Parking Lot Allocation Based on Matching Theory using Prediction-based Optimal Vehicle Routing

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Abstract: The purpose of this paper is to relax traffic congestion caused by the decrease in vehicle speed in case of a driver searching for a parking lot in traffic network, by using Smart Parking System. Smart Parking System is a system that allocates parking lot considering both the driver’s preference and the parking lot manager’s preference in advance. At that time, driver should know the optimal route and its time from current location to each parking lot. In this paper, Smart Parking System consider the road condition in traffic network and present the driver time by the optimal route from the driver’s current location to each parking lot. Then, the parking lot allocation is determined by using matching theory considering both the driver’s preference including information of optimal route and its time and the parking lot manager’s preference. Finally, the effectiveness is confirmed by numerical simulations and results of parking lot allocation using optimal vehicle routing.

Keywords: Smart Parking System, parking lot allocation, optimal routing algorithm, matching theory, ITS

1. INTRODUCTION

Recently, traffic congestion occured by increasing of the population and traffic volume is worldwide problem. Especially in urban area, one of causes of traffic congestion is the decrease in vehicle speed in case of a driver searching for parking lots. Nearly 30 \% of urban traffic is due to vehicle searching for parking lot[1] and it takes about 3.5 minutes to 14 minutes when driver finds vacant parking lot, so traffic congestion occurs because many driver drive prowling [2].

Intelligent Transport System(ITS) is developed and ITS aims to improve the use of traffic systems. Then, as one of the ITS technologies, ”Smart Parking System” is attracting attention. By using ITS, Smart Parking System get real time information on parking lots and drivers searching for parking lot, then Smart Parking System allocates appropriate parking lot to the driver based on preferences submitted by drivers and parking managers.

In [3] and [4], Smart Parking System and the structure of parking lot allocation are described. In [4], however, driver’s preference is only considered, and parking manager’s preference is not mentionned. In [5], both driver’s preference and parking manager’s preference are considered, however, the detailed road network in traffic network is not mentioned and the optimal route and time are not considered when driver head to the parking lot.

In [6], both the distance and the vehicle speed are set for each path and the cost for each path is not the distance but travel time. Optimal route is predicted by updating the cost for each path because road conditions will change travel time vehicle moving along each path. However, this method determine the optimal route only considering the vehicle’s adjacent path at the time.

The purpose of Smart Parking System is to reduce searching time for parking lot and increase parking lot profit. Also, driver should know optimal route and its time from current location to each parking lot. In this paper, we consider road network that are not consid- erd in conventional research, and propose a prediction-based optimal vehicle routing considering road conditions such as two ahead.

Then, we use GS(Gale=Shapley) algorithm of math- cing theory when allocating parking lot. GS algorithm has good stability and strategy-proofness, and is suitable for considering both driver’s preference and parking manager’s preference. Based on matching theory, we aims to reduce searching time for parking lot and maximize profits both driver and parking manager.

The flow of this paper as follows. In chapter 2, we explain about Smart Parking System, and traffic network and traffic flow model in road network. In chapter 3, we propose a prediction-based optimal vehicle routing. In chapter 4, we determine driver’s preference and parking manager’s preference, then, parking lot is allocated based on matching theory. In chapter 5, the effectiveness is confirmed by numerical simulations and results of parking lot allocation using optimal vehicle routing.

2. PROBLEM FORMULATION

2.1 Smart Parking System

Smart Parking System is shown in Fig. 1. Smart Parking System determine appropriate parking lot allocation that satisfies with both driver’s request and parking manager’s request. After allocation determined, driver reserves the allocated parking lot by Smart Parking System and parks in it.

2.2 Traffic Network

Traffic network is shown in Fig. 2, the width is about 1 km and height is about 750 m.
The purpose of Smart Parking System is to reduce the parking time vehicle moving along each path. How- ever, the parking system is not mentioned, and the optimal route and time are not considered. Finally, the effectiveness is confirmed by numerical simulations and result of parking lot allocation using optimal vehicle routing.

### 2.3 Road Network

In Fig. 2, we consider 38 paths traffic flow. One path of a set of paths $L = \{L_1, L_2, ..., L_{37}, L_{38}\}$. Star markers represent inflowpoint from outside the deal with area and these vehicles supposed not to be allocated parking lot.

#### 2.3.1 Traffic Flow Model

We consider traffic flow model on $l$ is shown in Fig. 3 based on the literature [7].

At time $k$, traffic flow model on $l$ can be expressed by the following linear discrete-time model.

$$\begin{align*}
x_i(k+1) &= x_i(k) + q_{in,l}(k) - q_{out,l}(k) + d_l(k) \\
x_l(k) &= h_l s_l(k) \\
q_{in,l}(k) &= \sum_{m \in L} \tau_{m,l} q_{out,m}(k)
\end{align*}$$

In this traffic network, it is assumed that there is a traffic light at each intersection and all the signals turn green periodically at regular intervals. $q_{out,l}(k)$ can be expressed as Eq. (3).

$$q_{out,l}(k) = h_l s_l(k)$$

$q_{in,l}(k)$ depends on other $q_{out,l}(k)$ and $q_{in,l}(k)$ can be expressed as Eq. (4).

$$q_{in,l}(k) = \sum_{m \in L} \tau_{m,l} q_{out,m}(k)$$

## Table 1: Parking Information

<table>
<thead>
<tr>
<th>Index</th>
<th>Parking lot</th>
<th>Parking fee(yen/min)</th>
<th>Capacity(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Parking 2-1</td>
<td>300/30</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Parking 1-1</td>
<td>450/30</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>Parking 3</td>
<td>500/20</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>Parking 1-2</td>
<td>600/20</td>
<td>42</td>
</tr>
<tr>
<td>5</td>
<td>Parking 2-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Parking 1-3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Table 2: Definition of Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_i(k)$</td>
<td>Number of vehicles on $i$</td>
</tr>
<tr>
<td>$q_{in,l}(k)$</td>
<td>Number of vehicles flowing into $l$</td>
</tr>
<tr>
<td>$q_{out,l}(k)$</td>
<td>Number of vehicles flowing out of $l$</td>
</tr>
<tr>
<td>$q_l(k)$</td>
<td>Number of vehicles flowing outside from the area</td>
</tr>
<tr>
<td>$d_l(k)$</td>
<td>Number of disturbance vehicles</td>
</tr>
<tr>
<td>$h_l$</td>
<td>Outgoing vehicles from $l$ at unit green light time</td>
</tr>
<tr>
<td>$r_{m,n}$</td>
<td>Path length between node $m$ and $n$ on $l$</td>
</tr>
<tr>
<td>$v_h$</td>
<td>Optimal vehicle speed</td>
</tr>
<tr>
<td>$r_{max}$</td>
<td>The longest path length between nodes</td>
</tr>
<tr>
<td>$T$</td>
<td>Sampling time</td>
</tr>
<tr>
<td>$C_{total}(k)$</td>
<td>Total travel time(cost) at time $k$</td>
</tr>
<tr>
<td>$c_l(k)$</td>
<td>Maximum acceptable number of drivers</td>
</tr>
<tr>
<td>$X_0$</td>
<td>A set of matching</td>
</tr>
<tr>
<td>$X_k$</td>
<td>A set of temporary Matching</td>
</tr>
<tr>
<td>$X_j^l$</td>
<td>Temporary pair with parking lot $j$ in $X_k^l$</td>
</tr>
<tr>
<td>$X_{k,low}^l$</td>
<td>The lowest preferred driver among $P_j^l$ in $X_k^l$</td>
</tr>
</tbody>
</table>
\( d_l(k) \) represents the number of vehicles flowing into \( l \) from buildings or flowing out of \( l \) into buildings. Let \( D_l(k) = g_l(k) + d_l(k) \) and rewrite Eq. (2) into Eq. (5).

\[
x_l(k + 1) = x_l(k) + \sum_{m \in L} r_{m,l} h_m s_m(k) - h_l s_l(k) + D_l(k)
\]

(5)

If Eq. (5) is applied to all paths, the following state update equation can be obtained.

\[
x(k + 1) = x(k) + Ts(k) + D(k)
\]

(6)

We set \( x(k) = [x_{L1}(k), \ldots, x_l(k), \ldots, x_{L38}(k)]^T \) and \( s(k) = [s_{L1}(k), \ldots, s_l(k), \ldots, s_{L38}(k)]^T \) in Eq. (6).

Then, \( T \) includes \( \tau_{m,l} \) called Turning rate and can be expressed as Eq. (7).

\[
T = \begin{cases} 
-h_{l_s}, & \text{if } m = l \\
\tau_{m,l} h_m, & \text{if } m \text{ is connected to } l \\
0, & \text{otherwise}
\end{cases}
\]

(7)

2.3.2 Set of Vehicle Speed Based on Number of Vehicles

In general, travel time of one road depends on traffic volume of the road. So, referring to [8], we consider optimal speed function \( V_s(x_l(k)) \) depending on \( x_l(k) \) represented as Eq. 8.

\[
V_s(x_l(k)) := V\left(\frac{\tanh(\frac{\alpha x_l(k) - \alpha}{\alpha}) + \tanh(\alpha)}{1 + \tanh(\alpha)}\right)
\]

(8)

\[
tanh(\alpha) = \frac{e^{\alpha} - e^{-\alpha}}{e^{\alpha} + e^{-\alpha}}
\]

(9)

Then, set \( v_l(k) \) by using \( V_s(x_l(k)) \) and \( v_l(k) \) represents vehicle speed on \( l \) at time \( k \).

\[
v_l(k) = V - \left\{ V_s(x_l(k)) - V_s(0) \right\} \times \frac{V}{V - V_s(0)}
\]

(10)

\( V \) represents vehicle normal speed, \( \alpha \) and \( \beta \) represent optional parameter. Change of \( v_l(k) \) is shown in Fig. 4 when \( V = 500 \) [min/m], \( \alpha = 15 \) and \( \beta = 35 \) are set.

Fig. 4 Vehicle Speed Based on Number of Vehicles

3. PREDICTION-BASED OPTIMAL VEHICLE ROUTING

Prediction-based optimal vehicle routing is a method that searches optimal route to update cost between paths according to travel time of vehicle moving. But this paper does not consider the synchronization of signals.

Let parking lot \( j_1 \sim j_6 \) be node 15–20. Based on both \( v_l(k) \) and \( r_{m,n} \), travel cost \( C_{m,n}(k) \) is given by:

\[
C_{m,n}(k) = \frac{r_{m,n}}{v_l(k)} \quad l \in L
\]

(11)

Let \( h^*(n) \) be estimated cost from node \( n \) to desired parking lot, and \( h^*(n) \) is given by:

\[
h^*(n) = \frac{|d_x - n_x| + |d_y - n_y|}{v_h}
\]

(12)

\( (d_x, d_y) \) represents the coordinates of desired parking lot, and \( (n_x, n_y) \) represents the coordinates of node \( n \). Set penalty \( p_h \) optimally to satisfy Eq. (13).

\[
0 \leq p_h < \frac{r_{\max}}{v_h}
\]

(13)

Then, let \( R \) be adjacency matrix, and \( R \) is given by:

\[
R = \begin{cases} 
1, & \text{if node } m \text{ is connected to node } n \\
0, & \text{otherwise}
\end{cases}
\]

(14)

Let \( k' \) be update step, and set \( k' = k + \lfloor C_{\text{total}}/\tau \rfloor \).

So, let \( N = [1, 2, \ldots, 20] \) be a set of nodes, and optimal vehicle routing algorithm is shown below.

**Optimal vehicle routing algorithm**

**Step 1:** Set initial position \( s \) and desired parking lot \( d \). Next, set \( C_{\text{total}} = 0 \) and \( k = 1 \).

**Step 2:** Let current position be node \( m \). Consider the following condition for node \( n \) adjacent to node \( m \).

\[
R(m, n) = \begin{cases} 
1, & \text{if } h^*(n) \leq h^*(m) + p_h \\
0, & \text{if } h^*(n) > h^*(m) + p_h
\end{cases}
\]

(15)

**Step 3:** Calculate \( k' \) and update \( C_{m,n} \) in case of \( k \). Add \( C_{m,n}(k') \) to \( C_{\text{total}}(k) \), and move to node \( n \). If \( m = d \), go to Step 4. If \( m \neq d \), go back to Step 2.

**Step 4:** Determine the path with the lowest total cost and its time. Also, it is assumed to call its time \( T_n(k) \).

\[
\min_{m,n} J_n = \sum_{m,n \in N} C_{m,n}(k')
\]

(16)

**Step 5:** \( k = k + 1 \) and reset initial position. Then, go back to Step 2.

In Step 2, \( R(m, n) \) is 1 if vehicle get closer to \( d \) or does not change to \( d \) after moving, and \( R(m, n) \) is 0 if vehicle go away from \( d \) after moving.

4. PARKING LOT ALLOCATION

We explain a method of parking lot allocation based on matching theory. Smart Parking System determines parking lot allocation considering both driver’s preference including information of travel time by prediction-based optimal routing and parking manager’s preference.
4.1 Preference Determination

In discussing the matching theory, it is assumed that a driver has a preference for all parking lots in the area, and a parking manager has a preference for all drivers flowing in the area at time $k$. Preference is described below.

Definition 1: Preference $\geq_i$ of an individual $i$ on a set $X$ is a binary relation on $X$ that satisfies the following conditions.
1. $x \geq_i x, \forall x \in X$
2. $[x \geq_i y$ and $y \geq_i z] \Rightarrow x \geq_i z, \forall x, y, z \in X$
3. $x \geq_i y$ or $y \geq_i x, \forall x, y \in X$

$x \geq_i y$ represents that individual $i$ prefers $x$ to $y$ or individual $i$ like those to some extent.

4.1.1 Driver’s Preference Determination

Three items to determine driver’s preference $P_i$ for parking lots are described below.

First, we set walking distance $D_{ij}$ from parking lot $j$ in which driver $i$ will park to the driver $i$’s destination. For driver $i$, the coordinates of the driver $i$’s destination are set $(d_{i,x}, d_{i,y})$ and coordinates of the parking lot $j$ are $(l_{j,x}, l_{j,y})$ are set, so $D_{ij}$ is given by:

$$D_{ij} = |d_{i,x} - l_{j,x}| + |d_{i,y} - l_{j,y}|$$ (17)

Second, we set travel time $T_{ij}(k)$ from driver $i$’s current location to parking lot $j$ in which driver $i$ will park. Using travel time $T_{n}(k)$ obtained by prediction-based optimal routing, $T_{ij}(k)$ is given by:

$$T_{ij}(k) = T_{n}(k)$$ (18)

Third, we set parking fee $F_{ij}$ for parking lot $j$, where $o_i$ is driver $i$’s scheduled parking time, $\tau_j$ is additional time of parking fee for parking lot $j$, and $f_j$ is fee per $\tau_j$. Using the above, $F_{ij}$ is given by:

$$F_{ij} = \frac{o_i}{\tau_j} f_j$$ (19)

Then, based on Eq. (17) ~ (19), cost function for parking lot $j$ of driver $i$ is as follows.

$$J^d_{ij} = w_D D_{ij} + w_T T_{ij}(k) + w_F F_{ij}$$ (20)

$w_D$, $w_T$ and $w_F$ are weight values determined by driver $i$ independently, and determine the importance of each element for driver $i$.

For all parking lots, repeatedly resolving Eq. (20) to minimize, we can obtain driver’s preference vector $P_i$.

4.1.2 Parking Manager’s Preference Determination

We think parking lot $j$ of parking manager has a preference. Two items to determine parking manager’s preference $P_j(k)$ for drivers flowing into the area at time $k$ are described below.

First, let $F_{ij}$ be benefit obtained from parking fee of driver $i$. $F_{ij}$ is the same as Eq. (19) and given by:

$$F_{ij} = \left[ \frac{o_i}{\tau_j} \right] f_j$$ (21)

Second, let $U_{ij}$ be average utilization rate of parking manager’s parking lot $j$. $U_{ij}$ is given by:

$$U_{ij} = \frac{e_i(k)}{N_j} (1 - \int_0^{o_i} \frac{1}{\lambda} e^{-\frac{\lambda}{\nu}} dx)$$ (22)

$N_j$ represents the number of parking spaces in parking lot $j$, and $\lambda$ represents the average number of vehicles flowing into the area within the sampling time. The former half is empty space for the number of parking spaces in parking lot $j$. The latter is the probability that no other vehicles will flow during scheduled parking time $o_i$ of driver $i$. That is, Eq. (22) represents an indicator of whether to accept driver $i$ at time $k$.

Then, based on Eq. (21), (22), using $w_m$ as a weighting factor, gain function is as follows.

$$J^m_{ij} = F_{ij} + w_m U_{ij}$$ (23)

For all drivers flowing into the area at time $k$, repetitively solving Eq. (23) to maximize, we can obtain parking manager’s preference vector $P_j(k)$.

4.2 Parking Lot Allocation Algorithm Based on Matching Theory

We determine parking lot allocation based on GS algorithm of matching theory using both driver’s preference and parking manager preference.

Based on both $e_i(k)$ and $V_{in}(k)$, $c_j(k)$ is given by:

$$c_j(k) = \begin{cases} |V_{in}(k)|, & \text{if } |V_{in}(k)| < e_j(k) \\ e_j(k), & \text{if } 0 \leq e_j(k) \leq |V_{in}(k)| \\ 0, & \text{if } e_j(k) = 0 \end{cases}$$ (24)

Parking lot allocation algorithm is shown below.

**Parking lot allocation algorithm**

**Step 1:** Determine both driver $i$’s preference $P_i$ based on Eq. (20) and parking manager’s preference $P_j(k)$ based on Eq. (23). Let $X^i_k(j) = \emptyset$.

**Step 2:** Driver $i$ applies for parking to the parking lot most preferred at present based on own preference $P_i$.

**Step 3:** Based on $P_j(k)$ and $c_j(k)$, applied parking lot $j$ accepts or refuses driver $i$’s parking application according to following three situations

- if $|X^i_k(j)| < c_j(k)$
  Parking lot $j$ accept driver $i$’s application, and make a new $X^i_k(j)$. Next, update $X_{k, low}(j)$. Then, $i = i + 1$, and go back to Step 2.

- elseif $|X^i_k(j)| = c_j(k)$ and $i \geq_j X_{k, low}(j)$
  Parking lot $j$ clear the temporary pair of $X_{k, low}(j)$, and accept driver $i$’s application, and make a new $X^i_k(j)$. Next, set $i' = X_{k, low}(j)$, and exclude parking lot $j$ from $P_i$. Then, $i = i'$, and go back to Step 2.

- else $|X^i_k(j)| = c_j(k)$ and $i <_j X_{k, low}(j)$
  Exclude parking lot $j$ from $P_i$, and go back to Step 2.
Step 4: At time $k$, when all drivers in area make a pair with a parking lot, a set of matching $X_k$ is given by:

$$X_k = X'_k$$ (25)

Step 5: $k = k + 1$, and go back to Step 1.

5. SIMULATION VERIFICATION

5.1 Simulation Conditions

The design parameters for traffic network are shown in Table 3.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Symbols</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling rate [sec]</td>
<td>$\tau$</td>
<td>30</td>
</tr>
<tr>
<td>Number of users</td>
<td>$i$</td>
<td>$1 \sim 239$</td>
</tr>
<tr>
<td>Number of parking spaces</td>
<td>$N$</td>
<td>198</td>
</tr>
<tr>
<td>Mean value of driver’s parking time [min]</td>
<td>$\mu$</td>
<td>60</td>
</tr>
<tr>
<td>Mean value of inflow interval</td>
<td>$\lambda$</td>
<td>4</td>
</tr>
<tr>
<td>Weight value for distance between parking lot and destination</td>
<td>$w_D$</td>
<td>${25 50 90 160 250 400}$</td>
</tr>
<tr>
<td>Weight value for parking fee</td>
<td>$w_F$</td>
<td>${10 20 35 60 90 120}$</td>
</tr>
<tr>
<td>Weight value for time from current location to parking lot</td>
<td>$w_T$</td>
<td>${10 20 40 80 120 200}$</td>
</tr>
<tr>
<td>Weight value for distance from current location to parking lot</td>
<td>$w_R$</td>
<td>${50 100 150 250 400 550}$</td>
</tr>
<tr>
<td>Weight value for average utilization rate</td>
<td>$w_m$</td>
<td>100</td>
</tr>
<tr>
<td>Disturbance vehicle</td>
<td>$d_i(k)$</td>
<td>$\sim 3 \sim 3$</td>
</tr>
<tr>
<td>External vehicle inflow</td>
<td>$g_i(k)$</td>
<td>${3 6 10}$</td>
</tr>
<tr>
<td>Vehicle inflow [sec]</td>
<td>$h_l$</td>
<td>${1800 3600}$</td>
</tr>
<tr>
<td>Initial number of vehicles</td>
<td>$x(1)$</td>
<td>$22 \sim 25$</td>
</tr>
<tr>
<td>Signal time [sec]</td>
<td>$s_l$</td>
<td>20</td>
</tr>
</tbody>
</table>

Let $w_R$ be weight value for distance, and cost function using distance is given by:

$$J_{ij} = w_D D_{ij} + w_R R_{ij}(k) + w_F F_{ij}$$ (27)

For all parking lots, repetitively resolving Eq. (27) to minimize, we can obtain driver’s preference vector.

The number of drivers flowing into the area to which the parking lot is allocated at each time is shown in Fig. 5, and the simulation is performed.

5.2 Simulation Results

Simulation results are shown in Fig. 6 ~ Fig. 10. Fig. 6 shows travel time from each inflow point to parking lot $j$. The dotted line shows travel time without speed change, and the solid line shows travel time considering speed change according to Fig. 4.

The conditions for driver’s parking lot search are assumed to be calculated based on the coordinates, route, time, and traffic rules in traffic network.

$\sigma_i$ and $\mathcal{V}_{in}(k)$ follow the exponential distribution and Poisson distribution respectively, that is, each variable is assumed to be randomly determined without being influenced by other drivers and previous time.

It is assumed that Smart Parking System can get information of all drivers in the area, and driver who acts in disturbance is not considered, and the vehicle to which parking lot allocation is performed does not affect the road condition.

We compare parking lot allocation results using distance $R_{ij}(k)$ from current position to parking lot. In [5], assuming that the coordinates of driver $i$ at time $k$ are $(z_{i,x}(k), z_{i,y}(k))$, $R_{ij}(k)$ is given by:

$$R_{ij}(k) = |z_{i,x}(k) - l_{j,x}| + |z_{i,y}(k) - l_{j,y}|$$ (26)
Fig. 7 shows Utilization of each parking lot. The horizontal axis represents the number of steps, and the vertical axis represents the number of used parking lots. Also, the dotted line shows maximum number of parking spaces and constraint that driver can not park beyond empty spaces is kept for all parking lots.

Fig. 8 shows total walking distance from parking lot that driver parked to driver’s destination, and Fig. 9 shows total parking profit paid by drivers, and Fig. 10 shows total searching time. Table 4 summarize figures of Fig. 8 ~ Fig. 10.

Compared with the conventional method of parking lot allocation without considering road network in traffic network[5] and the proposed method, the proposed method can reduce total walking distance from the parking lot parked to the driver to the destination. Also the proposed method can keep total profit a little good results, and especially reduce total parking searching time by about 42 minutes compared to the conventional method[5]. The effectiveness of the proposed method using prediction-based optimal routing is able to be confirmed.

6. CONCLUSION

In this paper, we aimed to relax traffic congestion caused by the decrease in vehicle speed in case of a driver searching for a parking lot, by using Smart Parking System. Initially, we consider traffic flow model in road network of traffic network. Next, we proposed prediction-based optimal routing, and determine parking lot allocation based on the matching theory considering both driver preference including travel time by optimal routing and parking manager preference. In the numerical simulations, the effectiveness of the proposed method is confirmed from the viewpoint of reduction of searching time and walking distance about the proposed method.

As a future work, extension to realistic urban traffic network like 23 wards of Tokyo and the addition of constraints on the driver’s walking distance are required.

REFERENCES


Table 4 Summary of Simulation Results

<table>
<thead>
<tr>
<th></th>
<th>Proposed</th>
<th>Conventional[5]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Walking Distance [m]</td>
<td>85,405</td>
<td>89,105</td>
</tr>
<tr>
<td>Total Parking Profit [Yen]</td>
<td>380,780</td>
<td>290,360</td>
</tr>
<tr>
<td>Total Searching Time [sec]</td>
<td>18,836</td>
<td>21,334</td>
</tr>
</tbody>
</table>