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by Irmeilyana Irmeilyana

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WIRELESS SINGLE LINK PRICING SCHEME UNDER MULTI SERVICE NETWORK WITH BANDWIDTH QOS ATTRIBUTE

Irmeilyana, Fitri Maya Puspita, Indrawati, Rahayu Tamy Agustin and Muthia Ulfa
Department of Mathematics, Faculty of Mathematics and Natural Sciences, Sriwijaya University, South Sumatera, Indonesia
E-Mail: fitrimayapuspita@unsri.ac.id

ABSTRACT

In this paper, pricing schemes were set up on wireless internet of multi service network to the improved models as Internet service providers (ISPs) require new pricing schemes to maximize revenue and provide high quality of service to end users. The model was formed by improving the original model together with the model of multi- service network by setting the base price (α) and premium quality (β)as variables and constants. The models are solved by the program Lingo 11.0 to get the optimal solution. The results show that the improved models yield maximum revenue for ISP.ISP' maximum income is obtained by applying the improved model by setting up a variable α and β as constant as well as by increasing the cost of all the changes in QoS and QoS value.

Keywords: wireless pricing scheme, multi service network, bandwidth QoS atributte, optimal solution.

INTRODUCTION

The usage of the internet by large segments of the community provides an important role in economic life. In this era of internet usage has reached the wireless internet. Wireless Internet is a computer network information distribution medium does not use the cable but uses radio waves which digital data is sent via wireless to be modulated to the electromagnetic waves like discussed in Kennington *et al*., [1], Maiti [2] and Wallenius and Hämäläinen [3]. Economically, the use of wireless internet is cheaper than using a wired internet. This situation provides a great challenge for ISPs in arranging appropriate pricing scheme and can provide maximum benefit ISPs and users of the service.

The pricing scheme is based on the latest internet flat fee rate, usage based and two-part tariff explained previously by Sain and Herpers [4], Indrawati *et al*., [5] and Wu and Banker [6]. Customers generally have tendency to use flat-rate pricing for the scheme due to its simplicity. However, this scheme basically has a disadvantage because it does not solve the problems of congestion. This led to a pricing scheme flat rate is less appropriate for ISPs because it cannot avoid the congestion so that the ISP cannot maximize revenue.

Recently, the discussion of model of wireless pricing scheme on multi class network were due to Irmeilyana *et al*. [7], Irmeilyana *et al*., [8]and Puspita *et al*., [9] with different QoS attributes. Their results show by improving the models with considering the base value and quality premium, ISP is able to improve their profit. The improved models are to be proven in maximizing the profit of providers.

So, in this paper, the notion of pricing scheme of wireless internet pricing schemes in single link formed by [3] with QoS attributes such as bandwidth and multi-service network model [4] also [10] by setting the base price (α) and premium (β) will be designed with a new improved models taking into account the pricing model of wireless networks that will be solved optimally by using LINGO program 11.0. The solution obtained is expected to be used to maximize revenue ISP and provide the best quality services for users.

RESEARCH METHOD

In this research, the scheme of single link wireless internet network by multi service is completed with LINGO 11.0 program that can solve the nonlinear model to get the optimal solution. The model used is improved by the original model with QoS attributes are bandwidth and multi- service network model by setting the base price (α) and premium (β). Model established will then be processed using the data have been obtained from one of the local server in Palembang, where data used consists of mail IP cam traffic data.

MODELS

Original models using bandwidth Qos attribute

The parameters used in the original model, namely

R	: Function for income
PR_{ik}	: The cost to connect to the QoS provided
PQ_{ik}	: Changes in the cost of all the changes QoS
x	: Amount of increase or decrease in the value of QoS
Q_{bik}	: Nominal value attribute QoS in the network operator
PB_{ik}	: The basic fee for a connection with the service i and links k
Lx	: Linearity factor
a_{ik}	: Linear cost factor in servicei and links k
T_l	: Traffic goods
a	: Linear parameter set
B	: Linear parameter set
f, g, h	: A predetermined minimum value for service provider
a_{ik}	: The maximum value that has been set for the service provider
T_l	: The minimum amount of traffic goods that is allowed.

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$T_l k$: The maximum amount of traffic goods that is allowed.

Pricing schemes wireless internet in the original model for attribute QoS bandwidth is divided into four (4) cases based on the value and x.

Thus, the objective function is as follows.

$$MaxR = \sum_{k=1}^{r}\sum_{i=1}^{s}(PR_{ik} \pm PQ_{ik}) \quad (1)$$

Subject to

$$PQ_{11} = \left(1 \pm \frac{x}{2000}\right) PB_{11}Lx \quad (2)$$

$$PQ_{12} = \left(1 \pm \frac{x}{2000}\right) PB_{12}Lx \quad (3)$$

$$PQ_{21} = \left(1 \pm \frac{x}{2000}\right) PB_{21}Lx \quad (4)$$

$$PQ_{22} = \left(1 \pm \frac{x}{2000}\right) PB_{22}Lx \quad (5)$$

$$PB_{11} = a_{11}(e - e^{-xB})T_l/100 \quad (6)$$

$$PB_{12} = a_{12}(e - e^{-xB})T_l/100 \quad (7)$$

$$PB_{21} = a_{21}(e - e^{-xB})T_l/100 \quad (8)$$

$$PB_{22} = a_{22}(e - e^{-xB})T_l/100 \quad (9)$$

$$L_x = (e - e^{-xB}) \quad (10)$$

$$0{,}05 \le a_{11} \le 0{,}15 \quad (11)$$

$$0{,}06 \le a_{12} \le 0{,}14 \quad (12)$$

$$0{,}07 \le a_{21} \le 0{,}13 \quad (13)$$

$$0{,}08 \le a_{22} \le 0{,}12 \quad (14)$$

$$50 \le T_l \le 1000 \quad (15)$$

$$0 \le x \le 1 \quad (16)$$

$$0.8 \le B \le 1.07 \quad (17)$$

$$a = 1 \quad (18)$$

Improved models

In the modified model, the model developed by combining with a model of multi- service network and by adding parameters, decision variables and constraints of each model and set a base price (α) and premium (β).The parameters used in the improved model, namely:

I_i : Quality of service index$i$
p_{ik} :The price of the service users i on the link k
x_{ik} :The amount of users$i$ on the link k
d_{ik} : Capacity required to service$i$ the link k
Q_{bik} : Nominal value attribute QoS in the network operator
C_k : Total capacity contained in link k
a_{ik} : Total capacity in service i on link k
m_i :Minimum QoS for service i
n_i : The number of service users i
l_i : The minimum premium for the service i
b_i :The maximum premium for the service i
y :The minimum base price for service i
z : The maximum base price for service i

Improved model case α and β constants in QoS bandwidth

Wireless pricing schemes in case of improved model constants α andβ as an objective function is

$$\text{Max } R = \sum_{k=1}^{r}\sum_{i=1}^{s} PR_{ik} \pm PQ_{ik} + \left((\alpha + \beta . I_i).p_{ik}.x_{ik}\right) \quad (19)$$

Subject to

$$PQ_{11} = \left(1 \pm \frac{x}{2000}\right) PB_{11}Lx \quad (20)$$

$$PQ_{21} = \left(1 \pm \frac{x}{2000}\right) PB_{21}Lx \quad (21)$$

$$PQ_{31} = \left(1 \pm \frac{x}{2000}\right) PB_{31}Lx \quad (22)$$

$$PB_{11} = a_{11}(e - e^{-xB})T_l/100 \quad (23)$$

$$PB_{21} = a_{21}(e - e^{-xB})T_l/100 \quad (24)$$

$$PB_{31} = a_{31}(e - e^{-xB})T_l/100 \quad (25)$$

$$L_x = (e - e^{-xB}) \quad (26)$$

$$0{,}05 \le a_{11} \le 0{,}15 \quad (27)$$

$$0{,}06 \le a_{21} \le 0{,}14 \quad (28)$$

$$0{,}07 \le a_{31} \le 0{,}13 \quad (29)$$

$$50 \le T_l \le 1000 \quad (30)$$

$$0 \le x \le 1 \quad (31)$$

$$0.8 \le B \le 1.07 \quad (32)$$

$$a = 1 \quad (33)$$

$$I_1 x_{11} \le a_{11} \quad (34)$$

$$I_2 x_{21} \le a_{21} \quad (35)$$

$$I_3 x_{31} \le a_{31} \quad (36)$$

$$I_1 x_{11} + I_2 x_{21} + I_3 x_{31} \le C \quad (37)$$

$$a_{11} + a_{21} + a_{31} = 1 \quad (38)$$

$$0 \le a_{11} \le 1 \quad (39)$$

$0 \leq a_{21} \leq 1$ (40)

$0 \leq a_{31} \leq 1$ (41)

$0{,}01 \leq I_1 \leq 1$ (42)

$0{,}01 \leq I_2 \leq 1$ (43)

$0{,}01 \leq I_3 \leq 1$ (44)

$0 \leq x_{11} \leq 10$ (45)

$0 \leq x_{21} \leq 10$ (46)

$0 \leq x_{31} \leq 10$ (47)

$\{x_{11}, x_{21}, x_{31}\} \subseteq \mathbb{Z}^+$ (48)

By modifying the index of quality of servicei (Ii) we obtain
$I_i = I_{i-1}$ then added constraints:

$I_2 - I_1 = 0$ (49)

$I_3 - I_2 = 0$ (50)

Improved model case α constants and β variable in QoS bandwidth

Wireless pricing schemes in case of modified model constants α and βvariable objective function is

$\text{Max } R = \sum_{k=1}^{r} \sum_{i=1}^{s} PR_{ik} \pm PQ_{ik} + ((\alpha + \beta_i . I_i) . p_{ik} . x_{ik})$ (51)

With subject to Equation. (2)-(30), as well as the added constraints:

$\beta_2 I_2 \geq \beta_1 I_1$ (52)

$\beta_3 I_3 \geq \beta_2 I_2$ (53)

$0.01 \leq \beta_1 \leq 0.5$ (54)

$0.01 \leq \beta_2 \leq 0.5$ (55)

$0.01 \leq \beta_3 \leq 0.5$ (56)

$\beta_i = \beta_{i-1}$by modifying the service quality index i (Ii) and the premium quality of service then added constraints

$\beta_2 - \beta_1 = 0$ (57)

$\beta_3 - \beta_2 = 0$ (58)

Improved model case α and β variabels in QoS bandwidth

Wireless pricing schemes in case of improved model α and β variable objective function is

$\text{Max } R = \sum_{k=1}^{r} \sum_{i=1}^{s} PR_{ik} \pm PQ_{ik} + ((\alpha_i + \beta_i . I_i) . p_{ik} . x_{ik}$ (59)

With subject to Equation.(2)- (32) and Equation.(36) - (38), as well as the added constraints:

$\alpha_2 + \beta_2 I_2 \geq \alpha_1 + \beta_1 I_1$ (60)

$\alpha_3 + \beta_3 I_3 \geq \alpha_2 + \beta_2 I_2$ (61)

$0 \leq \alpha_1 \leq 1$ (62)

$0 \leq \alpha_2 \leq 1$ (63)

$0 \leq \alpha_3 \leq 1$ (64)

$\alpha_i = \alpha_{i-1}$by modifying the service quality index i (Ii) and and set a base price (α) and premium service (β), then added constraints

$\alpha_2 - \alpha_1 = 0$ (65)

$\alpha_3 - \alpha_2 = 0$ (66)

Improved model case α variabels and β constants in QoS bandwidth

Wireless pricing schemes in case of improved model variables α and β constant objective function is

$\text{Max } R = \sum_{k=1}^{r} \sum_{i=1}^{s} PR_{ik} \pm PQ_{ik} + ((\alpha_i + \beta . I_i) . p_{ik} . x_{ik})$ (67)

with subject to Equation.(2)- (32), (47), (48) and constraints (44) until the constraint (46), as well as the added constraints:

$\alpha_2 + I_2 \geq \alpha_1 + I_1$ (68)

$\alpha_3 + I_3 \geq \alpha_2 + I_2$ (69)

RESULTS AND DISCUSSIONS

The optimal solutionsare given in Table-1 to Table-11 for each case. Based on the objective function (1) with Equation. (2) to Equation. (18), the optimal solution for each case on bandwidth QoS attributes solved using LINGO 11.0. The results are presented in Table-1 to Table-3 as follow.

Based on Table-1, the value will achieve the most optimal results in the first case is equal to 32.6816. These results will be obtained by iterating as many as 11 iterations with the infeasibility of 0. Generated Memory Used (GMU) the total allocation of memory used is equal to 24K and Elapsed Runtime (ER) shows the total time used to generate and solve the model that is 0 seconds.

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Table-1. Optimal solution for original model.

Var	PQ_{ij} increase x increase	PQ_{ij} increase x decrease	PQ_{ij} decrease x increase	PQ_{ij} decrease x decrease
Model Class	**NLP**	**NLP**	**NLP**	**NLP**
State	Local Opt	Local Opt	Local Opt	Local Opt
Objec-tive	32.68	32.65	1.816	1.816
Infeasi-bility	0	0	1.3 x 10^{-17}	1.3 x 10^{-17}
Iter	11	11	9	9
GMU	24K	25K	25K	25K
ER	0s	0s	0s	0s

Table-2. Variable values for original model.

Var	PQ_{ij} increase x increase	PQ_{ij} increase x decrease	PQ_{ij} decrease x increase	PQ_{ij} decrease x decrease
PQ_{11}	**8.487065**	**8.438705**	**0.073812**	**0.073812**
PQ_{12}	7.921260	7.876125	0.088574	0.088574
PQ_{21}	7.355456	7.313545	0.103337	0.103337
PQ_{22}	6.789652	6.750964	0.118099	0.118099
x	1	1	0	0
PB_{11}	3.562910	3.562910	0.042957	0.042957
PB_{12}	3.325383	3.325383	0.051548	0.051548
PB_{21}	3.087855	3.087855	0.060139	0.060139
PB_{22}	2.850328	2.850328	0.068731	0.068731
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
L_x	2.375273	2.375273	1.718282	1.71828
T_l	1000	1000	50	50
B	1.07	1.07	0.8	0.8

Based on Table-2, it can be seen that the values of variables for case 1 and case 3 is not much different, but very much different from the case 3 and case 4 in which case 3 and case 4 have the values of the same variable.

Based on the objective function (19) with Equation. (20) to (50), the optimal solution in each case on bandwidth QoS attributes solved using LINGO 11.0 are presented in Table-3 and Table-4.

Based on Table-3, the value will achieve the most optimal results in the first case is equal to 125.681. These results will be obtained by iterating by 13 iterations of the infeasibility of 0. Generated Memory Used (GMU) that is 32K and Elapsed Runtime (E) is 0 seconds.

Table-3. Optimal solution for models for α and β constants in bandwidth QoS.

Variables	PQ_{ij} increase x increase	PQ_{ij} increase x decrease	PQ_{ij} decrease x increase	PQ_{ij} decrease x decrease
Model Class	**INLP**	**INLP**	**INLP**	**INLP**
State	Local Opt	Local Optimal	Local Optimal	Local Optimal
Objective	125.681	125.625	67.7576	67.7576

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Infeasibility	0	0	0	0
Iterations	13	13	45	45
GMU	32K	32K	32K	32K
ER	0	0s	0s	0s

Table-4. Optimal solution for models for α and β constants in bandwidth Qos.

Var	**PQ_{ij} increase x increase**	**PQ_{ij} increase x decrease**	**PQ_{ij} decrease x increase**	**PQ_{ij} decrease x decrease**
PQ_{11}	**2.905738**	**2.902833**	**0.075407**	**0.075407**
PQ_{21}	0.600000	7.894743	0.206674	0.206674
PQ_{31}	45.63906	49.59345	1.194164	1.194164
x	1	1	0	0
PB_{11}	1.222716	1.222716	0.043885	0.043885
PB_{21}	3.325383	3.325383	0.120279	0.120279
PB_{31}	19.20463	19.20463	0.694975	0.694975
PR_{11}	0.5	0.5	0.5	0.5
PR_{21}	0.6	0.6	0.6	0.6
PR_{31}	0.7	0.7	0.7	0.7
a_{11}	0.05	0.05	0.05	0.05
a_{12}	0.14	0.14	0.14	0.14
α_{31}	0.81	0.81	0.81	0.81
L_x	2.375273	2.375273	1.718282	1.718282
T_l	1000	1000	1000	1000
α	1	1	1	1
B	1.07	1.07	1.07	1.07
l_1	0.014	0.014	0.014	0.014
l_2	0.014	0.014	0.014	0.014
l_3	0.014	0.014	0.014	0.014
x_{11}	10	10	10	10
x_{21}	10	10	10	10
x_{31}	10	10	10	10

Based on Table-4, it can be seen that the values of variables for case 1 and case 3 is not much different, but very much different from the case 3 and case 4 in which case 3 and case 4 have the values of the same variable . value in Case 1 and Case 2 together , but not much different from the case 3 and case 4 in which cases 3 and 4 have the values of the same variable a_{ik} value in each case have the values of the same variable .

Based on the objective function (51) and the constraints (20) until the constraint (50) as well as the added constraint (52) until the constraint (58), the optimal solution for each case on bandwidth QoS attributes solved using LINGO 11.0 as presented in Table-5 and Table-6.

Based on Table-5, the value will achieve the most optimal results in the first case is equal to 125.681. These results will be obtained by iterating total of 40 times with the infeasibility of 1.5 x 10^{-2}. Generated Memory Used (GMU) in the amount of 34k and Elapsed Runtime (ER) is 0 seconds. Based on Table-6, it can be seen that the values of variables for case 1 and case 3 is not much different, but very much different from the case 3 and case 4 in which case 3 and case 4 have the values of the same variable. value and the value a_{ik} in case 1 and case 2 together , but not much different from the case 3 and case 4 in which cases 3 and 4 have the values of the same variable.

Table-5. Optimal solution for models for α constant and β variable in bandwidth Qos.

Var	PQ_{ij} increase x increase	PQ_{ij} increase x decrease	PQ_{ij} decrease x increase	PQ_{ij} decrease x decrease
Model class	**INLP**	**INLP**	**INLP**	**INLP**
State	Local Optimal	Local Optimal	Local Optimal	Local Optimal
Objective	125.681	125.625	67.7576	67.7576
Infeasibility	0.015	0.011	0	0
Iterations	24	24	13	13
GMU	34K	34K	34K	34K
ER	0s	0s	0s	0s

Furthermore, for the objective function (59) with constraints (20) to the constraints (50) and constraints (54) until the constraint (56) as well as the added constraint (60) until the constraint (66) , the optimal solution for each case on QoS attribute bandwidth solved using LINGO 11.0 like stated in Table-7 and Table-8.

Based on Table-7 grades will achieve the most optimal results in both cases is equal to 629.681. These results will be obtained by iterating by 12 iterations of the infeasibility of 0. Generated Memory Used (GMU) that is 35K and Elapsed Runtime (ER) is 0 seconds.

Based on Table-8, it can be seen that the values of variables for case 1 and case 2 is not much different, but very much different from the case 3 and case 4 in which case 3 and case 4 have the values of the same variable. value in Case 1 and Case 2 together, but not much different from the case 3 and case 4 in which cases 3 and 4 have the values of the same variable. a_{ik} value in each case have the values of the same variable.

The latter by the objective function (67) and the constraints (20) until the constraint (50), (65), (66) and constraints (62) until the constraint(64) as well as the added constraints (68) and constraints (69), the optimal solution for each case on bandwidth QoS attributes solved using LINGO 11.0 like stated in Table-9 and Table-10.

Based on Table-9, the values will achieve the most optimal results in the first case is equal to 692.681. These results will be obtained by iterating by 13 iterations of the infeasibility of 0. Generated Memory Used (GMU) that is 35K and Elapsed Runtime (ER) is 0 seconds.

Table-6. Variable values for models for α constant and β variable in bandwidth QoS.

Var	PQ_{ij} increase x increase	PQ_{ij} increase x decrease	PQ_{ij} decrease x increase	PQ_{ij} decrease x decrease
PQ_{11}	**8.467111**	**8.458648**	**0.076208**	**0.076208**
PQ_{21}	7.902640	7.894742	0.206674	0.206674
PQ_{31}	40.07769	4003763	1.193363	1.193363
x	1	1	0	0
PB_{11}	3.562908	3.562908	0.044351	0.044351
PB_{21}	3.325382	3.325382	0.120279	0.120279
PB_{31}	16.86444	16.86444	0.694509	0.694509
PR_{11}	0.5	0.5	0.5	0.5
PR_{21}	0.6	0.6	0.6	0.6
PR_{31}	0.7	0.7	0.7	0.7
a_{11}	0.15	0.15	0.05	0.05
a_{12}	0.14	0.14	0.14	0.14
α_{31}	0.71	0.71	0.81	0.81
L_x	2.375273	2.375273	1.718282	1.718282
T_l	1000	1000	1000	1000
α	1	1	1	1
B	1.07	1.07	1,07	1.07

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l_1	0.014	0.014	0.014	0.014
l_2	0.014	0.014	0.014	0.014
l_3	0.014	0.014	0.014	0.014
x_{11}	10	10	10	10
x_{21}	10	10	10	10
x_{31}	10	10	10	10
β_1	0.5	0.5	0.5	0.5
β_2	0.5	0.5	0.5	0.5
β_3	0.5	0.5	0.5	0.5

Table-7. Optimal solutions for models for α and β variable in bandwidth QoS.

Var	PQ_{ij} **increase** x **increase**	PQ_{ij} **increase** x **decrease**	PQ_{ij} **decrease** x **increase**	PQ_{ij} **decrease** x **decrease**
Model Class	**INLP**	**INLP**	**INLP**	**INLP**
State	Local Optimal	Local Optimal	Local Optimal	Local Optimal
Objective	629.681	692.625	634.758	634.758
Infeasibility	0	0	$1.1x10^{-16}$	$1.1x\ 10^{-16}$
Iterations	12	12	13	13
GMU	35K	35K	35K	35K
ER	0s	0s	0s	0s

Table-8. Variable values for models for α and β variable in bandwidth QoS.

Var	PQ_{ij} **increase** x **increase**	PQ_{ij} **increase** x **decrease**	PQ_{ij} **decrease** x **increase**	PQ_{ij} **decrease** x **decrease**
PQ_{11}	**2.822372**	**2.819551**	**0.073812**	**0.073812**
PQ_{21}	7.902642	7.894743	0.206674	0,206674
PQ_{31}	45.72243	45.67673	1.195759	1.195759
x	1	1	0	0
PB_{11}	1.187637	1.187637	0.042957	0.042957
PB_{21}	3.325383	3.325383	0.120279	0.120279
PB_{31}	19.23971	19.23971	0.695904	0.695904
PR_{11}	0.5	0.5	0.5	0.5
PR_{21}	0.6	0.6	0.6	0.6
PR_{31}	0.7	0.7	0.7	0.7
a_{11}	0.05	0.05	0.05	0.05
a_{12}	0.14	0.14	0.14	0.14
α_{31}	0.81	0.81	0.81	0.81
L_x	2.375273	2.375273	1.718282	1.718282
T_l	1000	1000	1000	1000
α	1	1	1	1
B	1.07	1.07	1.07	1.07
l_1	0.014	0.014	0.014	0.014
l_2	0.014	0.014	0.014	0.014

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l_3	0.014	0.014	0.014	0.014
x_{11}	1	1	1	1
x_{21}	1	1	1	1
x_{31}	1	1	1	1
β_1	0.5	0.5	0.5	0.5
β_2	0.5	0.5	0.5	0.5
β_3	0.5	0.5	0.5	0.5

Table-9. Optimal solutions for models for α variable and β constants in bandwidth Qos.

Var	PQ_{ij} increase x increase	PQ_{ij} increase x decrease	PQ_{ij} decrease x increase	PQ_{ij} decrease x decrease
Model Class	**INLP**	**INLP**	**INLP**	**INLP**
State	Local Optimal	Local Optimal	Local Optimal	Local Optimal
Objective	692.681	692.625	634.758	634.758
Infeasibility	0	0	0	0
Iterations	13	13	14	14
GMU	35K	35K	35K	35K
ER	0s	0s	0s	0s

Table-10. Variable values for models for α variable and β constants in bandwidth QoS.

Var	PQ_{ij} increase x increase	PQ_{ij} increase x decrease	PQ_{ij} decrease x increase	PQ_{ij} decrease x decrease
PQ_{11}	2.822372	2.819551	0.077160	0.077160
PQ_{21}	7.902642	7.894743	0.206674	0.206674
PQ_{31}	45.72243	45.67673	1.192411	1.192411
x	1	1	0	0
PB_{11}	1.187637	1.187637	0.044905	0.044905
PB_{21}	3.325383	3.325383	0.120279	0.120279
PB_{31}	19.23971	19.23971	0.693955	0.693955
PR_{11}	0,5	0,5	0.5	0.5
PR_{21}	0.6	0.6	0.6	0.6
PR_{31}	0.7	0.7	0.7	0.7
a_{11}	0.05	0.05	0.05	0.05
a_{12}	0.14	0.14	0.14	0.14
α_{31}	0.81	0.81	0.81	0.81
L_x	2.375273	2.375273	1.718282	1.718282
T_l	1000	1000	1000	1000
α	1	1	1	1
B	1.07	1.07	1.07	1,07
l_1	0.014	0.014	0.014	0.014
l_2	0.014	0.014	0.014	0.014
l_3	0.014	0.014	0.014	0.014
x_{11}	1	1	1	1

x_{21}	1	1	1	1
x_{31}	1	1	1	1

Based on Table-10, it can be seen that the values of variables for case 1 and case 3 is not much different, but very much different from the case 3 and case 4 in which case 3 and case 4 have the values of the same variable. value in case 1 and case 2 together , but not much different from the case 3 and case 4 in which cases 3 and 4 have the values of the same variable. a_{ik} value in each case have the values of the same variable.After combining each solver by each case which based in a base price (i) and premium price (β). A comparison for each case will given in Table-11.

Table-11. Comparison of original and our modified model for qos bandwidth.

Var	Orig Models	Modified models			
		$\alpha$and βconst	α const β var	α and β var	α varand β const
Model Class	NLP	INLP	INLP	INLP	INLP
State	Local Opt	Local Opt	Local Opt	Local Opt	Local Opt
Objet	32.681	125.68	125.68	692.62	692.681
Infeasibility	0	0	0	0	0
Iterations	11	13	13	12	13
GMU	24K	34K	35K	35K	35K
ER	0s	0s	0s	0s	0s

Based on Table-11, the most optimal solution is the modified model solution when we have the case of $\alpha$to be variable and β constants is by raising the cost of all the changes in QoS and QoS value which gained income in the amount of Rp. 692.681.

CONCLUSIONS

Based on solutions of comparative results of original model and the improved models, it can be concluded that ISPs obtain the maximum benefit in the modified model by setting the base price (α) as variable and premium quality (β) as constant as well as increasing the cost of all the changes in QoS and QoS value which gained the income in the amount of Rp. 692.681. By comparing with previous discussion the modified model by setting the base price (α) as variable and premium quality (β) as constant as well as increasing the cost of all the changes in QoS and QoS value gained more income.

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