12} = (1 - \frac{x}{2000})\ PB_{12}Lx$

$PQ_{21} = (1 - \frac{x}{2000})\ PB_{21}Lx$

$PQ_{22} = (1 - \frac{x}{2000})\ PB_{22}Lx$ (4.1.29)

PQ_{jk} turun dan x naik

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} - PQ_{jk}\right) + (\alpha + \beta I_j)P_{jk}X_{jk}\right)$ (4.1d)

Dengan mengikuti Kendala (4.1.1) sampai Kendala (4.1.28).

PQ_{jk} turun dan x turun

Dengan Fungsi Tujuan (4.1d) dilanjutkan dengan mengikuti Kendala (4.1.1) sampai Kendala (4.1.27) dan dilanjutkan dengan Kendala (4.1.29).

Setelah menetapkan model kombinasi, maka tambahkan kendala 3 skema pembiayaan, yaitu *flat fee*, *usage based*, *two part tariff*.

Jika skema pembiayaannya *Flat fee* ditambahkan kendala :

$P_x = 0$

$P_y = 0$

$P > 0$ (4.1.30)

Jika skema pembiayaannya *Usage based* ditambahkan kendala :

$P_x > 0$

$P_y > 0$

$P = 0$ (4.1.31)

Jika skema pembiayaannya *Two part tariff* ditambahkan kendala :

$P_x > 0$

$P_y > 0$

$P > 0$ (4.1.32)

Model Kasus 2 (α Sebagai Parameter dan β Sebagai Variabel)

***PQ_{jk}* naik dan *x* naik**

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} + PQ_{jk}\right) + \left(\alpha + \beta_j I_j\right)P_{jk}X_{jk}\right)$ (4.2c)

Dengan Kendala (4.1.1) sampai Kendala (4.1.28) lalu menambahkan Kendala (4.1.30) sampai Kendala (4.1.32) dan menambahkan kendala baru :

$\beta_2 I_2 \geq \beta_1 I_1$ (4.1.33)

$I_1 \leq \beta_1 \leq b_1$

$I_2 \leq \beta_2 \leq b_2$ (4.1.34)

***PQ_{jk}* naik dan *x* turun**

Dengan Fungsi Tujuan (4.2c) dilanjutkan dengan menambahkan Kendala (4.1.1) sampai Kendala (4.1.27) lalu menambahkan Kendala (4.1.29) sampai Kendala (4.1.34).

***PQ_{jk}* turun dan *x* naik**

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} - PQ_{jk}\right) + \left(\alpha + \beta_jI_j\right)P_{jk}X_{jk}\right)$ (4.2d)

Dengan Kendala (4.1.1) sampai Kendala (4.1.28) dan menambahkan Kendala (4.1.30) sampai Kendala (4.1.34).

***PQ_{jk}* turun dan *x* turun**

Dengan Fungsi Tujuan (4.2d) dilanjutkan dengan mengikuti Kendala (4.1.1) sampai Kendala (4.1.27) dilanjutkan dengan Kendala (4.1.29) sampai Kendala (4.1.34).

Berikut adalah penjelasan dari Kendala (4.1.33) sampai Kendala (4.1.34) :

1. Kendala (4.1.33) menyatakan bahwa kualitas premium memiliki tingkat yang berbeda untuk setiap layanan setidaknya pada tingkat yang sama ataupun tingkat yang lebih rendah.
2. Kendala (4.1.34) menjelaskan bahwa harga nilai kualitas premium berada diantara rentang nilai yang telah ditentukan.

Model Kasus 3 (α dan β Sebagai Variabel)

***PQ_{jk}* naik dan *x* naik**

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} + PQ_{jk}\right) + \left(\alpha_j + \beta_jI_j\right)P_{jk}X_{jk}\right)$ (4.3c)

Dengan Kendala (4.1.1) sampai Kendala (4.1.28) lalu menambahkan Kendala (4.1.30) sampai Kendala (4.1.34) dan menambahkan kendala baru :

$\alpha_2 + \beta_2I_2 \geq \alpha_1 + \beta_1I_1$ (4.1.35)

$c_1 \leq \beta_1 \leq g_1$

$c_2 \leq \beta_2 \leq g_2$ (4.1.36)

***PQ_{jk}* naik dan *x* turun**

Dengan Fungsi Tujuan (4.3c) dilanjutkan dengan menambahkan Kendala (4.1.1) sampai Kendala (4.1.27) lalu menambahkan Kendala (4.1.29) sampai Kendala (4.1.36).

***PQ_{jk}* turun dan *x* naik**

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - Y_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} - PQ_{jk}\right) + \left(\alpha_j + \beta_jI_j\right)P_{jk}X_{jk}\right)$ (4.3d)

Dengan Kendala (4.1.1) sampai Kendala (4.1.28) lalu menambahkan Kendala (4.1.30) sampai Kendala (4.1.36).

***PQ_{jk}* turun dan *x* turun**

Dengan Fungsi Tujuan (4.3d) dilanjutkan dengan menambahkan Kendala (4.1.1) sampai Kendala (4.1.27) lalu menambahkan Kendala (4.1.29) sampai Kendala (4.1.36).

Berikut adalah penjelasan dari Kendala (4.1.35) sampai Kendala (4.1.36):

1. Kendala (4.1.35) menyatakan bahwa nilai harga dasar dan kualitas premium setidaknya berada pada tingkat yang sama ataupun tingkat yang lebih rendah untuk setiap layanan.
2. Kendala (4.1.36) menyatakan bahwa nilai harga dasar berada diantara rentang nilai yang telah ditentukan.

Model Kasus 4 (α Sebagai Variabel dan β Sebagai Parameter)

***PQ_{jk}* naik dan *x* naik**

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 + \sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} + PQ_{jk}\right) + \left(\alpha_j + \beta I_j\right)P_{jk}X_{jk}\right)$ (4.4c)

Dengan Kendala (4.1.1) sampai Kendala (4.1.28) lalu menambahkan Kendala (4.1.30) sampai Kendala (4.1.32) serta Kendala (4.1.36) dan menambahkan kendala baru :

$\alpha_2 I_2 \geq \alpha_1 I_1$ (4.1.37)

***PQ_{jk}* naik dan *x* turun**

Dengan Fungsi Tujuan (4.4c) dilanjutkan dengan menambahkan Kendala (4.1.1) sampai Kendala (4.1.27) lalu menambahkan Kendala (4.1.29) sampai Kendala (4.1.32) serta menambahkan Kendala (4.1.36) sampai Kendala (4.1.37).

***PQ_{jk}*turun dan *x* naik**

Maks $R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 - \sum_{j=1}^{2}\sum_{k=1}^{2}\left(\left(PR_{jk} + PQ_{jk}\right) + \left(\alpha_j + \beta I_j\right)P_{jk}X_{jk}\right)$ (4.4d)

Dengan Kendala (4.1.1) sampai Kendala (4.1.28) lalu menambahkan Kendala (4.1.30) sampai Kendala (4.1.32) serta menambahkan Kendala (4.1.36) sampai Kendala (4.1.37).

***PQ_{jk}*turun dan *x* turun**

Dengan Fungsi Tujuan (4.4d) dilanjutkan dengan menambahkan Kendala (4.1.1) sampai Kendala (4.1.27) lalu menambahkan Kendala (4.1.29) sampai Kendala (4.1.32) serta menambahkan Kendala (4.1.36) sampai Kendala (4.1.37).

Kendala (4.1.37) menjelaskan bahwa harga dasar setidaknya bernilai sama ataupun lebih rendah untuk setiap layanan.

Tabel 4.15 Solusi Optimal Model *Improved* Pembiayaan Insentif Internet dengan α dan β Sebagai Parameter pada Data *Traffic Sisfo* (Skema Pembiayaan *Usage Based*)

Solver Status	**Kasus α dan β Sebagai Parameter**			
	PQ_{jk}naik $x$naik	PQ_{jk}naik $x$turun	PQ_{jk}turun $x$naik	PQ_{jk} turun $x$turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1612,133	1612,103	1581,268	1581,268
Infeasibility	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$
Iterations	515	529	458	458
Extender Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1612,133	1612,103	1581,268	1581,268
Steps	9	9	9	9
Update interval	2	2	2	2
GMU (K)	50	50	50	50
ER (Sec)	0	0	0	0

Tabel 4.16 Nilai-Nilai Variabel dengan Kasus α dan β Sebagai Parameter pada Skema Pembiayaan *Usage Based*

Variabel	**PQ_{jk} naik x naik**	**PQ_{jk}naik x turun**	**PQ_{jk} turun x naik**	**PQ_{jk} turun x turun**
P_1	1,1	1,1	1,1	1,1
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,881	0,881	0,881	0,881
X_2	0,1	0,1	0,1	0,1
Y_1	0,661	0,661	0,661	0,661

Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1
Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,15	0,15	0,05	0,05
a_{12}	0,14	0,14	0,06	0,06
a_{21}	0,13	0,13	0,07	0,07
a_{22}	0,12	0,12	0,08	0,08
T_l	1000	1000	50	50
I_1	1	1	1	1
I_2	0,01	0,01	0,01	0,01

Tabel 4.17 Solusi Optimal Model *Improved* Pembiayaan Insentif Internet dengan Kasus α Sebagai Parameter dan β Sebagai Variabel pada Data *Traffic Sisfo (*Skema Pembiayaan *Usage Based*)

Solver Status	**Kasus α sebagai parameter dan β sebagai variabel**			
	PQ_{jk}naik $x$naik	PQ_{jk}naik $x$turun	PQ_{jk}turun $x$naik	PQ_{jk} turun $x$turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1463,633	1463,603	1432,768	1432,768
Infeasibility	9,0955× 10^{-14}	9,0955× 10^{-14}	9,0955× 10^{-14}	9,0955× 10^{-14}
Iterations	101	102	87	87
Extender Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1463,633	1463,951	1432,768	1432,768
Steps	2	2	2	2
Update interval	2	2	2	2
GMU (K)	51	51	51	51

ER (Sec)	0	0	0	0

Tabel 4.18 Nilai-Nilai Variabel pada Kasus α Sebagai Parameter dan β Sebagai Variabel pada Skema Pembiayaan *Usage Based*

Variabel	PQ_{jk} naik x naik	PQ_{jk} naik x turun	PQ_{jk} turun x naik	PQ_{jk} turun x turun
P_1	1,1	1,1	1,1	1,1
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,881	0,881	0,881	0,881
X_2	0,1	0,1	0,1	0,1
Y_1	0,661	0,661	0,661	0,661
Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1
Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,15	0,15	0,05	0,05
a_{12}	0,14	0,14	0,06	0,06
a_{21}	0,13	0,13	0,07	0,07
a_{22}	0,12	0,12	0,08	0,08
T_l	1000	1000	50	50
β_1	0,5	0,5	0,5	0,5
β_2	0,5	0,5	0,5	0,5

Tabel 4.19 Solusi Optimal Model *Improved* Pembiayaan Insentif Internet dengan Kasus α dan β Sebagai Variabel pada Data *Traffic Sisfo* (Skema Pembiayaan *Usage Based*)

Solver Status	**Kasus α dan β Sebagai Variabel**			
	PQ_{jk} naik x naik	PQ_{jk} naik x turun	PQ_{jk} turun x naik	PQ_{jk} turun x turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1733,633	1733,603	1702,768	1702,768
Infeasibility	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$
Iterations	108	105	95	95
Extender Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1733,633	1733,603	1702,768	1702,768
Steps	2	2	2	2
Update interval	2	2	2	2
GMU (K)	53	53	53	53
ER (Sec)	0	0	0	0

Tabel 4.20 Nilai-Nilai Variabel pada Kasus α dan β Sebagai Variabel pada Skema Pembiayaan *Usage Based*

Variabel	**PQ_{jk} naik x naik**	**PQ_{jk} naik x turun**	**PQ_{jk} turun x naik**	**PQ_{jk} turun x turun**
P_1	1,1	1,1	1,102	1,102
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,881	0,881	0,881	0,881
X_2	0,1	0,1	0,1	0,1
Y_1	0,661	0,661	0,661	0,661
Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1

Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,15	0,15	0,05	0,05
a_{12}	0,14	0,14	0,06	0,06
a_{21}	0,13	0,13	0,07	0,07
a_{22}	0,12	0,12	0,08	0,08
T_l	1000	1000	50	50
α_1	1	1	1	1
α_2	1	1	1	1
β_1	0,5	0,5	0,5	0,5
β_2	0,5	0,5	0,5	0,5

Tabel 4.21 Solusi Optimal Model *Improved* Pembiayaan Insentif Internet dengan Kasus α Sebagai Variabel dan β Sebagai Parameter pada Data *Traffic Sisfo* (Skema Pembiayaan *Usage Based*)

Solver Status	**Kasus α sebagai Variabel dan β Sebagai Parameter**			
	PQ_{jk}naik $x$naik	PQ_{jk}naik $x$turun	PQ_{jk}turun $x$naik	PQ_{jk} turun $x$turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1733,633	1733,603	1702,768	1702,768
Infeasibility	$9{,}0955 \times 10^{-14}$	$1{,}13687 \times 10^{-13}$	$9{,}0955 \times 10^{-14}$	$9{,}\ 0955 \times 10^{-14}$
Iterations	136	143	93	93
Extender Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1733,633	1733,603	1702,768	1702,768
Steps	0	0	0	0
Update interval	2	2	2	2

GMU (K)	52	52	52	52
ER (Sec)	0	0	0	0

Tabel 4.22 Nilai-Nilai Variabel pada KasusαSebagai Variabel dan $\boldsymbol{\beta}$ Sebagai Parameter pada Skema Pembiayaan *Usage Based*

Variabel	$\boldsymbol{PQ_{jk}}$ **naik** $\boldsymbol{x}$ **naik**	$\boldsymbol{PQ_{jk}}$ **naik** $\boldsymbol{x}$ **turun**	$\boldsymbol{PQ_{jk}}$ **turun** $\boldsymbol{x}$ **naik**	$\boldsymbol{PQ_{jk}}$ **turun** $\boldsymbol{x}$ **turun**
P_1	1,1	1,1	1,1	1,1
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X_1	0,881	0,881	0,881	0,881
X_2	0,1	0,1	0,1	0,1
Y_1	0,661	0,661	0,661	0,661
Y_2	0,1	0,1	0,1	0,1
Z_1	1	1	1	1
Z_2	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,15	0,15	0,05	0,05
a_{12}	0,14	0,14	0,06	0,06
a_{21}	0,13	0,13	0,07	0,07
a_{22}	0,12	0,12	0,08	0,08
T_l	1000	1000	50	50
α_1	1	1	1	1
α_2	1	1	1	1

4.4 Solusi Model Pembiayaan Intensif Internet

4.4.1 Solusi Model Pembiayaan Insentif Internet pada Data *Traffic Digilib* Menggunakan Fungsi Utilitas Quasi Linier

Pada penelitian sebelumnya yang dilakukan oleh Puspita et al (2020) diperoleh solusi optimal dari model pembiayaan insentif, dengan fungsi tujuan:

$$\text{Maks} R_1 = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)\, X_{ij} - \sum_{j=1}^{2} MY_j - (4X + Y^3) + P_X X + P_Y Y + PZ \sum_{i=1}^{2}\sum_{j=1}^{2}\Big((PR_{ij} + PQ_{ij}) + (\alpha + \beta I_i) P_{ij} X_{ij}\Big) \qquad (4.5)$$

Pada Subbab 4.3.2 yaitu kasus 1 PQ_{ij} naik x naik, dan dengan kendala yang ditentukan, sehingga diperoleh solusi sebagai berikut:

Tabel 4.23 Solusi Model Pembiayaan Insentif Internet pada Skema Pembiayaan *Flat fee*

Solver Status	**Subkasus**			
	PQ_{ij} naik x naik	**PQ_{ij} naik x turun**	**PQ_{ij} turun x naik**	**PQ_{ij} turun x turun**
Model Class	MINLP	MINLP	MINLP	MINLP
State	Local Optimal	Local Optimal	Local Optimal	Local Optimal
Objective	814,93	814,89	782,19	782,19
Infeasibility	$1{,}18157 \times 10^{-4}$	$1{,}18157 \times 10^{-4}$	$4{,}0573 \times 10^{-5}$	$4{,}0573 \times 10^{-5}$
Iterations	629	631	544	544
Extended Solver Status				
Best Objective	814,93	814,89	782,19	782,19
Steps	19	19	16	16
Update Interval	2	2	2	2
GMU (K)	47	47	47	47
ER (Sec)	1	1	1	1

Tabel 4.24 Nilai - Nilai Variabel pada Skema Pembiayaan *Flat Fee*

Variabel	**PQ_{ik} naik x naik**	**PQ_{ik} naik x turun**	**PQ_{ik} turun x naik**	**PQ_{ik} turun x turun**
PQ_{11}	8,467116	8,458654	0	0
PQ_{12}	8,467116	8,458654	0	0
PQ_{21}	7,902642	7,894743	0	0
PQ_{22}	7,902642	7,894743	0	0
PB_{11}	3,562910	3,562910	0	0
PB_{12}	3,562910	3,562910	0	0
PB_{21}	3,325383	3,325383	0	0
PB_{22}	3,325383	3,325383	0	0
a_{11}	0,15	0,15	0,05	0,05

a_{12}	0,15	0,15	0,05	0,05
a_{21}	0,14	0,14	0,06	0,06
a_{22}	0,14	0,14	0,06	0,06
I_1	1	1	1	1
I_2	0,01	0,01	0,01	0,01
T_L	1000	1000	0	0
Lx	2,375273	2,375273	1,718282	1,718282
X	1	1	0	0
B	1,07	1,07	0,8	0,8
P_1	0,01	0,01	0,01	0,01
P_2	1299,99	1299,99	1299,99	1299,99
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
y_1	0	0	0	0
y_2	1	1	1	1
S_1	0,01	0,01	0,01	0,01
S_2	200.01	200,01	200,01	200,01
X_1	0,72	0,72	0,72	0,72
Y_1	0,57	0,57	0,57	0,57
Z	1	1	1	1

4.4.2 Solusi Model Pembiayaan Insentif Internet pada Data *Traffic Sisfo* menggunakan Fungsi Utilitas Cobb-Douglas

Dengan menggunakan model pada persamaan (2.2) dilanjutkan Kendala (2.2.1) sampai Kendala (2.2.28) serta mensubstitusikan nilai-nilai parameter pada Tabel 4.6. Maka, diperoleh solusi Model Pembiayaan Insentif Internet yang ditunjukkan pada Tabel 4.25 dan nilai variabel yang ditunjukkan pada Tabel 4.58

Tabel 4.25 Solusi Model Pembiayaan Insentif Internet dengan Data *Traffic Sisfo*

Solver Status	**Subkasus**			
	PQ_{jk}naik $x$naik	PQ_{jk}naik $x$turun	PQ_{jk}turun $x$naik	PQ_{jk} turun $x$turun
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1612,282	1612,251	1581,416	1581,416
Infeasibility	$5{,}77095\times 10^{-7}$	$5{,}79547\times 10^{-7}$	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$
Iterations	412	412	418	418
Extender Solver Status				

Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1612,282	1612,251	1581,416	1581,416
Steps	9	9	10	10
Update interval	2	2	2	2
GMU (K)	46	46	46	46
ER (Sec)	0	0	0	0

Tabel 4.26 Nilai-Nilai Variabel yang diperoleh dari Model Pembiayaan Insentif Internet

Variabel	PQ_{jk} **naik** x **naik**	PQ_{jk} **naik** x **turun**	PQ_{jk}**turun** x **naik**	PQ_{jk} **turun** x **turun**
P_1	2,334	2,334	1,1	1,1
P_2	1299,9	1299,9	1299,9	1299,9
S_1	0,1	0,1	0,1	0,1
S_2	200,1	200,1	200,1	200,1
X_{11}	0	0	0	0
X_{12}	1	1	1	1
X_{21}	0	0	0	0
X_{22}	1	1	1	1
X	1,356	1,356	0,671	0,671
Y	0,309	0,309	0,790	0,790
Z	1	1	1	1
PQ_{11}	8,467	8,459	0,074	0,074
PQ_{12}	7,903	7,895	0,089	0,089
PQ_{21}	7,338	7,331	0,103	0,103
PQ_{22}	6,774	6,767	0,118	0,118
PB_{11}	3,563	3,563	0,043	0,043
PB_{12}	3,325	3,325	0,052	0,052
PB_{21}	3,088	3,088	0,060	0,060
PB_{22}	2,850	2,850	0,069	0,069
Lx	2,375	2,375	1,718	1,718
a_{11}	0,15	0,15	0,05	0,05
a_{12}	0,14	0,14	0,06	0,06
a_{21}	0,13	0,13	0,07	0,07
a_{22}	0,12	0,12	0,08	0,08
T_l	1000	1000	50	50
I_1	1	1	1	1
I_2	0,01	0,01	0,01	0,01

4.5 Perbandingan Solusi Optimal pada Setiap Kasus

Setelah memperoleh solusi optimal dari masing-masing subkasus, maka dilakukan perbandingan untuk menperoleh solusi optimal pada *improved* pembiayaan insentif internet yang akan ditunjukkan pada Tabel 4.27.

Tabel 4.27 Perbandingan Solusi Optimal pada Setiap Kasus pada Data *Traffic Digilib* Menggunakan Fungsi Utilitas Quasi Linier

Solver Status	**Model**			
	Kasus α dan β sebagai parameter (*two part tariff*)	**Kasus α sebagai parameter dan β sebagai variabel (*two part tariff*)**	**Kasus α dan β sebagai variabel (*flat fee*)**	**Kasus α sebagai variabel dan β sebagai parameter (*two part tariff*)**
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1611,86	1463,36	1733,36	1733,36
Infeasibility	$7{,}7307\times 10^{-13}$	$1{,}3641\times 10^{-13}$	$9{,}0955\times 10^{-14}$	$5{,}2266\times 10^{-5}$
Iterations	169	271	80	79
Extended Solver Status				
Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1611,86	1463,36	1733,36	1733,36
Steps	0	0	0	0
Update interval	2	2	2	2
GMU (K)	49	51	53	52
ER (Sec)	1	0	0	0

Tabel 4.28 Perbandingan Solusi Optimal pada Setiap Kasus pada Data *Traffic Digilib* Menggunakan Fungsi Utilitas Quasi Linier

Solver Status	**Model**			
	Kasus α dan β sebagai parameter	**Kasus αsebagai parameter dan β sebagai variabel**	**Kasus α dan β sebagai variabel**	**Kasus α sebagai variabel dan β sebagai parameter**
Model Class	MINLP	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	1612,133	1463,633	1733,633	1733,633
Infeasibility	$9{,}0955 \times 10^{-14}$	$9{,}0955\times 10^{-14}$	$9{,}0955 \times 10^{-14}$	$9{,}0955 \times 10^{-14}$
Iterations	515	101	108	136
Extender Solver Status				

Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	1612,133	1463,633	1733,633	1733,633
Steps	9	2	2	0
Update interval	2	2	2	2
GMU (K)	50	51	53	52
ER (Sec)	0	0	0	0

4.6 Perbandingan Solusi Optimal pada Model Pembiayaan Insentif dengan Model *improved* Pembiayaan Insentif

Untuk memperoleh hasil yang optimal pada pembiayaan insentif internet maka dilakukan perbandingan solusi optimal antara model pembiayaan insentif dengan model *improved* pembiayaan insentif. Tabel 4.29 berikut menyajikan perbandingan solusi optimal.

Tabel 4.29 Perbandingan antara Solusi Optimal Model Pembiayaan Insentif dengan Solusi Optimal Model *Improved* Pembiayaan Insentif Internet pada Data *Traffic Digilib* Menggunakan Fungsi Utilitas Quasi Linier

Solver Status	**Data**	
	Model Pembiayaan Insentif (Tabel 4.30)	**Model *Improved* Pembiayaan Insentif (Tabel 4.18)**
Model Class	MINLP	MINLP
State	Local Optimal	Local Optimal
Objective	814,93	1733,36
Infeasibiliy	$1{,}18157 \times 10^{-4}$	$5{,}2266\times 10^{-5}$
Iterations	629	79
Extended Solver Status		
Best Objective	814,93	1733,36
Steps	19	0
Update Interval	2	2
GMU (K)	47	52
ER (Sec)	1	0

Tabel 4.30 Perbandingan antara Solusi Optimal Model Pembiayaan Insentif dengan Solusi Optimal Model *Improved* Pembiayaan Insentif Internet pada Data *Traffic Sisfo* Menggunakan Fungsi Utilitas Cobb-Douglas

Solver Status	**Model**	
	Improved pembiayaan insentif internet	Pembiayaan insentif internet

Model Class	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*
Objective	1733,633	1612,282
Infeasibility	$9{,}0955 \times 10^{-14}$	$5{,}77095 \times 10^{-7}$
Iterations	108	412
Extender Solver Status		
Solver Type	*Branch and Bound*	*Branch and Bound*
Best Objective	1733,633	1612,282
Steps	2	9
Update interval	2	2
GMU (K)	53	46
ER (Sec)	0	0

4.7 Nilai Insentif yang Diperoleh Konsumen

Nilai insentif diperoleh konsumen dari hasil kombinasi model *bundling* (2.4.1), konsumen heterogen (2.4.3), fungsi utilitas Quasi Linier (2.4.4), dengan Kendala (2.1.1) sampai Kendala (2.1.10), dilanjutkan dengan Kendala (2.1.17) sampai Kendala (2.1.20), serta dengan tiga skema pembiayaan yaitu *flat fee*, *usage based*, dan *two part tariff*, dengan mensubstitusikan nilai parameter pada Tabel 4.2.

a. Bentuk umum nilai insentif yang diperoleh konsumen pada data *traffic digilib* menggunakan fungsi utilitas quasi linier:

Maks $R = \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_1 - PZ_1 - PZ_2$ (4.8a)

Dengan Kendala (4.2) sampai Kendala (4.16).

Tabel 4.31 Solusi Model Nilai Insentif yang Diperoleh Konsumen pada Data *Traffic Digilib* Menggunakan Fungsi Utilitas Quasi Linier

Untuk memperoleh solusi dari model ini, digunakan *software* LINGO 13.0. Tabel 4.71 ini akan menunjukkan solusi optimal nilai insentif internet.

Solver Status	**Model**		
	$Flat\ fee$	$Usage\ based$	$Two\ part\ tariff$
Model Class	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	398,98	399,297	398,88
Infeasibility	$1{,}9099\times 10^{-11}$	0	0
Iterations	22	25	26
Extended Solver Status			

Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	398,98	399,297	398,88
Steps	0	0	0
Update interval	2	2	2
GMU (K)	29	29	29
ER (Sec)	0	0	0

Tabel 4.32 Nilai Variabel Solusi Model Nilai Insentif yang Diperoleh Konsumen

Variabel	***Flat fee***	***Usage based***	***Two part tariff***
P_1	1,3213	1.166	1.2189
P_2	1,1396	1,113	1,1236
S_1	1298,86	1298,887	1298,876
S_2	1498,86	1498,887	1498,876
X_1	0,1	0,1138	0,1828
X_2	0,1	0,1	0,1
Y_1	0,4582	0,1	0,1
Y_2	0,1	0,1	0,1
Z_1	1	1	1
Z_2	1	1	1

b. Bentuk umum nilai insentif yang diperoleh konsumen pada data *traffic sisfo* menggunakan fungsi utilitas cobb-douglas:

Maks$R = \sum_{j=1}^{2} MY_j - X_1^4 Y_1^3 - X_2^3 Y_2^2 - P_x X_1 - P_x X_2 - P_y Y_1 - P_y Y_2 - PZ_1 - PZ_2$ (4.8b)

Dengan Kendala (4.1.1) sampai Kendala (4.1.10) dilanjutkan Kendala (4.1.17) sampai Kendala (4.1.20) serta Kendala (4.1.30) sampai Kendala (4.1.32).

Tabel 4.33 Solusi ModelNilai Insentif yang diperoleh Konsumen pada Data *Traffic Sisfo* Menggunakan Fungsi Utilitas Cobb-Douglas

Solver Status	**Model**		
	$Flat\ fee$	$Usage\ based$	$Two\ part\ tariff$
Model Class	MINLP	MINLP	MINLP
State	*Local Optimal*	*Local Optimal*	*Local Optimal*
Objective	399,6	399,652	399,213
Infeasibility	0	0	0
Iterations	23	38	37
Extender Solver Status			

Solver Type	*Branch and Bound*	*Branch and Bound*	*Branch and Bound*
Best Objective	399,6	399,652	399,213
Steps	0	0	0
Update interval	2	2	2
GMU (K)	29	29	29
ER (Sec)	0	0	0

Tabel 4.34 Nilai Variabel Solusi ModelNilai Insentif yang diperoleh Konsumen

Variabel	***Flat fee***	***Usage based***	***Two part tariff***
P_1	1,166	0,1	0,1
P_2	1,113	2,435	1,584
S_1	1298,887	1297,565	1298,416
S_2	1498,887	1297,565	1298,416
X_1	0,622	0,881	0,990
X_2	0,1	0,1	0,1
Y_1	1,1	0,661	0,743
Y_2	0,1	0,1	0,1
Z_1	1	1	1
Z_2	1	1	1

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Title		*The updated improved internet incentive-pricing scheme based on consumer preference on Cobb-Douglas utility functior*
Abstract		Internet incentive-pricing is established to optimize the price of internet services in the internet pricing scheme. This study involves a new updated heterogeneous consumer preference-pricing model based on the desire to pay. The increasing need for consumers to get the best internet service and market competition in creating the best internet service are the basis for this research. This study aims to obtain updated models and solutions for improved internet incentive-pricing models based on a combination of bundling, Cobb Douglas utility functions, high-end and low-end consumers, and reverse charging as well as usage-based pricing scheme. In this model, the solution of optimal updated results as numerical example shows that where the base price as a variable and quality premium as a parameter with a usage based pricing scheme, when 〖PQ〗_ij as the amount of changes of price along with QoS change, increases and x as the amount of QoS value, increases with the incentive value obtained of IDR 270 / kbps is obtained. With the results display, it shows that the ISP gets the maximum benefit from the updated improved incentive-pricing model.
Keywords		Incentive; Bundling; Reverse Charging; Cobb-Douglas utility
Topics		Computer networks; Computing & Communications
Status		Pending (no manuscript)
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The updated improved internet incentive-pricing scheme based on consumer preference on Cobb-Douglas utility function

Fitri Maya Puspita, Felia Apriyanti Silalahi, Sugandi Yahdin, Yusuf Hartono
Department of Mathematics, Faculty of Mathematics and Natural Sciences, Sriwijaya University, Indonesia

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ABSTRACT

Internet incentive-pricing is established to optimize the price of internet services in the internet pricing scheme. This study involves a new updated heterogeneous consumer preference-pricing model based on the desire to pay. The increasing need for consumers to get the best internet service and market competition in creating the best internet service are the basis for this research. This study aims to obtain updated models and solutions for improved internet incentive-pricing models based on a combination of bundling, Cobb Douglas utility functions, high-end and low-end consumers, and reverse charging as well as usage-based pricing scheme. In this model, the solution of optimal updated results as numerical example shows that where the base price as a variable and quality premium as a parameter with a usage based pricing scheme, when PQ_{ij} as the amount of changes of price along with QoS change, increases and x as the amount of QoS value, increases with the incentive value obtained of IDR 270 / kbps is obtained. With the results display, it shows that the ISP gets the maximum benefit from the updated improved incentive-pricing model.

Corresponding Author:

Fitri Maya Puspita,
Department of Mathematics, Faculty of Mathematics and Natural Sciences,
Sriwijaya University,
Jln. Raya Palembang-Prabumulih, KM 32 Inderalaya Ogan Ilir 30662 South Sumatera, Indonesia.
Email: pipitmac140201@gmail.com

1. INTRODUCTION

The desire of consumers to get the best service makes service providers compete to create internet services that consumers woud like to choose. ISPs (Internet Service Provider) [1], [2] offer many service options that make consumers choose according to their needs and budget. In providing services, ISPs look at various aspects in making choices so that consumers are satisfied with the services provided and ISPs also benefit from positive consumer responses. The concept of bundling [3]–[5] is widely used by ISPs because bundling provides sales of two or more products in one package.. The reverse charging method focuses on switching from 3G to 4G networks automatically according to the user's distance from the antenna[6]–[9]. This model is an energy optimization model such as in charging battery or electric vehicles [10]–[14].

The utility function is defined as the satisfaction felt by users when using an item [15]–[19]. The utility function consists of four types, namely the Cobb-Douglas, Bandwidth, Perfect Subtitute, and Quasi Linear utility functions [20]. This study uses the Cobb-Douglas utility function because this utility function is good in terms of production and can show an increasing or decreasing scale of yield [21], [22].

To maintain the quality of internet services, ISPs provide QoS (Quality of Service) as internet network performance with quality standards[13]. In determining the type of service, ISPs also pay attention to consumer considerations, one of which is heterogeneous consumers. Heterogeneous consumers have different consumption based on the desire to pay and the level of consumption [23]–[25]. This study uses the

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The improved model of incentive-pricing of internet schemes for Cobb-Douglas utility function by using LINGO 13.0

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The improved model of incentive-pricing of internet schemes for Cobb-Douglas utility function by using LINGO 13.0

F M Puspita[1*], E Yuliza[1], B J Rezky[1], A N Y Simarmata[1] and Y Hartono[2]

[1] Mathematics Department, Universitas Sriwijaya, Indonesia
[2] Mathematics Study Program, Universitas Sriwijaya, Indonesia

*Corresponding author's e-mail: fitrimayapuspita@unsri.ac.id

Abstract. In this paper, an improved model of the incentive-pricing scheme was designed. Previous research only shows the incentive model with the disadvantages of no considering the utility function to measure the satisfaction of the user. Then, the models are improved by deriving from the incorporation of bundling and reverse charging models obtained from previous studies, as well as taking into account the quality of service to users by using the Cobb-Douglas utility function. Optimal pricing schemes applied to the local data server, which is mail traffic data. The model used is the nonlinear optimization problem and solved by LINGO 13.0 to get the optimal solution. The results show that optimal results in the form of pricing schemes by applying flat fee, usage-based, and two-part tariff for homogeneous consumer's schemes and the improved models show better performance in achieving the profit than the previous incentive pricing models.

1. Introduction

In the era of modern technology at this time, the need to access the internet is indispensable in information is critical both locally and globally. The internet service provider (ISP) is trying to compete to become the best by giving its best services to the satisfaction of its customers. ISPs use several ways or strategies to obtain an optimal result, which results in a minimal cost. The way is to perform the method of bundling and considering the utility function [1]. Bundling strategies are undertaken to increase profits because they utilize the method in the form of a merger or doing a combination of existing services. So the best of services - services that are available can be taken that the maximum benefits [2]. This model also uses a utility function. Utility functions can be interpreted by considering the level of satisfaction of users of services that can provide information to the ISP in improving the quality of services so as to achieve the target for the user who will use the services of the provider [3].

Every network needs a pricing mechanism, which varies depending on the level of service. The price on the internet as an important economic incentive for users can be regarded as an effective mechanism for network management [4]. If each user requires resources to maximize the level of satisfaction, it would require some mechanism to provide an incentive for users to increase the overall benefit. Due to various pricing models that have been widely grown, classification is divided into at

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Abstract

Internet incentive pricing is established to optimize the price of internet services in the internet pricing scheme. This study utilizes heterogeneous consumers based on the desire to pay as one of the requirement for having consumers to subscribe the service. With the increasing consumer demand for the internet, the best quality service is needed which makes service providers compete and compete to provide the best service to improve service quality and attract consumers. This is the basis for making this research. This study aims to obtain the optimal model and solution of an improved internet incentive-pricing model with a combination of bundling, Quasi Linear utility functions, high demand and low demand consumers, and reverse charging as well as a two part tariff pricing scheme. The optimal solution in this model is found in the case α as a parameter and β as a parameter with a two-part tariff-pricing scheme when 〖PQ〗_ij increases and x increases, as numerical example from local data shows an incentive value of IDR 797.55 / kbps. This suggests that ISPs have benefited from an improved incentive-pricing model.

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Updated Improved of Modeling of Wireless Internet Incentive-Pricing Utilizing Quasi Linear Utility Function

Fitri Maya Puspita*
Mathematics Department
Mathematics and Natural Sciences Faculty
Sriwijaya University, South Sumatra Indonesia
*fitrimayapuspita@unsri.ac.id

Depianna Br. Haloho
Mathematics Department
Mathematics and Natural Sciences Faculty
Sriwijaya University, Indonesia
depiannahaloho123@gmail.com

Sugandi Yahdin
Mathematics Department
Mathematics and Natural Sciences Faculty
Sriwijaya University, Indonesia
sugandi@unsri.ac.id

Yusuf Hartono
Mathematics Education Studi Program
Education and Teacher Training Faculty
Sriwijaya University, South Sumatra Indonesia
y.hartono@unsri.ac.id

***Abstract* - Internet incentive pricing is established to optimize the price of internet services in the internet pricing scheme. This study utilizes heterogeneous consumers based on the desire to pay as one of the requirement for having consumers to subscribe the service. With the increasing consumer demand for the internet, the best quality service is needed which makes service providers compete and compete to provide the best service to improve service quality and attract consumers. This is the basis for making this research. This study aims to obtain the optimal model and solution of an improved internet incentive-pricing model with a combination of bundling, Quasi Linear utility functions, high demand and low demand consumers, and reverse charging as well as a two part tariff pricing scheme. The optimal solution in this model is found in the case α as a parameter and β as a parameter with a two-part tariff-pricing scheme when PQ_{ij} increases and x increases, as numerical example from local data shows an incentive value of IDR 797.55 / kbps. This suggests that ISPs have benefited from an improved incentive-pricing model.**

Keywords—: incentives, bundling, reverse charging, Quasi Linear utility function, multiple QoS, mixed integer nonlinear programming (MINLP).

I. Introduction

The internet is a medium for searching information through computers that can reach the entire world in its use. The use of computers in the future can dominate human work and may defeat human computing capabilities; this will make internet users increasingly with various internet facilities and services.

The internet is provided by a service provider known as an internet service provider (ISP)[1], [2]. ISPs are also often referred to as internet service provider companies. The number of internet users will not decrease but will continue to increase; therefore ISPs must take advantage of ever-developing information technology to increase their ability to face competition and to provide optimal services to customers. To keep the available services good and quality, the ISP provides Quality of Service (QoS)[3]–[5]. According to Puspita et al [6], there are several reasons why QoS is needed as follows: namely to maximize the use of existing networks, give priority to applications that are critical to the network, and also to improve performance for applications, sensitive to delay [7]such as video and voice[8], [9].

Bundling is a marketing strategy where two or more products are sold in one package at a special price[10]–[14]. Bundling pricing [15]–[17] is the price of selling two or more products in one package but at a price lower than the price per unit product.

IRC (Internet Reverse Charging) means that the ISP will adjust 3G and 4G networks appropriately in their use and according to the conditions and location of the user [18], [19]. The reverse charging method only focuses in one direction, namely between the ISP and its users. Meanwhile, other ISPs cannot perform reverse charging. Reverse charging is a scheme that is formed and adapted to suit user demands or desires, by combining incentive mechanisms to gain user satisfaction and reduce congestion[20].

One way to measure the desires to pay of the consumers[21] is by utilizing the utility function[22]–[24]. ISP can seek for the amount of preferences of the user by choosing the perfect utility function that can measure linearity and nonlinearity of satisfaction of consumers through utility function called quasi linear utility function [16], [25], [26].

Utility function also deals with users who would like to subscribe the network. Previous research already described the homogeneous users which are users who has the same preferences on everything in network. For real network, it is

E**. PERAN MITRA:** Tuliskan realisasi kerjasama dan kontribusi Mitra baik *in-kind* maupun *in-cash* (untuk Penelitian Terapan, Penelitian Pengembangan, PTUPT, PPUPT serta KRUPT). Bukti pendukung realisasi kerjasama dan realisasi kontribusi mitra dilaporkan sesuai dengan kondisi yang sebenarnya. Bukti dokumen realisasi kerjasama dengan Mitra diunggah melalui Simlitabmas.

Tidak ada

F. **KENDALA PELAKSANAAN PENELITIAN**: Tuliskan kesulitan atau hambatan yang dihadapi selama melakukan penelitian dan mencapai luaran yang dijanjikan, termasuk penjelasan jika pelaksanaan penelitian dan luaran penelitian tidak sesuai dengan yang direncanakan atau dijanjikan.

Kendala dalam mencapai luaran yang dijanjikan adalah kemungkinan artikel ditolak pada jurnal yang disubmit tanpa memberikan keterangan/alasan mengapa ditolak. Keterbatasan software aplikasi juga menjadi penghambat karena software yang dipakai terbatas pada jumlah variabel dan dan kendala yang ditetapkan dalam sistem.

G**. RENCANA TAHAPAN SELANJUTNYA:** Tuliskan dan uraikan rencana penelitian di tahun berikutnya berdasarkan indikator luaran yang telah dicapai, rencana realisasi luaran wajib yang dijanjikan dan tambahan (jika ada) di tahun berikutnya serta*roadmap* penelitian keseluruhan. Pada bagian ini diperbolehkan untuk melengkapi penjelasan dari setiap tahapan dalam metoda yang akan direncanakan termasuk jadwal berkaitan dengan strategi untuk mencapai luaran seperti yang telah dijanjikan dalam proposal. Jika diperlukan, penjelasan dapat juga dilengkapi dengan gambar, tabel, diagram, serta pustaka yang relevan. Jika laporan kemajuan merupakan laporan pelaksanaan tahun terakhir, pada bagian ini dapat dituliskan rencana penyelesaian target yang belum tercapai.

Target pada tahun ke dua ini selesai dengan diperoleh model imrpved incentive pricing dan juga model updated improved incentive pricing yang melibatkan bundling pricing yang sebelumnya belum dijelaskan dalam literatur yang ada mengenai pembiayaan layanan internet incentive.

H. DAFTAR PUSTAKA: PenyusunanDaftar Pustaka berdasarkan sistem nomor sesuai dengan urutan pengutipan. Hanya pustaka yang disitasi pada laporan kemajuan yang dicantumkan dalam Daftar Pustaka.

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The updated improved internet incentive-pricing scheme based on consumer preference on Cobb-Douglas utility function

Fitri Maya Puspita, Felia Apriyanti Silalahi, Sugandi Yahdin, Yusuf Hartono
Department of Mathematics, Faculty of Mathematics and Natural Sciences, Sriwijaya University, Indonesia

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ABSTRACT

Internet incentive-pricing is established to optimize the price of internet services in the internet pricing scheme. This study involves a new updated heterogeneous consumer preference-pricing model based on the desire to pay. The increasing need for consumers to get the best internet service and market competition in creating the best internet service are the basis for this research. This study aims to obtain updated models and solutions for improved internet incentive-pricing models based on a combination of bundling, Cobb Douglas utility functions, high-end and low-end consumers, and reverse charging as well as usage-based pricing scheme. In this model, the solution of optimal updated results as numerical example shows that where the base price as a variable and quality premium as a parameter with a usage based pricing scheme, when PQ_{ij} as the amount of changes of price along with QoS change, increases and x as the amount of QoS value, increases with the incentive value obtained of IDR 270 / kbps is obtained. With the results display, it shows that the ISP gets the maximum benefit from the updated improved incentive-pricing model.

Corresponding Author:

Fitri Maya Puspita,
Department of Mathematics, Faculty of Mathematics and Natural Sciences,
Sriwijaya University,
Jln. Raya Palembang-Prabumulih, KM 32 Inderalaya Ogan Ilir 30662 South Sumatera, Indonesia.
Email: pipitmac140201@gmail.com

1. INTRODUCTION

The desire of consumers to get the best service makes service providers compete to create internet services that consumers woud like to choose. ISPs (Internet Service Provider) [1], [2] offer many service options that make consumers choose according to their needs and budget. In providing services, ISPs look at various aspects in making choices so that consumers are satisfied with the services provided and ISPs also benefit from positive consumer responses. The concept of bundling [3]–[5] is widely used by ISPs because bundling provides sales of two or more products in one package.. The reverse charging method focuses on switching from 3G to 4G networks automatically according to the user's distance from the antenna[6]–[9]. This model is an energy optimization model such as in charging battery or electric vehicles [10]–[14].

The utility function is defined as the satisfaction felt by users when using an item [15]–[19]. The utility function consists of four types, namely the Cobb-Douglas, Bandwidth, Perfect Subtitute, and Quasi Linear utility functions [20]. This study uses the Cobb-Douglas utility function because this utility function is good in terms of production and can show an increasing or decreasing scale of yield [21], [22].

To maintain the quality of internet services, ISPs provide QoS (Quality of Service) as internet network performance with quality standards[13]. In determining the type of service, ISPs also pay attention to consumer considerations, one of which is heterogeneous consumers. Heterogeneous consumers have different consumption based on the desire to pay and the level of consumption [23]–[25]. This study uses the

MINLP (Mixed Integer Nonlinear Programming) model. MINLP problems focus on determining optimal solutions from various fields of optimization studies [26]–[28]. MINLP is a form of variation of the Nonlinear Programming problem that is combined with Integer Programming [29][30]. This research combines research that has been done regarding bundling [31], reverse charging [29] and usage-based pricing schemes [24], [32] .

Incentive-pricing originally derived from the model of reverse charging in charging back users subscribing other networks[33]. It involved the amount of incentive obtained by ISP for users subscribing the networks, without no subscription fee[34]. Then, recent research followed the idea by attempting to improve the incentive-pricing by charge back the usage of network by introducing the improved incentive-pricing scheme in wired network [35] whose lacks of possibility to have promote heterogeneous users to engage in subscribing the services in networks.

Due to the lackness of research in discussing such strategies by combining several models to maximize customer satisfaction and minimize costs and maximize ISP profits with various kinds of users, and due to lackness in involving mathematical programming problem as MINLP, therefore this research is designed to involve this combination. The recent improved incentive-pricing sceme will be compared with the updated improved incentive-pricing to validate the model designed. Finally, this study seeks to find an ideal model that can satisfy consumers and benefit ISPs [36].

2. RESEARCH METHOD

This study uses a combination of bundling, improved reverse charging, high-end and low-end consumers, Cobb-Douglas utility functions, and usage-based pricing schemes. This study is limited by the number of variables used in LIINGO 13.0 Super Edition, namely the use of consumer links (i = 1,2) and service class (j = 1,2). The model is examined by applying real data using traffic data obtained in local server traffic data in Januari 2020. The data is used for validating the model designed to assisting the comparison between improved incentive-pricing and the updated ones. The steps for completing an improved incentive-pricing model are as follows.

1. Describe the data, that transform inbound and outbound data into average bandwidth per day and in peak hour and non peak hour times.
2. Define the parameters and variables used.
3. Establish an updated improved internet incentive-pricing model using a combination of bundling, improved reverse charging, high-end and low-end consumers, Cobb-Douglas utility functions, and usage-based pricing schemes.
4. Complete of an updated improved internet incentive-pricing model solution with LINGO 13.0.
5. Compare the optimal solution of the internet incentive-pricing model with an improved internet incentive-pricing model.
6. Analyze the results obtained.

Figure 1 depicted the model designed into simple flowchart as follows.

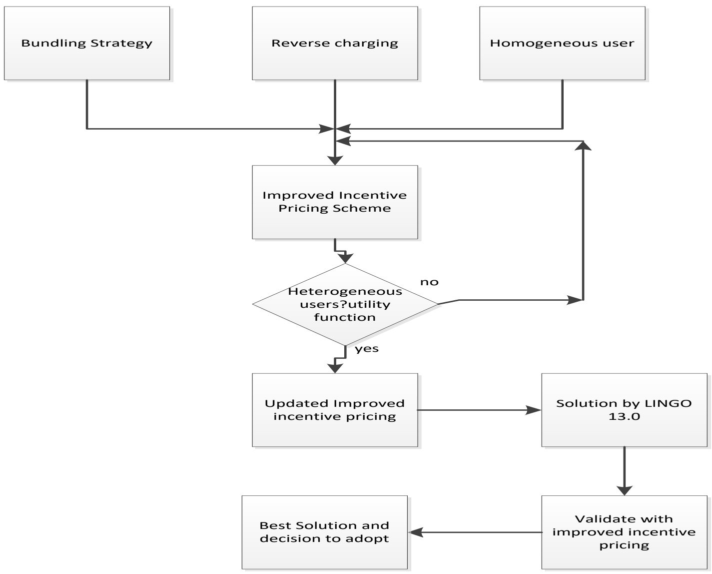

Figure 1. Flowchart of Proposed Updated Improved Incentive-pricing Scheme.

3. RESULTS AND ANALYSIS

The designs were begun by introducing the parameter and variables used for the whole model. The defining parameters are described in Table 1 and the defining variables are in Table 2. In the updated improved incentive-pricing scheme is formulated to optimize internet pricing in multiple QoS networks.

Table 1. Parameters of Updated Improved Internet Incentive-pricing

Parameter		Definition
B_j	:	Cost in bundling each service *j*.
M	:	Marginal cost when ISP would like to add more than one bundle of services in the list
V_{ik}	:	The price when of the *i*-th consumer would like to order for each *k*-th favourable service
R_{ij}	:	Order price taken would be the total price for each *i*th customer in each *k*-to service
$\bar{X}_i$	:	The maximum consumption rate of consumer *i* of the service during peak hours
$\bar{Y}_i$	:	Consumer *i*'s maximum consumption rate of service during off-peak hours
$X^a Y^b$	:	The consumer's utility function at the level of consumption during peak and off-peak hours
a_1	:	Upper bound on service constant rush hour heterogeneous consumer level groups
a_2	:	Lower bound on service constant rush hour heterogeneous consumer level groups
b_1	:	Service constant off-peak hours of heterogeneous consumers top level
b_2	:	Service constant off-peak hours of heterogeneous consumers bottom level
α	:	Base price set up for each service
β	:	Premium quality set up for every service
C	:	Capacity required on the network
PR_{ij}	:	Fees for connecting with the available QoS
P_{ij}	:	Price of service user *i* on network *j*
Q_{bij}	:	The value in form of nomial one for Qos attribute in the ISP network (kbps)
f	:	The minimal value that ISP predetermined for a_{ij}
g	:	The maximal value that ISP predetermined for a_{ij}
h	:	The minimal allowable amount of traffic load for *Tl* (kbps)
k	:	The maximal allowable amount of traffic load for *Tl* (kbps)
m_i	:	Minimum QoS for services *i*
n_i	:	Number of service users *i*
d_{ij}	:	The capacity required for *i* service on the *j* network
b_i	:	Minimum base price required for service *i*
c_i	:	Minimum premium quality set up for service *i*
g_i	:	Maximum premium quality set up for *i* service

Table 2. Variables of Updated Improved Internet Incentive-pricing

Variable		Definition
S_i	:	The benefits of using it for the *i*th consumer
X_{ij}	:	Value 1 if customer *i* choose bundle in service *j* and value 0 if customer *i* does not select bundle in service *j*
Z_i	:	Value 1 if customer *i* chooses to gather the program and is worth 0 if customer *i* does not choose to gather the program
PQ_{ij}	:	Changes in costs along with changes in QoS (IDR)
PB_{ij}	:	Base fee for connecting with user *i* and class *j*
Lx	:	The factor of proving linearity
a_{ij}	:	Linear cost factor of user *i* and class *j*
T_l	:	Traffic content
α_i	:	Basic price of service *i*
β_i	:	Premium of quality *i*
I_i	:	Quality of service *i*

Table 3 presents the parameter values obtained from data processiong or raw secondary data collected from local server for 30 days. The data show the inbound and outbound bandwidth data for 30 days in one of well-known public university in South Sumatra. Parameter i shows number of user in service and j stands for class j. For showing the computation example, the model will be solved with $i = 2$ and $j = 2$ due to limitation of LINGO 13.0 solver ability in solvingthe model.

The scheme chosen will be usage based pricing, since this pricing schemes has the best effort in calculating the amount of usage of bandwidth in peak and non peak hours. The base price and quality premium chosen will be parameters to gain certain goal which are to revocer cost and allow user to select classes.Also, the base price as variable to do market competiton if there is opportunity and quality premium to be set in order to enable user to select the class.those conditions for base price and quality premium are chosen since those conditions are one of the good goals can be offerd to ISP.

Table 3. Value parameters of Updated Improved Internet Incentive-pricing .

Parameter	Value	Parameter	Value	Parameter	Value
B_1	300	b_1	3	Q_{bij}	2000
B_2	500	b_2	2	f_{11}	0.05
M	200	α	0.1	f_{12}	0.06
V_{11}	500	β	0.5	f_{21}	0.07
V_{12}	800	C	35000	f_{22}	0.08
V_{21}	600	PR_{11}	0.5	g_{11}	0.15
V_{22}	900	PR_{12}	0.6	g_{12}	0.14
$\bar{X}_1$	28455.37	PR_{21}	0.4	g_{21}	0.13
$\bar{X}_2$	10109.80	PR_{22}	0.7	g_{22}	0.12
$\bar{Y}_1$	1527.89	P_{11}	15	h	50
$\bar{Y}_2$	798.97	P_{12}	15	k	1000
a_1	4	P_{21}	15	m_1	0.01
a_2	3	P_{22}	15	m_2	0.01
d_{12}	95.80	b_1	0.5	n_1	10
d_{21}	95.80	b_2	0.5	n_2	10
d_{22}	95.80	c_1	0	d_{11}	95.80
c_2	0	g_1	1	g_2	1

Based on parameters and variables, then, next step is to create an updated improved internet incentive-pricing model.

Case Model 1 (α as a Parameter dan β as a Parameter)

$\underline{PQij}$ increases and x increases

$$\text{Max } R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 + P_xX_2 + P_yY_1 + P_yY_2 + PZ_1 + PZ_2 + \sum_{i=1}^{2}\sum_{j=1}^{2}\left(\left(PR_{ij} + PQ_{ij}\right) + (\alpha + \beta_i I_i)P_{ij}X_{ij}\right) \quad (1)$$

Subject to

$S_i \geq \left(R_{ij} - P_j\right)Y_j$ (1.1)

$S_i = \sum_{j=1}^{2}\left(R_{ij} - P_j\right)X_{ij}$ (1.2)

$\left(R_{ij} - P_i\right)X_{ij} \geq 0$ (1.3)

$\sum_{j=1}^{2} X_{ij} \leq 1$ (1.4)

$X_{ij} \leq Y_j$ (1.5)

$S_i \geq 0$ (1.6)

$P_i \geq 0$ (1.7)

$X_{ij} \in \{0,1\}$ (1.8)

$Y_j \in \{0,1\}$ (1.9)

$I_i\, d_{ij}\, x_{ij} \leq a_i\, C$ (1.10)

$\sum_{i=1}^{2}\sum_{j=1}^{2} I_i d_{ij}\, x_{ij} \leq a_i\, C$ (1.11)

$\sum_{i=1}^{2} a_i = 1$ (1.12)

$0 \leq a_i \leq 1$ (1.14)

$m_i \leq I_i \leq 1$ (1.15)

$0 \leq x_{ij} \leq n_i$ (1.16)

$X_i \leq \bar{X}_i Z_i$ (1.17)

$Y_i \leq \bar{Y}_i Z_i$ (1.18)

$U_{i(x_i,y_i)} - P_xX_1 - P_xX_2 - P_yY_1 - P_yY_2 - PZ_1 - PZ_2 \geq 0$ (1.19)

$Z_i \in \{0,1\}$ (1.20)

$PB_{ij} = a_{ij}(e - e^{-xB})T_l/100$ (1.21)

$Lx = a(e - e^{-xB})$ (1.22)

$f \leq a_{ij} \leq \text{g}$ (1.23)

$h \leq T_l \leq T_l$ (1.24)

$0 \leq x \leq 1$ (1.25)

$0.8 \leq B \leq 1.07$ (1.26)
$a = 1$ (1.27)
$P_x > 0$
$P_y > 0$
$P = 0$ (1.28)
$PQ_{ij} = (1 + \frac{x}{Qbij})\, PB_{11}Lx$ (1.29)

$\underline{PQij}$ increases and x decreases

With the Objective Function (1) and subject to Eq. (1.1) to Eq.(1.29) then addition of a new constraint:

$$PQ_{ij} = (1 - \frac{x}{Qbij})\, PB_{11}Lx \quad (1.30)$$

Case Model 2 (α as a Variable and β as a Parameter)

$\underline{PQij}$ increases and x increases

$$\text{Max } R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - X_1^4Y_1^3 - X_2^3Y_2^2 - P_xX_1 + P_xX_2 + P_yY_1 + P_yY_2 + PZ_1 + PZ_2 + \sum_{i=1}^{2}\sum_{j=1}^{2}\left(\left(PR_{ij} + PQ_{ij}\right) + (\alpha_i + \beta_i I_i)P_{ij}X_{ij}\right) \quad (2)$$

By following Eq. (1.1) to Eq. (1.29) and adding new constraints:

$c_i \leq \beta_i \leq g_i$ (2.1)
$\alpha_i I_i \geq \alpha_{i-1} I_{i-1} \quad ; i = 2$ (2.2)

$\underline{PQij}$ increases and x decreases

With the Objective Function (2) and following Eq. (1.1) to Eq. (1.29) followed by Eq. (1.30) and adding Eq. (2.1) to (2.2).

Table 4 shows the optimal results that have been done previously by [37] showing the optimal solution is in the case of α as a parameter and β as a parameter when PQ_{ij} increases and x increases with a solution of IDR 1612.482 kbps/sec.

Table 5 shows the results of the usage based pricing scheme in the case of α as a parameter and β as a parameter with the number of allocations used of 48K and iterations of 430. When PQ_{ij} increases and x increases, a solution of 1612.482 and PQ_{ij} increases and x decreases, the solution is IDR 1612.451 kbps/sec.

Table 6 shows the cases of α as a variable and β as a parameter with an iteration of 159. When PQ_{ij} increases and x increases, a solution of 1882,482 and PQ_{ij} increases and x decreases, a solution of 1882,451 is obtained with the total allocation which is used in each case is 51K.

Based on the results of the model solution in Table 5 and Table 6, the optimal value is obtained in the case of α as a variable and β as a parameter that can provide more benefits to ISPs that have provided the best service according to consumer needs.

Table 4. The solution for the improved internet incentive-pricing model, when α as a parameter and β as a parameter with a usage-based pricing scheme done by [37]

Solver Status	**Case α and β as a Parameter**	
	PQ_{ij} increases x increases	PQ_{ij} increases x dccreases
Model Class	MINLP	MINLP
Objective	1612.482	1612.451
Iterations	430	430
GMU (K)	48	48
ER (Sec)	0	0

Table 5. Solution for updated improved internet incentive-pricing model when α as a parameter and β as a parameter with a usage based pricing scheme

Solver Status	Internet Pricing Cases	
	PQ_{ij} increases x increases	PQ_{ij} increases x dccreases
Model Class	MINLP	MINLP
Objective	1612.482	1612.451
Iterations	400	400
GMU (K)	45	46
ER (Sec)	0	0

Table 6. Solution for improved internet incentive-pricing model when α as a variable and β as a parameter with a usage based pricing scheme

Solver Status	Case α as a Variable and β as a Parameter	
	PQ_{ij} increases x increases	PQ_{ij} increases x decreases
Model Class	MINLP	MINLP
Objective	1882.482	1882.451
Iterations	159	159
GMU (K)	51	51
ER (Sec)	0	0

To validate the model designed, comparison between previous research and design proposed show that in terms of profit achieved, the model yield the same results, but for time to complete the iterations and memory unit needed to complete the iterations have significant differences. If iterations is considered as time to complete the model, it means that it saves time to get the profit in updated model rather than the improved one as Fig. 2 and Fiq 3. showed.

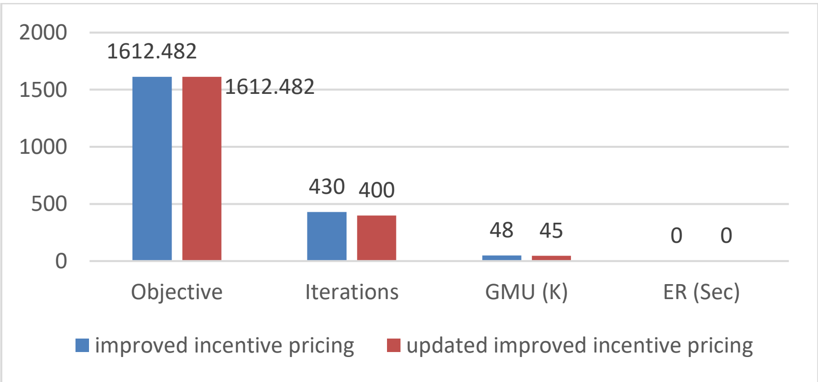

Figure 2. Comparison between improved incentive-pricing and updated improved incentive-pricing for when α as a parameter and β as a parameter for PQ_{ij} increases, x increases

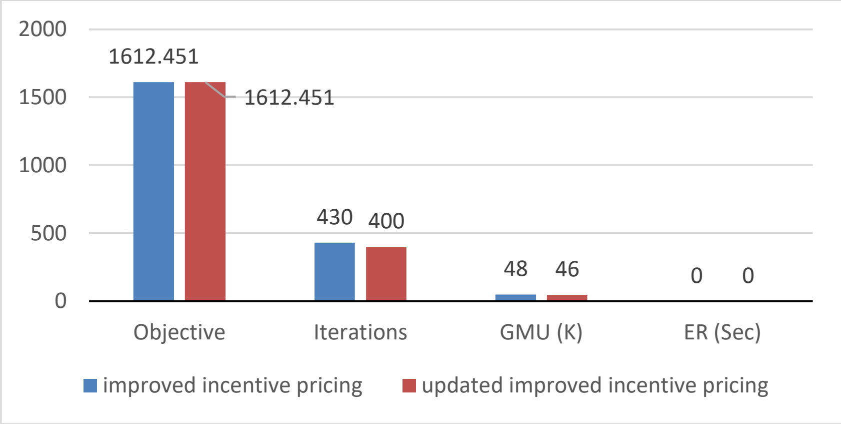

Figure 3. Comparison between improved incentive-pricing and updated improved incentive-pricing for when α as a parameter and β as a parameter PQ_{ij} increases, x decreases

In case when updated model with α as a parameter and β as a parameter, the solution is comparable to improved model but in case of updated model with α as a variable and β as a parameter, the improved model previously proposed did not discussed that possibility. In fact, the various kinds of base price and quality premium need to be set up to achieve some certain goals of ISP like stated in [38], [39]**.** Therefore, again, our proposed updated models show better performance compared to previous improved model.

4. CONCLUSION

This improved model of internet incentive-pricing based on heterogeneous consumer preferences based on the desire to pay has the optimal solution in the case of α as a variable and β as a parameter of IDR 1882.482 / kbps when PQ_{ij} increases and x increases. A comparison of the optimal results of the updated improved incentive-pricing model with improved internet incentive-pricing is obtained at IDR 270 / kbps which indicates that this improved incentive-pricing model can provide more benefits to ISPs because it has provided the best service to consumers.

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BIOGRAPHIES OF AUTHORS

	Fitri Maya Puspita received her S.Si degree in Mathematics from Sriwijaya University, South Sumatera, Indonesia in 1997. Then she received her M.Sc in Mathematics from Curtin University of Technology (CUT) Western Australia in 2004. She got her Ph.D from Faculty of Science and Technology Islamic Science University of Malaysia (USIM), Nilai, Negeri Sembilan Darul Khusus, Malaysia in 2015. She has been a Mathematics Department member at Faculty mathematics and Natural Sciences Sriwijaya University South Sumatera Indonesia since 1998. Her research interests include optimization and its applications such as vehicle routing problems and QoS pricing and charging in third generation internet.
	Felia Apriyanti Silalahi currently receives her S.Si degree in Mathematics from Sriwijaya University, South Sumatera, Indonesia in the beginning of year 2021. Her research interest focus on optimization problem especially on vehicle routing problem and its varian.
	Sugandi Yahdin received his Bachelor of Science in Mathematics from Padjajaran University, Western Java, Indonesia. Then he received his Magister Management from University of Tridinanti Palembang. He has been a Head of Mathematics Department at Faculty of mathematics and Natural Sciences Sriwijaya University South Sumatera Indonesia since 2016. His research interests include operation research and its applications.
	Yusuf Hartono received his Bachelor of Science in Mathematics Education from Sriwjaya University, Indonesia in 1988. Then he received his M.Sc in Math and Stats from Univ. of Missouri at Rolla, USA in 1993. He reveived his Ph.D in Mathematics in 2003 from Technische Universiteit Delft, Nederland. He has been a Mathematics Study Program member at Faculty of Education and Theacher Training Sriwijaya University South Sumatera Indonesia since 1990. His research interests include statistics and its application.

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Title		*The updated improved internet incentive-pricing scheme based on consumer preference on Cobb-Douglas utility functior*
Abstract		Internet incentive-pricing is established to optimize the price of internet services in the internet pricing scheme. This study involves a new updated heterogeneous consumer preference-pricing model based on the desire to pay. The increasing need for consumers to get the best internet service and market competition in creating the best internet service are the basis for this research. This study aims to obtain updated models and solutions for improved internet incentive-pricing models based on a combination of bundling, Cobb Douglas utility functions, high-end and low-end consumers, and reverse charging as well as usage-based pricing scheme. In this model, the solution of optimal updated results as numerical example shows that where the base price as a variable and quality premium as a parameter with a usage based pricing scheme, when 〖PQ〗_ij as the amount of changes of price along with QoS change, increases and x as the amount of QoS value, increases with the incentive value obtained of IDR 270 / kbps is obtained. With the results display, it shows that the ISP gets the maximum benefit from the updated improved incentive-pricing model.
Keywords		Incentive; Bundling; Reverse Charging; Cobb-Douglas utility
Topics		Computer networks; Computing & Communications
Status		Pending (no manuscript)
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Judul artikel: Updated Improved of Modeling of Wireless Internet Incentive-Pricing Utilizing Quasi Linear Utility Function

Updated Improved of Modeling of Wireless Internet Incentive-Pricing Utilizing Quasi Linear Utility Function

Fitri Maya Puspita*
Mathematics Department
Mathematics and Natural Sciences Faculty
Sriwijaya University, South Sumatra Indonesia
*fitrimayapuspita@unsri.ac.id

Depianna Br. Haloho
Mathematics Department
Mathematics and Natural Sciences Faculty
Sriwijaya University, Indonesia
depiannahaloho123@gmail.com

Sugandi Yahdin
Mathematics Department
Mathematics and Natural Sciences Faculty
Sriwijaya University, Indonesia
sugandi@unsri.ac.id

Yusuf Hartono
Mathematics Education Studi Program
Education and Teacher Training Faculty
Sriwijaya University, South Sumatra Indonesia
y.hartono@unsri.ac.id

Abstract - **Internet incentive pricing is established to optimize the price of internet services in the internet pricing scheme. This study utilizes heterogeneous consumers based on the desire to pay as one of the requirement for having consumers to subscribe the service. With the increasing consumer demand for the internet, the best quality service is needed which makes service providers compete and compete to provide the best service to improve service quality and attract consumers. This is the basis for making this research. This study aims to obtain the optimal model and solution of an improved internet incentive-pricing model with a combination of bundling, Quasi Linear utility functions, high demand and low demand consumers, and reverse charging as well as a two part tariff pricing scheme. The optimal solution in this model is found in the case α as a parameter and β as a parameter with a two-part tariff-pricing scheme when PQ_{ij} increases and x increases, as numerical example from local data shows an incentive value of IDR 797.55 / kbps. This suggests that ISPs have benefited from an improved incentive-pricing model.**

Keywords—: incentives, bundling, reverse charging, Quasi Linear utility function, multiple QoS, mixed integer nonlinear programming (MINLP).

I. Introduction

The internet is a medium for searching information through computers that can reach the entire world in its use. The use of computers in the future can dominate human work and may defeat human computing capabilities; this will make internet users increasingly with various internet facilities and services.

The internet is provided by a service provider known as an internet service provider (ISP)[1], [2]. ISPs are also often referred to as internet service provider companies. The number of internet users will not decrease but will continue to increase; therefore ISPs must take advantage of ever-developing information technology to increase their ability to face competition and to provide optimal services to customers. To keep the available services good and quality, the ISP provides Quality of Service (QoS)[3]–[5]. According to Puspita et al [6], there are several reasons why QoS is needed as follows: namely to maximize the use of existing networks, give priority to applications that are critical to the network, and also to improve performance for applications, sensitive to delay [7]such as video and voice[8], [9].

Bundling is a marketing strategy where two or more products are sold in one package at a special price[10]–[14]. Bundling pricing [15]–[17] is the price of selling two or more products in one package but at a price lower than the price per unit product.

IRC (Internet Reverse Charging) means that the ISP will adjust 3G and 4G networks appropriately in their use and according to the conditions and location of the user [18], [19]. The reverse charging method only focuses in one direction, namely between the ISP and its users. Meanwhile, other ISPs cannot perform reverse charging. Reverse charging is a scheme that is formed and adapted to suit user demands or desires, by combining incentive mechanisms to gain user satisfaction and reduce congestion[20].

One way to measure the desires to pay of the consumers[21] is by utilizing the utility function[22]–[24]. ISP can seek for the amount of preferences of the user by choosing the perfect utility function that can measure linearity and nonlinearity of satisfaction of consumers through utility function called quasi linear utility function [16], [25], [26].

Utility function also deals with users who would like to subscribe the network. Previous research already described the homogeneous users which are users who has the same preferences on everything in network. For real network, it is impossible to have such condition. Therefore, seeking for real consumer as heterogeneous consumers seems to be more realistic to be discussed.

Incentives [27], [28] can be interpreted as a means to encourage or motivate either material or other things. In the discussion of incentive pricing, ISPs can use incentives to give to consumers which can reduce congestion[29]–[31]. So that the ISP can optimize profits [32] and services to its users.

Then, this study seeks to develop the Mixed Integer Nonlinear Programming model (MINLP) [33], [34] by updating the improved reverse charging model previously proposed by Puspita et al [35] which has transformed into previously proposed of improved internet incentive pricing scheme [20], to be updated improved incentive pricing scheme by considering the bundling scheme in the model to be formed as an internet incentive pricing scheme, with two part tariff[21] pricing scheme and quasi linear utility function for heterogeneous users.

Scarce research in formulating the updated improved incentive pricing involving bundling strategy for heterogeneous consumers trigger the deep research about those possibility in finding new design involving those schemes as mentioned before. The new research MINLP focuses on problems in determining the optimal solution of an objective function, which is limited by one or more Constraint, will be main contribution to this research.

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II. Research Method

In this study, calculations were carried out using an optimization solution, MINLP by simulating the form of an optimization model using LINGO 13.0 [36] software which is limited by the variables on the use of consumer links ($i = 1, 2$) and service class ($j = 1, 2$). This study uses a combination of bundling, improved reverse charging, high demand and low demand consumers with Quasi Linear utility functions, and the Two Part Tariff pricing scheme. The data used is digilib traffic data, and the steps to complete an improved incentive pricing model are as follows:

1. Explain data, parameters and variables used. Data for numerical results is obtained from local server data that comprised bandwidth traffic for one month.
2. Establish an updated improved internet incentive pricing model using a combination of bundling, improved reverse charging. High demand and low demand consumers with Quasi Linear utility functions, as well as two Part Tariff pricing scheme.
3. Complete of an improved internet incentive pricing model solution using LINGO 13.0.
4. Compare the optimal solution of the improved internet incentive pricing model with an updated improved internet incentive pricing model.
5. Validate the model by those data utilization
6. Analyze the results obtained.

As Fig. 1 shows, the framework of designing the updated incentive model based on quasi linear function is displayed as follows.

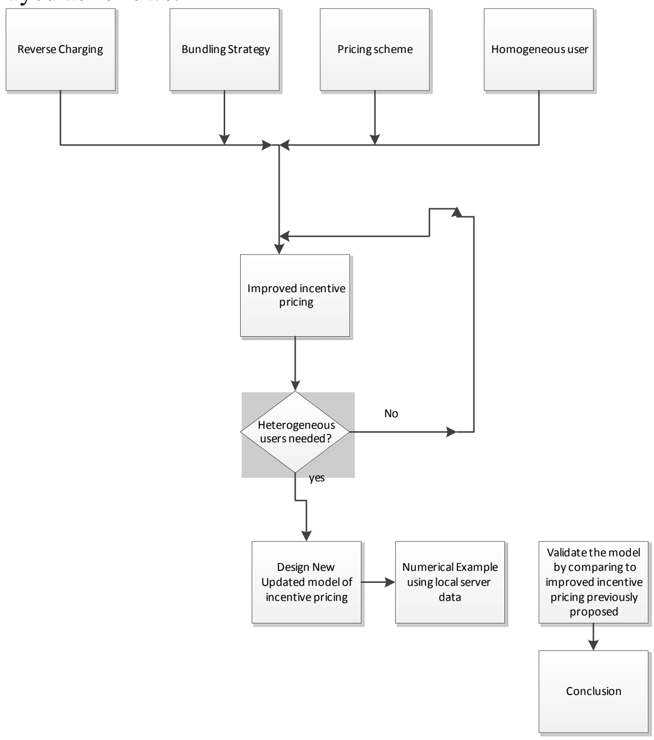

Figure 1. Design Process of Proposed Updated Improved Incentive Pricing Scheme

III. Result and Analysis

Variables definitions are described in Table 1, parameter definitions are described in Table 2 and Table 3 shows the parameter values.

TABLE I. VARIABLES OF UPDATED IMPROVED INTERNET INCENTIVE PRICING

Variable	
P_j	The price set for each bundle of services i
S_i	The benefits of using it for the ith consumer
X_{ij}	Value 1 if consumer i chooses bundle in service j and has value 0 if customer i does not choose bundle in service j
Y_j	Value 1 if the service provider offers a bundle of service j and a value 0 if the service provider does not offer the bundle of service j
X_i	The level of consumption of consumers i at peak hour services
Y_i	The level of consumption of consumers i on off - peak service
Z_i	Value 1 if customer i chooses to join the program and score 0 if customer i does not choose to join the program
$\bar{X}_i$	The maximum consumption level of consumer i at peak hour services
$\bar{Y}_i$	The maximum consumption level of consumer i at off-peak service
PQ_{ij}	Changes in costs during changes in QoS (rupiah)
PB_{ij}	Base fee for a connection with user i and class j
Lx	The linearity factor
a_{ij}	Linear cost factor in user i and class j
Tl	Traffic content
x	The amount of increase or decrease in the QoS value
B	Linear parameters defined

TABLE II. PARAMETERS OF UPDATED IMPROVED INTERNET PRICING SCHEME

Parameter	
PR_{ij}	Fees for connecting with the available QoS
M	Marginal cost if adding more than one service bundle to the menu
B_j	Costs in bundling each service j
V_{ij}	The price of the i-th customer order for each of the j-favorite services
R_{ij}	The total order price for each ith customer on each *j* th favorite service
P	Costs that will be incurred by consumers for following the service
Px	Unit price set by the service provider during peak hours
Py	Unit price set by the service provider during off-peak hours
$aX + Yb$	Consumer utility function for peak and off-peak consumption rates
$\bar{X}_i$	The maximum consumption level of consumer *i* at peak hour services
$\bar{Y}_i$	The maximum consumption level of consumer *i* at off-peak service
a_1	Service constant rush hour heterogeneous consumers of high usage levels
a_2	Service constant rush hour heterogeneous consumers of low-level usage
b_1	Service constant off-peak hours of heterogeneous consumers of high usage groups
b_2	Service constant off-peak hours of heterogeneous consumers of low usage groups
α	Base price for performing each service
β	Premium quality for every service
C	The total capacity found on the link
P_{ij}	Service starter price i on link j
m_i	Minimum QoS for services i
n_i	Number of service users i
Q_{bij}	The nominal value of the QoS attribute in the operator's network (kbps)
d_{ik}	Capacity required for service i on link j
f	The value limit the service provider has set for aij
k	The limit of traffic load allowed for Tl
h	The limit of traffic load allowed for Tl
g	The value limit the service provider has set for aij
I_i	Minimum base price required for services i
b_i	Maximum base price required for service i
g_i	Maximum premium quality for i service
c_i	Minimum premium quality for service i

TABLE III. VALUES OF PARAMETERS OF UPDATED IMPROVED INTERNET INCENTIVE PRICING

Par	Value	Par	Value	Par	Value
$\bar{X}_1$	48429.72	P_{22}	15	b_1	2
$\bar{X}_2$	34738.76	Q_{bij}	2000	b_2	2
$\bar{Y}_1$	41193.55	f_{11}	0.05	PR_{11}	0.5
$\bar{Y}_2$	19170.73	f_{12}	0.06	PR_{12}	0.6
α	0.1	f_{21}	0.07	PR_{21}	0.4
β	0.5	f_{22}	0.08	PR_{22}	0.7
C	350000	g_{11}	0.15	P_{11}	15
B_1	300	g_{12}	0.14	P_{12}	15
B_2	500	g_{21}	0.13	P_{21}	15
M	200	g_{22}	0.12	c_1	0
V_{11}	500	h	50	c_2	0
V_{12}	800	k	1000	d_{11}	18.18
V_{21}	600	m_1	0.01	d_{12}	18.18
V_{22}	900	m_2	0.01	d_{21}	17.37
a_1	3	n_1	10	d_{22}	17.37
a_2	3	n_2	10	g_1	1
				g_2	1

Next step, create an updated improved model of internet incentive pricing.

A. Case 1: α and β Constants

Case a: PQij increase, x increase

Max $$R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) + P_X X_1 + P_X X_2 + P_Y Y_1 + P_Y Y_2 + PZ_1 + PZ_2 + \sum_i^2\sum_j^2 \left((PR_{ij} + PQ_{ij}) + (\alpha + \beta I_i) + P_{ij}X_{ij}\right) \quad (1)$$

Subject to:

$$S_i \geq (R_{ij} - P_j)Y_j \quad (1.1)$$
$$S_i = \sum_{j=1}^{2}(R_{ij} - P_j) \quad (1.2)$$
$$(R_{ij} - P_j)X_{ij} \geq 0 \quad (1.3)$$
$$\sum_{j=1}^{2} X_{ij} \leq 1 \quad (1.4)$$
$$X_{ij} \leq Y_j \quad (1.5)$$
$$S_i \geq 0.1 \quad (1.6)$$
$$P_i \geq 0.1 \quad (1.7)$$
$$X_i \leq \bar{X}_i Z_i \quad (1.8)$$
$$Y_i \leq \bar{Y}_i Z_i \quad (1.9)$$
$$(3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 \geq 0 \quad (1.10)$$
$$Z_i \in \{0,1\} \quad (1.11)$$
$$I_i d_{ij} x_{ij} \leq a_i C \quad (1.12)$$
$$\sum_{i=1}^{2}\sum_{j=1}^{2} I_i d_{ij} x_{ij} \leq a_i C \quad (1.13)$$
$$a_1 + a_2 = 1 \quad (1.14)$$
$$0 \leq a_i \leq 1 \quad (1.15)$$
$$0 \leq m_i \leq I_i \leq 1 \quad (1.16)$$
$$0 \leq X_{ij} \leq n_i \quad (1.17)$$
$$PQ_{ij} = \left(1 + \frac{x}{Q_{bij}}\right) PB_{ij} L_x \quad (1.18)$$
$$PB_{ij} = a_{ij}(e - e^{-xB})^{T_l}/_{100} \quad (1.19)$$
$$L_x = (e - e^{-xB}) \quad (1.20)$$
$$f \leq a_{ij} \leq g \quad (1.21)$$
$$h \leq T_l \leq k \quad (1.22)$$
$$0 \leq x \leq 1 \quad (1.23)$$
$$0.8 \leq B \leq 1.07 \quad (1.24)$$
$$a = 1 \quad (1.25)$$

Case b: PQ_{ij} increase, x decrease

With the objective function (1) followed by Constraint (1.1) to Constraint (1.17) and adding a new Constraint,

$$PQ_{ij} = \left(1 - \frac{x}{Q_{bij}}\right) PB_{ij} L_x \quad (1.26)$$

then proceed with Constraint (1.19) to Constraint (1.26).

B. Case 2: α as parameter and β as variable

Case a: PQ_{ij} increases and x increases

With the objective function:

Max $$R = \sum_{i=1}^{2}\sum_{j=1}^{2}(P_j - B_j)X_{ij} - \sum_{j=1}^{2} MY_j - (3X_1 + Y_1^2) - (3X_2 + Y_2^2) - P_X X_1 - P_X X_2 - P_Y Y_1 - P_Y Y_2 - PZ_1 - PZ_2 + \sum_i^2\sum_j^2 \left((PR_{ij} + PQ_{ij}) + (\alpha + \beta_i I_i) + P_{ij}X_{ij}\right) \quad (2)$$

With Constraint (1.1) through Constraint (1.26) and adding new Constraint:

$$\beta_2 I_2 \geq \beta_1 I_1 \quad (1.27)$$

$I_i \leq \beta_i \leq b_i$ (1.28)

Case b: PQ_{ij} increase, x decrease
With the objective function (2) followed by Constraint (1.1) to Constraint (1.17), followed by Constraint (1.26) and ending with Constraint (1.19) to Constraint (1.25) and Constraint (1.27) to Constraint (1.28).

TABLE IV. SOLUTIONS FOR AN UNPDATED IMPROVED INTERNET PRICING SCHEME WITH TRAFFIC DATA WHEN α AND β AS PARAMETERS

Solver Status	**Case α and β as Parameters**	
	PQ_{ij} increase x increase	PQ_{ij} increase x decrease
Model Class	MINLP	MINLP
Objective	1612.48	1612.45
Iterations	157	157
GMU (K)	48	48
ER (Sec)	1	0

TABLE V. SOLUTIONS FOR AN UNPDATED IMPROVED INTERNET PRICING SCHEME WITH TRAFFIC DATA WHEN α AS PARAMETERS AND β AS VARIABLE

Solver Status	**Case α as Parameter and β as Variable**	
	PQ_{ij} increase x increase	PQ_{ij} increase x decrease
Model Class	MINLP	MINLP
Objective	1537.48	1537.45
Iterations	184	184
GMU (K)	50	50
ER (Sec)	1	0

TABLE VI. IMPROVED INTERNET INCENTIVE PRICING MODEL SOLUTIONS

Solver Status	**Internet Incentive Pricing Case**	
	PQ_{ij} increase x increase	PQ_{ij} increase x decrease
Model Class	MINLP	MINLP
Objective	814.93	814.89
Iterations	629	631
GMU (K)	47	47
ER (Sec)	1	1

For showing more clearer differences on previous model and proposed model, Fig. 2 dan Fig .3 will displayed those differences that explains that all updated models yield higher profit for ISP.

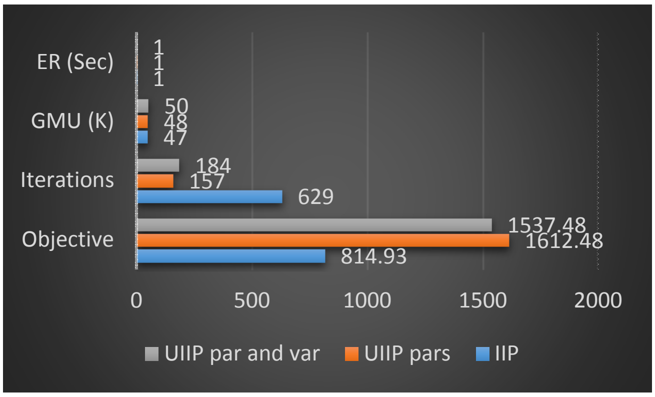

FIGURE 2. COMPARISON AMONG UPDATED IMPROVED INCENTIVE PRICING (UIIP) WITH α AND β AS PARAMETERS AND α AS VARIABLE AND β AS PARAMETER AND IMPROVED INCENTIVE PRICING (IIP) WHEN PQ_{ij} INCREASE x INCREASE

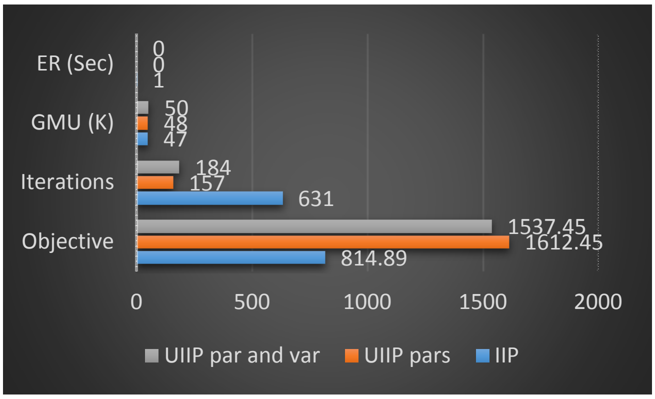

FIGURE 3 COMPARISON AMONG UPDATED IMPROVED INCENTIVE PRICING (UIIP) WITH α AND β AS PARAMETERS AND α AS VARIABLE AND β AS PARAMETER AND IMPROVED INCENTIVE PRICING (IIP) WHEN PQ_{ij} INCREASE x DECREASE

For validating the model to state that design model is better than the previous model is by comparing the model with local data server that stated that all new updated incentive pricing model has higher revenue compared with improved incentive pricing previously discussed by Puspita et al [20].

IV. CONCLUDING REMARKS

The optimal solution is obtained from an improved internet incentive pricing scheme for heterogeneous consumers based on willingness to pay as much as 1612.48 / kbps when PQ_{ij} increases and x increases. The incentive value is the difference from the optimal solution of the improved incentive pricing model with the optimal solution for internet incentive pricing, with values of 1612.48 / kbps and 814.93 / kbps respectively. So, the incentive value obtained is 797.55 / kbps. So by using an improved incentive pricing model, the ISP gets a bigger profit.

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Internet incentive pricing is established to optimize the price of internet services in the internet pricing scheme. This study utilizes heterogeneous consumers based on the desire to pay as one of the requirement for having consumers to subscribe the service. With the increasing consumer demand for the internet, the best quality service is needed which makes service providers compete and compete to provide the best service to improve service quality and attract consumers. This is the basis for making this research. This study aims to obtain the optimal model and solution of an improved internet incentive-pricing model with a combination of bundling, Quasi Linear utility functions, high demand and low demand consumers, and reverse charging as well as a two part tariff pricing scheme. The optimal solution in this model is found in the case α as a parameter and β as a parameter with a two-part tariff-pricing scheme when 〖PQ〗_ij increases and x increases, as numerical example from local data shows an incentive value of IDR 797.55 / kbps. This suggests that ISPs have benefited from an improved incentive-pricing model.

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