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Application of Linear Programming in optimization of parking slot: A case study of Tamale-Bolgatanga lorry station in Ghana

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Abstract-- **This paper deals with optimization of parking slot via linear programming of Tamale/Bolgatanga main lorry station at the Tamale Metropolis in the Northern region of Ghana. It examined the maximum parking capacity of the Terminal and how it will be optimized to avoid traffic congestion in the metropolis and determined the best parking slot allocation to be distributed among different types of vehicle on limited parking space.**

Key word-- **Optimization, Parking slot, Linear, Programming,**

I. MODEL FORMULATION

Proportionality of average parking accumulation is computed out of the daily data obtained for each type of vehicle. This implies that proportion of vehicle average parking accumulation daily for each type of vehicle is computed from the vehicle average parking accumulation divided by total average parking accumulation for each vehicles and then multiplied by parking space capacity of the form:

$$\left.\begin{array}{l}\frac{q_1}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{q_2}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{q_3}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{q_4}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{q_5}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_4)\end{array}\right\} \quad (1)$$

Where

q_1 is taxi average parking accumulation (number of vehicles daily)

q_2 is 207 Benz Bus average parking accumulation (number of vehicles daily)

q_3 is Sprinter Benz Bus average parking accumulation (number of vehicle daily)

q_4 is Benz Bus average parking accumulation (number of vehicle daily)

q_5 is Yutong Bus average parking accumulation (number of vehicle daily)

While $(y_1+y_2+y_3+y_4+y_5)$ is parking space capacity allocated with

y_1 is the parking space capacity Taxi

y_2 is parking space capacity for 207 Benz Bus

y_3 is parking space capacity for Sprinter Benz Bus

y_4 is parking space capacity for Benz Bus

y_5 is parking space capacity for Yutong Bus

Which represent the proportionality to average on-the-scale parking duration/time (in minutes) for Taxi, 207 Benz Bus, Sprinter Benz Bus, Benz Bus and Yutong Bus. This is computed from the vehicle average on-the-scale parking duration divided by total average on-the-scale parking duration for all vehicles in a day and then multiplied by parking space capacity mathematically written as:

$$\left.\begin{array}{l}\frac{t_1}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{t_2}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{t_3}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{t_4}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\\ \frac{t_5}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_4)\end{array}\right\} \quad (2)$$

Where

t_1 is average on-the-scale parking duration for taxi in minutes,

t_2 is average on-the-scale parking duration for 207 Benz Bus in minutes,

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t_3 is average on-the-scale parking duration for Sprinter Benz Bus in minutes,

t_4 is average on-the-scale parking duration for Benz Bus in minutes,

t_5 is average on-the-scale parking duration for Yutong Bus in minutes

While $(y_1 + y_2 + y_3 + y_4 + y_5)$ is the parking space capacity allocated to each vehicles.

II. Parking Characteristics

We adopt the following Parking characteristics/parameters in the model formulation

1. *Parking volume:* The number of vehicle entering a parking site.
2. *Parking accumulation:* A number of vehicles parked at a parking site at a certain time.
3. *Parking index:* The percentage of the vehicle occupying the parking area.
4. *Parking duration:* The time interval (minute/hour) for a certain vehicle parked at a parking site. Percentage amount of parking duration is formulated as ratio between the amount of vehicle parked during certain time interval and total number of vehicle observed.
5. *Average parking duration:* Total number of vehicle parked during certain time interval compared to vehicle enter parking site.
6. *Parking exchanges:* Measurement of parking occupation calculated as ratio between the numbers of vehicle parked compared to parking capacity available.
7. Parking utilization level, computed from the ratio between average parking and parking space capacity.

Here we want to maximize the parking space capacity at Tamale/Bolgatanga main lorry station subject to available parking land, and at the same time meet the demand of parking for each type of vehicle Average parking is obtained from the ratio between sum of parking accumulation for all observation time and number of observation. The parking demand is based on proportionality of average parking accumulation and average on-the-scale parking duration.

Table 1 show the packing control unit (PCU) which depend on vehicle dimension with additional space needed for a vehicle to manoeuvre whose value depending on the parking angle showing the allocated parking space without additional space (PSWoAS) and parking space with additional space (PSWAS) of $0.5m^2$ for all five types of vehicle is shown the table below.

Table 1

S/N	Type of Vehicle	Width/m	Parking Width/m	Length/m	Parking Length/m	PSWoAS /meter sqr	PSWAS/ meter sqr
1	Taxi	1.90	2.40	4.42	4.92	8.40	11.81
2	Urvan	2.07	2.57	4.96	5.46	10.27	14.03
3	Ssang Young	2.07	2.57	5.49	5.99	11.36	15.39
4	207 Bus	2.20	2.70	5.57	6.07	12.25	16.39
5	Sprinter Bus	2.14	2.64	5.87	6.37	12.56	16.82
6	Benz Bus	2.20	2.70	7.22	7.72	15.88	20.84
7	Yutong Bus	2.44	2.94	11.89	12.39	29.01	36.43

From the table, the allocated parking space for all five types of vehicle is as follows:

a. Parking space for Taxi is $11.81m^2$.
b. Parking space for 207 Benz Bus is $16.39m^2$.
c. Parking space for Sprinter Benz Bus is $16.82m^2$.
d. Parking space for Benz Bus is $20.84m^2$.
e. Parking space for Yutong Bus is $36.43m^2$

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Table 2 shows the structure of decision making for maximization of parking capacity

Table 2

		Activity	
		y_1 y_2 y_3 y_4 y_5	
No	Coefficient of objective functions	w_1 w_2 w_3 w_4 w_5	Limitation factors
1	Parking space area	u_{11} u_{12} u_{13} u_{14} u_{15}	$\leq v_1$
2	Taxi parking accumulation	u_{21} u_{22} u_{23} u_{24} u_{25}	$\geq v_2$
3	207 Benz Bus parking accum	u_{31} u_{32} u_{33} u_{34} u_{35}	$\geq v_3$
4	Sprinter Benz Bus parking	u_{41} u_{42} u_{43} u_{44} u_{45}	$\geq v_4$
5	Benz Bus parking accumulation	u_{51} u_{52} u_{53} u_{54} u_{55}	$\geq v_5$
6	Yutong Bus parking accumulation	u_{61} u_{62} u_{63} u_{64} u_{65}	$\geq v_6$
7	Proportional average on-the-scale parking duration for Taxi	u_{71} u_{72} u_{73} u_{74} u_{75}	$\geq v_7$
8	Proportional average on-the-scale parking duration for 207 Bus	u_{81} u_{82} u_{83} u_{84} u_{85}	$\geq v_8$
9	Proportional average on-the-scale parking duration for Sprinter Bus	u_{91} u_{92} u_{93} u_{94} u_{95}	$\geq v_9$
10	Proportional average on-the-scale parking duration for Benz Bus	u_{101} u_{102} u_{103} u_{104} u_{105}	$\geq v_{10}$
11	Proportional average on-the-scale parking duration for Yutong Bus	u_{111} u_{112} u_{113} u_{114} u_{115}	$\geq v_{11}$

III. Linear Programming Processing Model

We set our objective function and its constraints as followed

Maximize: $y_1 + y_2 + y_3 + y_4 + y_5$

Subject to:

$$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \leq PSArea$$

$$y_1 \geq \frac{q_1}{q_1 + q_2 + q_3 + q_4 + q_5}(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_2 \geq \frac{q_2}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_3 \geq \frac{q_3}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_4 \geq \frac{q_4}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_5 \geq \frac{q_5}{q_1+q_2+q_3+q_4+q_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_1 \geq \frac{t_1}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_2 \geq \frac{t_2}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_3 \geq \frac{t_3}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_4 \geq \frac{t_4}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

$$y_5 \geq \frac{t_5}{t_1+t_2+t_3+t_4+t_5}(y_1+y_2+y_3+y_4+y_5)\beta$$

Non-negativity constraints:

$$y_1, y_2, y_3, y_4, y_5, q_1, q_2, q_3, q_4, q_5, t_1, t_2, t_3, t_4, t_5, \geq 0 : 0 \leq \beta \leq 1$$

Table.3 shows the total on-the-scale parking duration/time and exit daily ( ) in minutes.

Table 3

Day	Taxi	Urvan	Ssang Yo	207 Benz	Sprinter	Benz	Yutong
1	515 (55)	229 (8)	95(2)	269(10)	124(3)	195(4)	434(4)
2	590 (65)	177(8)	267(2)	564(23)	289(3)	242(4)	570(4)
3	709 (62)	201(4)	41(1)	895(24)	662(7)	198(3)	401(3)
4	596 (55)	120(3)	99(2)	932(21)	629(7)	119(2)	434(3)
5	288 (33)	133(6)	22(1)	524(17)	461(6)	107(3)	278(3)
Tot.	**2698** (270)	**860**(29)	**524**(8)	**3184**(995)	**2165**(26)	**861**(16)	**2117**(17)

Substituting for the values of $q_1, q_2, q_3, q_4, q_5, t_1, t_2, t_3, t_4, t_5$ and solve equations (1) and (2)with parking space area of 1163m^2 into the optimization problem yields:

Maximize: $Z = y_1 + y_2 + y_3 + y_4 + y_5$

Subject to:

$$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \leq 1163$$

$$y_1 \geq 0.51(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_2 \geq 0.20(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_4 \geq 0.11(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_5 \geq 0.04(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_1 \geq 0.03(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_2 \geq 0.11(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_3 \geq 0.27(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_4 \geq 0.18(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

$$y_5 \geq 0.41(y_1 + y_2 + y_3 + y_4 + y_5)\beta$$

Where $y_1, y_2, y_3, y_4, y_5 \geq 0$ and $0 \leq \beta \leq 1$ When β = 0.80

Maximize: $Z = y_1 + y_2 + y_3 + y_4 + y_5$

Subject to:

$$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \leq 1163$$

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$$0.592y_1 - 0.408y_2 - 0.408y_3 - 0.408y_4 - 0.408y_5 \geq 0$$
$$0.840y_2 - 0.160y_1 - 0.160y_3 - 0.160y_4 - 0.160y_5 \geq 0$$
$$0.888y_3 - 0.112y_1 - 0.112y_2 - 0.112y_4 - 0.112y_5 \geq 0$$
$$0.912y_4 - 0.088y_1 - 0.088y_2 - 0.088y_3 - 0.088y_5 \geq 0$$
$$0.968y_5 - 0.024y_1 - 0.024y_2 - 0.024y_3 - 0.024y_4 \geq 0$$
$$0.976y_1 - 0.024y_2 - 0.024y_3 - 0.024y_4 - 0.024y_5 \geq 0$$
$$0.888y_2 - 0.112y_1 - 0.112y_3 - 0.112y_4 - 0.112y_5 \geq 0$$
$$0.784y_3 - 0.216y_1 - 0.216y_2 - 0.216y_4 - 0.216y_5 \geq 0$$
$$0.856y_4 - 0.144y_1 - 0.144y_2 - 0.144y_3 - 0.144y_5 \geq 0$$

IV. Analysis Of Optimization/Results

Considering average parking accumulation and average on-the-scale parking duration at β = 0.70, 0.80, 0.90 and 1.00.

When β = 0.70

Maximize: $Z = y_1 + y_2 + y_3 + y_4 + y_5$

Subject to:

$$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \leq 1163$$
$$0.643y_1 - 0.357y_2 - 0.357y_3 - 0.357y_4 - 0.357y_5 \geq 0$$
$$0.860y_2 - 0.140y_1 - 0.140y_3 - 0.140y_4 - 0.140y_5 \geq 0$$
$$0.902y_3 - 0.098y_1 - 0.098y_2 - 0.098y_4 - 0.098y_5 \geq 0$$
$$0.923y_4 - 0.077y_1 - 0.077y_2 - 0.077y_3 - 0.077y_5 \geq 0$$
$$0.979y_1 - 0.021y_2 - 0.021y_3 - 0.021y_4 - 0.021y_5 \geq 0$$
$$0.923y_2 - 0.077y_1 - 0.077y_3 - 0.077y_4 - 0.077y_5 \geq 0$$
$$0.811y_3 - 0.189y_1 - 0.189y_2 - 0.189y_4 - 0.189y_5 \geq 0$$
$$0.672y_5 - 0.328y_1 - 0.328y_2 - 0.328y_3 - 0.328y_4 \geq 0$$

Where $y_1, y_2, y_3, y_4, y_5 \geq 0$ & $\beta = 0.80$

When β = 0.90

Maximize: $Z = y_1 + y_2 + y_3 + y_4 + y_5$

Subject to:

$$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \leq 1163$$
$$0.541y_1 - 0.459y_2 - 0.459y_3 - 0.459y_4 - 0.459y_5 \geq 0$$
$$0.820y_2 - 0.180y_1 - 0.180y_3 - 0.180y_4 - 0.180y_5 \geq 0$$
$$0.874y_3 - 0.126y_1 - 0.126y_2 - 0.126y_4 - 0.126y_5 \geq 0$$
$$0.901y_4 - 0.099y_1 - 0.099y_2 - 0.099y_3 - 0.099y_5 \geq 0$$
$$0.964y_5 - 0.036y_1 - 0.036y_2 - 0.036y_3 - 0.036y_4 \geq 0$$
$$0.973y_1 - 0.027y_2 - 0.027y_3 - 0.027y_4 - 0.027y_5 \geq 0$$

$$y_1, y_2, y_3, y_4, y_5 \geq 0 \quad \beta = 0.70$$

$$0.901y_2 - 0.099y_1 - 0.099y_3 - 0.099y_4 - 0.099y_5 \geq 0$$
$$0.757y_3 - 0.243y_1 - 0.243y_2 - 0.243y_4 - 0.243y_5 \geq 0$$
$$0.838y_4 - 0.162y_1 - 0.162y_2 - 0.162y_3 - 0.162y_5 \geq 0$$
$$0.631y_5 - 0.369y_1 - 0.369y_2 - 0.369y_3 - 0.369y_4 \geq 0$$

$$y_1, y_2, y_3, y_4, y_5 \geq 0 \quad \beta = 0.90$$

When β = 1.00

Maximize: $Z = y_1 + y_2 + y_3 + y_4 + y_5$

Subject to

$$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \leq 1163$$
$$0.49y_1 - 0.51y_2 - 0.51y_3 - 0.51y_4 - 0.51y_5 \geq 0$$
$$0.80y_2 - 0.20y_1 - 0.20y_3 - 0.20y_4 - 0.20y_5 \geq 0$$
$$0.86y_3 - 0.14y_1 - 0.14y_2 - 0.14y_4 - 0.14y_5 \geq 0$$
$$0.89y_4 - 0.11y_1 - 0.11y_2 - 0.11y_3 - 0.11y_5 \geq 0$$
$$0.96y_5 - 0.04y_1 - 0.04y_2 - 0.04y_3 - 0.04y_4 \geq 0$$
$$0.97y_1 - 0.03y_2 - 0.03y_3 - 0.03y_4 - 0.03y_5 \geq 0$$
$$0.89y_2 - 0.11y_1 - 0.11y_3 - 0.11y_4 - 0.11y_5 \geq 0$$
$$0.73y_3 - 0.27y_1 - 0.27y_2 - 0.27y_4 - 0.27y_5 \geq 0$$
$$0.82y_4 - 0.18y_1 - 0.18y_2 - 0.18y_3 - 0.18y_5 \geq 0$$
$$0.59y_5 - 0.41y_1 - 0.41y_2 - 0.41y_3 - 0.41y_4 \geq 0$$

Where $y_1, y_2, y_3, y_4, y_5 \geq 0$ & $\beta = 1.00$

Optimization considering both parking

Accumulation and parking duration at

β values from 0.5 and 0.6

When β = 0.50

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Maximize: $Z = y_1 + y_2 + y_3 + y_4 + y_5$

Subject to:

$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \le 1163$

$0.745y_1 - 0.255y_2 - 0.255y_3 - 0.255y_4 - 0.255y_5 \ge 0$

$0.90y_2 - 0.10y_1 - 0.10y_3 - 0.10y_4 - 0.10y_5 \ge 0$

$0.93y_3 - 0.07y_1 - 0.07y_2 - 0.07y_4 - 0.07y_5 \ge 0$

$0.945y_4 - 0.055y_1 - 0.055y_2 - 0.055y_3 - 0.055y_5 \ge 0$

$0.98y_5 - 0.02y_1 - 0.02y_2 - 0.02y_3 - 0.02y_4 \ge 0$

$0.985y_1 - 0.015y_2 - 0.015y_3 - 0.015y_4 - 0.015y_5 \ge 0$

$0.945y_2 - 0.055y_1 - 0.055y_3 - 0.055y_4 - 0.055y_5 \ge 0$

$0.865y_3 - 0.135y_1 - 0.135y_2 - 0.135y_4 - 0.135y_5 \ge 0$

$0.91y_4 - 0.09y_1 - 0.09y_2 - 0.09y_3 - 0.09y_5 \ge 0$

$0.795y_5 - 0.205y_1 - 0.205y_2 - 0.205y_3 - 0.205y_4 \ge 0$

Where $y_1, y_2, y_3, y_4, y_5 \ge 0$ & $\beta = 0.50$

When β = 0.60

Maximize: $Z = y_1 + y_2 + y_3 + y_4 + y_5$

Subject to:

$11.81y_1 + 16.39y_2 + 16.82y_3 + 20.84y_4 + 36.43y_5 \le 1163$

$0.694y_1 - 0.306y_2 - 0.306y_3 - 0.306y_4 - 0.306y_5 \ge 0$

$0.88y_2 - 0.12y_1 - 0.12y_3 - 0.12y_4 - 0.12y_5 \ge 0$

$0.916y_3 - 0.084y_1 - 0.084y_2 - 0.084y_4 - 0.084y_5 \ge 0$

$0.934y_4 - 0.066y_1 - 0.066y_2 - 0.066y_3 - 0.066y_5 \ge 0$

$0.976y_5 - 0.024y_1 - 0.024y_2 - 0.024y_3 - 0.024y_4 \ge 0$

$0.982y_1 - 0.018y_2 - 0.018y_3 - 0.018y_4 - 0.018y_5 \ge 0$

$0.934y_2 - 0.066y_1 - 0.066y_3 - 0.066y_4 - 0.066y_5 \ge 0$

$0.838y_3 - 0.162y_1 - 0.162y_2 - 0.162y_4 - 0.162y_5 \ge 0$

$0.892y_4 - 0.108y_1 - 0.108y_2 - 0.108y_3 - 0.108y_5 \ge 0$

$0.754y_5 - 0.246y_1 - 0.246y_2 - 0.246y_3 - 0.246y_4 \ge 0$

Where $y_1, y_2, y_3, y_4, y_5 \ge 0$ & $\beta = 0.60$

V. Results

The model was tested for β value ranging from 0.70 to 1 with an interval of 0.10 using Management Scientist Version 5, (2000) to find the optimal solutions with respect to the various constraints and results as tabulated below

1. Optimization considering average parking accumulation constraints with β value of 0.70- 1.00.
2. Optimization considering only average on-the-scale parking duration constraints with values β from 0.70 to 1.00.
3. Optimization considering both constraints of average parking duration and average parking accumulation with values of β 0.50 and 0.60

Formulation Considering Parking Accumulation Only

Table 4 Results of Optimization considering average parking accumulation only

Table 4

Variable	$\beta = 0.70$	$\beta = 0.80$	$\beta = 0.90$	$\beta = 1.00$
y_1	53.333	48.147	43.207	38.501
y_2	11.365	12.670	13.913	15.099
y_3	7.955	8.869	9.739	10.569
y_4	6.251	6.969	7.652	8.304
y_5	2.273	2.534	2.783	3.020
Z	**81.176**	**79.189**	**77.297**	**75.493**

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From the above table, the result indicate that the higher the value of β (level of satisfaction), the smaller the parking slot obtained with Taxi having the highest accumulation and Yutong bus in(y_5) having the lowest accumulation in comparison to the others.

Table 5 shows Optimization considering average on-the-scale parking duration only

Table 5

Variable	$\beta = 0.70$	$\beta = 0.80$	$\beta = 0.90$	$\beta = 1.00$
y_1	17.514	12.496	6.147	1.374
y_2	4.202	5.772	4.792	5.039
y_3	10.313	8.942	11.761	12.369
y_4	6.875	7.421	7.841	8.246
y_5	15.661	16.903	17.860	18.783
Z	**54.567**	**51.533**	**48.401**	**45.812**

From the table, it shows that the higher the value of β (level of satisfaction) the smaller the parking slot obtained. Here Yutong buses (y_5) having highest average on-the-scale parking duration in comparison to the others.

However, as average on-the-scale parking duration for all vehicles almost closed, the differences were not very extreme and the resulting parking slot allocations were also closed among all five types of vehicle.

Table.6 Shows Optimization considering both parking accumulation and parking duration.

Table 6

Variable	$\beta = 0.50$	$\beta = 0.60$
y_1	29.069	20.954
y_2	6.185	6.908
y_3	8.349	9.326
y_4	5.566	6.217
y_5	12.679	14.161
Z	**61.848**	**57.566**

From the table, it shows that the higher the value of β (level of satisfaction) the smaller the parking slot obtained especially,

Taxi (y_1) having the highest average parking accumulation and parking duration in comparison to the others.

In contrast, parking slots for the remaining types of vehicle increased with the increase of the β value (i.e. level of satisfaction). Comparison of all three procedures suggest that the formulation considering parking accumulation only is the best option if the total number of optimal parking slot is used as a performance measurement and the formulation considering average on-the-scale parking duration only is clearly less preferable as it gives the result of less number of optimal parking slot and it does not relate significantly with the customer satisfaction practically.

VI. Conclusion

This paper deal with optimization of parking slot using linear programming at the Tamale Metropolis in the Northern Region of Ghana with particular emphasis at the Savelugu Terminal (i.e. Tamale/Bolgatanga main lorry station) where we examine the maximum parking capacity of the Terminal and how it will be optimized to avoid traffic congestion in the metropolis and determine the best parking slot allocation to distribute among different types of vehicle on limited parking space. It shows that the higher the value of β (level of satisfaction) the smaller the parking slot obtained as the formulation considering parking accumulation only is the best option if the total number of optimal parking slot is used as a performance measurement.

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