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# An Optimal Parking Space Allocation on Unoccupied Space for Addis Ababa City by Using AHP Model

Mengistu Manaye [a*], Abdu Mohammed [b], Elias Manaye[c], Hailemariam Berhanua[b]

[a] Department of Industrial Engineering, Kombolcha Institute of Technology, Wollo University, Ethiopia.
[b] Department of Mechanical Engineering , Kombolcha Institute of Technology, Wollo University, Ethiopia.
[c] Building and Housing Infrastructure Construction Sector, Ethiopian Construction Works Corporation, Ethiopia.

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*Corresponding Author: mengistumanaye2@gmail.com

**ABSTRACT**

A shortage of parking lots and allocation problems in cities leads the drivers to search parking area for a long time, create traffic congestion, long-distance walking to the final destination, increase fuel consumption, and also increase emission into the environments. Due to this, the objective of the study was to allocate new parking areas on unoccupied free space and to prioritize the selection criteria of parking location using AHP model. The study was collecting the data through using two data collection methods through quantitative and qualitative. The qualitative method included interviews and questionnaires. As a result of research, the newly allocated parking location in the unoccupied area was Yetekatelewu area. Those selection criteria were ranked with various experts and their judgments' were evaluated with the AHP model and prioritized as the following, Future of land purpose (31%), location of a parking area (30%), land-size (20%), future demand of parking area (8%), land-cost (7%) and environmental effect (4%) are respectively. And also finally, checking the consistency of the newly allocated location through sensitivity analysis is 0.003. As the result, it's not perfect or consistent. But, the acceptance level is 0.0024 which is an acceptable parking location.

Keywords: AHP Decision Model, Parking Space Selection Criteria, Optimum Location

## 1. INTRODUCTION

The civilization and industrialization of the world create migration of the population from rural areas to urban areas that cause the concentration of population in cities. The result of civilization changes the living standard of people from cave to house, rural area to urban area, and from animal transportation to car transportation. The car needs the space at the end of their destination that is called the parking area. Un development of parking space and misallocation of parking areas also creates congestion in the cities [1].

Besides these parking issues, the mainly affected bodies are the drivers. Because of the shortage of parking area and the sometimes parking area allocated faraway from service are for drivers in this time spending a long time walking to destination and searching for a long time for parking and moving long-distance out of service area they are needed to park their vehicles. The main challenging problem for the drivers in cities is finding a parking spot at the end of their destination. Due to the unavailability of parking space around their destination, the drivers search the parking lot for a long time. For instance, the drivers of England will spend their time up to 2549 hours searching a parking spot over their lifetime average vehicles'. Besides this, the other study indicates that 95% of people add an extra-long distance trip for searching a parking spot out of their destinations only for a parking spot and also one -third traffic congestion created in the city due to unavailability of the parking lot around their destination [2]. Another study supporter said that the Current request for parking lots has been increased from time to time in the cities. For example, there is a report which shows recently that, over one year in a small Los Angeles business district, vehicles searching for parking burned 47,000 gallons of gasoline and produced 730 tons of carbon dioxide [3].

Besides, there was another study that proposed that the request for parking space is increased today in Holland like America and England. Due to an unavailability of parking lot, consequently, the average vehicle parking time in the parking lot is 95% of the travel time of vehicles. So it is an indicator of the Holland government to increase the number of parking lots, construct new parking facilities, or allocate free parking space to construct parking lots to meet the needs of parking space and this has to be used as the solution for consumers in the metropolitan [3]. The same as European countries in Africa there is a lack of parking facilities and municipalities not considered parking space. Due to these African cities being very congested, the environment is polluted and the Absence of municipal parking is the major parking problem in Africa and this can be easily observed in major cities. In Africa, the number of vehicles increased rapidly. Due to this the desire for parking areas increased. Based on the Step & Mint research estimation report in Africa the number of parking spot requirements increased up to one million in 2020 G.C.

Also, Addis Ababa is a fast-growing metropolitan in different directions especially in the transportation sector to satisfy the population consumption of vehicles in the city. The number of cars increased year by year and also 70% of vehicles were found in the capital of Addis Ababa. This concentration of vehicles in the city creates main problems, for instance, congestion of the road, shortage of parking lots due to unbalance between several vehicles and parking lot, and some time parking area allocated out-off city that creates long-distance walking and spending time for the drive.

The objective of this research is to allocate new parking areas for the city and to identify parking area selection criteria. It's important to make a fast and good decision in parking area selection from different alternatives to make profitable decisions using AHP models. If we select optimal parking location we were got the following benefit (1) increase parking service, (2) decrease search time for a parking spot, (3) decrease 〖Co〗_2 emission, and (4) decrease congestion in the city and also helping to city administrators' to allocate optimum parking location in the cities.

In this literature part, we review some studies on the analytical Hierarchy process model application area and what are considerations criteria in the model are reviewed from various research works. The research proposed [4], to improve the performance of public transport in the city to minimize parking needs by the drivers. The study identified that the development of public transport increases the interest of the people purchasing personal vehicles that increase consumption rate of energy, increase parking demand and creates congestion in the city. The public transport performance is measured with performance indicators such as economic criteria, efficiency criteria, effectiveness criteria, and quality of service with analytical hierarchy process models. According to [5] to minimize road congestion and also to minimize roadside traffic accidents at a time of loading and unloading of passengers. This problem is created with e-taxi vehicles parking on the on-street parking due to shortage of parking spots in the city and the problem has been solved by developing a geographical information system and selecting optimal parking location for e-taxi vehicles considering parking lot selection criteria and with the help of AHP model. The expert proposed a multi-criteria decision model to solve parking problems by using two methods which are the Fuzzy analytical hierarchy process and Hurwitz (Realistic) method to select new parking location to construct new ground parking garage in the city to minimize the parking lot shortage effect on the roads and drivers [6].

Besides this, to reduce traffic congestion on the road we would develop a parking space and ride car parking system in the city to improve the existing transportation system. The developed system minimizes congestion of roads and pollution due to shortage of parking space and also the developed system increases utilization capacity of public transport and smooth mobility in the city. The new parking locations were allocated using multi-criteria decision models and also based on municipal parking area selection criteria. Some selection criteria are traveling distance from the parking location to the service area, nearness to a public area, and also traffic conditions around the parking area [7]. According to [8], investigating the growth of metropolises and emigration of peoples from the rural area to urban creates congestion in cities which leads to a shortage of free space in the urban area. This is not only for peoples also for vehicles' to park and trains to depot so the researcher proposed underground parking for vehicles and trains using multi-criteria decision models. According to [9] proposed solutions to minimize traffic congestion, the city administrators will apply the mobility sharing method.

The proposed solution minimizes congestion on the roads, decreases parking space usage, decreases private car or bike usage and also minimizes traffic jams on the roads. And also the researcher tries to find an optimal parking station for bike-mobility with applied bi-level mixed integer program to minimize long distance travel from parking station to service area. The proposed solution by [10] to minimize traffic congestion in the city the government must constructing off-street parking and also allocate optimum parking location maximize parking service coverage, and minimize the walking distance facilities and this study mention selection criteria of parking location .for example, walking distance from parking location, location it's nearness to service area, environmental pollution and final develop single-objective mathematical model.

AHP Models Approaches:

The model is used to ranking criteria and to select something from diverse alternatives. Thomas Saaty is a researcher he was advanced the analytical hierarchy computer AHP model. The model is used to choice the best one from various alternatives considering criteria and sub-criteria to make a good decision and to meet objectives. And also AHP model always answers the question of which one is the best from the given alternatives [11]. Analytical Hierarchy Process (AHP), which can analyze a lot of parameters at the same time in parking site selection processes. The research is trying to address how to determine the relative importance of the parking area selection criteria and to allocate new optimum parking location on the unoccupied free space with considering multiply criteria.

Table 1. Standard pairwise comparison scale and numerical Value adopted [12]

| Ranking explanation |
|---|
| Equally important stands for scale value 1. It gives for equal criteria (i) or alternatives (j) contribute to the objective equally. |
| Moderately important stands for scale value 3.It's for Adequate preference is given to one criterion (i) or alternative (j) over the other. |
| Strictly important stands for scale value 5.It;s |

| |
|---|
| gives Strict preference is given to one criterion or alternative over the other |
| Very strictly important it stands for scale value 7.It gives very strict preference is given to one criterion (i) or alternative (j) over the other. |
| Extremely important stands for scale value of 9.It's gives highest favorite is given to one criterion (i) or alternative (j) over the other |
| Middle values stands for scale value for 2,4,6, and 8. |

Ranking of criteria and alternative:

Prior to parking area selection criteria using the Eigenvector solution approach was used for ranking of various criteria from a pairwise matrix. The ranking of parking location from alternative is calculated using the following formula (weighted sum model) and the formula adopted [13].

$$V_i=\sum_{j=1}^{n} a_{ij}X_{ij}\ldots\ldots\ldots (1)$$

With $W_j$, the weight criterion $C_i$, and $Z_{ij}$ the performance measure of alternative $Z_i$ concerning criterion $C_i$, performance values are normalized, and pair-wise comparison matrices can also be represented as the following adopted[14].

Let P= {$P_j$, j =1, 2…n} be the set of unoccupied alternative location then the size of comparison matrix C will be $(n * n)$, and the entry $C_{ij}$ donates the relative importance of (i) criteria concerning (j)[15].

$$P_{m*m}=\begin{vmatrix} C_{ij} & c_{ij}\ldots\ldots & C_{mm} \\ C_{ij} & C_{ij}\ldots\ldots & C_{mm} \\ C_{ij} & C_{ij}\ldots. & C_{mm} \end{vmatrix}\ldots\ldots (2)$$

The problem is finding the matrix X (the nearest matrix P according to the selected norm), such that:

$$X=\begin{vmatrix} {}^{x_1}/_{x_1} & {}^{x_2}/_{x_2}\ldots\ldots & {}^{x_m}/_{m} \\ {}^{x_2}/_{x_2} & {}^{x_2}/_{x_2}\ldots\ldots & {}^{x_m}/_{W_m} \\ {}^{x_3}/_{x_3} & .{}^{x_2}/_{x_2}\ldots\ldots. & {}^{x_m}/_{x_m} \end{vmatrix}\quad\ldots\ldots (3)$$

For a consistency matrix, we can use the following:-

$$P=\begin{vmatrix} {}^{x_1}/_{x_1} & {}^{x_2}/_{x_2}\ldots\ldots & {}^{x_m}/_{m} \\ {}^{x_2}/_{x_2} & {}^{x_2}/_{x_2}\ldots\ldots & {}^{x_m}/_{W_m} \\ {}^{x_3}/_{x_3} & .{}^{x_2}/_{x_2}\ldots\ldots. & {}^{x_m}/_{x_m} \end{vmatrix} * \begin{bmatrix} x_1 \\ x_2 \\ x_m \end{bmatrix}$$

$$= \begin{bmatrix} W_1 \\ W_2 \\ W_m \end{bmatrix} *(m)\ldots\ldots (4)$$

Where, P =is the comparison matrix, X= is the result of pair-wise, matrix and 'm' is equal to several matrix or dimension of the matrix.

International Criteria:

The International criteria that have been used in a developed country to select the optimal vehicle parking location in the city are the following [16].

(i) Location is the key selection criteria of the new parking location and sub- criteria are nearest to market/shopping centers/malls/religious area/stadiums, Proximity to road links and railways, Proximity to commercial areas, and goods and service.

(ii) The parking lot size is the key criteria and sub-criteria are Parking capacity of vehicles in the parking lot and parking volume of the land.

(iii) Cost of Land rent or lease cost is the main criteria and sub-criteria are parking price per waiting time, per types of vehicles

(iv) Demand of parking facilities is the key criteria and sub-criteria are based on, easy to access, and security and safety of the parking zone.

(v) Environment factor is the main criteria and sub-criteria are noise and pollution of air quality.

(vi) The land purpose is the main criteria and sub-criteria is what the purpose of this free space is for mixed residence, for high density mixed residence, and micro and small scale enterprise. Alternatives on the AHP model:

The Figure 1 displays the objective of the Analytical process. The objective is to allocate optimal parking space on unoccupied space.

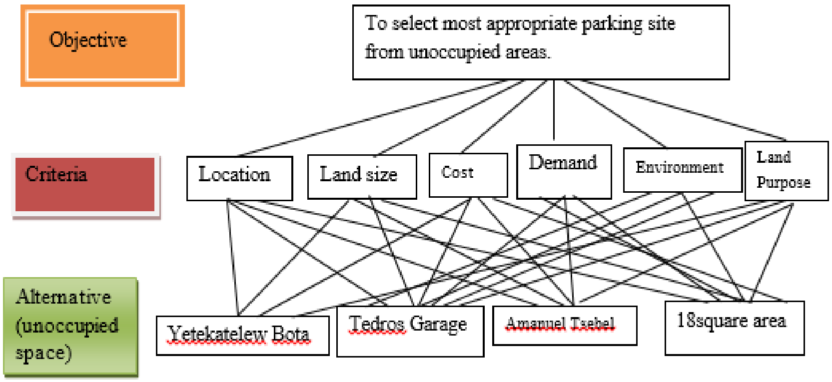


Fig 1. General Structure of AHP model.

## 2. MATERIALS AND METHODS

To achieve the objective of this study we reviewed scientific literature containing Analytical Hierarchy process models. In addition to this, different methods of data collection were employed, which can be collected or gained by two approaches of data collection systems; these are primary data collection & secondary data collection methods. Interviews, direct & indirect observation of the parking activities, and questionnaires are the primary data collection methods, and the questionnaires were developed in English and translated into the local language Amharic and distributed to assess the general status of the parking system in Addis Ababa city. The secondary data was also collected after various offices. Some of the major offices contacted from Addis Ababa Road Authority to collect the data about parking site selection criteria in Addis Ababa master plan and the standard of road length and width, Addis Ababa City Transport office to collect the data about parking facilities design consideration and parking area unavailability effects on the Addis Ababa transport service, and finally contact, Construction permit and control Authority to collect the data about the necessary amount of parking facilities and standard parking space in a building. In the method part, we select the essential total number of professionals for the decision-making process in the AHP model analysis the study using the sample size determination formula and the required number of experts was selected. Those experts were selected from Addis Ababa transportation and parking management, Addis Ababa Road Authority, and Addis Ketema sub-city master plan development office.

### 2.1 Steps to solve the problem using AHP

Generally, to solve any AHP model, the following steps are used [17]. The first step is Problem recognition: which means the problem was identified with direct observations of on-street parking, formal questionnaires' and interview with the responsible governmental bodies, Secondly, select a group of subject matter experts: the required number of experts was selected from Addis Ababa Road Authority, Addis Ababa transport and parking management office, land bank officers, and the city master plan development office. Thirdly, Define the scope and boundaries of the AHP: the scope of the study is finding an optimal parking location for Addis Ketema sub-city from alternatives or unoccupied free space. The fourth step, Decomposes the problem into a hierarchy: to determine the optimal parking location the problem decomposes as objective, criteria, and alternatives. For additional information, re-view the Figure 1. tableIn the fifth step, Perform pairwise comparisons at each level using scaled responses on the questionnaires. The sixth step, is the consistency index < 0.10 for all situations? If the consistency index is < 0.10 we continue to step seven. Otherwise, we go back to step five and check a pairwise comparison of the experts. The seventh step is an analysis of sensitivity to determine the source of variation and optimality. The eighth step, Eliminate the situation runs with ≥0.10. In the pairwise comparison matrix of parking location criteria at each level, the value is greater than 0.01eliminate this value from the table. Ninth steps, Use confidence intervals to identify the range within the mean of the rankings ( ) should fall. Finally, select the best from the alternative: In this stage selecting the best parking location from four options by comparing selection criteria. The pairwise comparison matrix values obtained from decision-makers or experts who assess the significance of each condition for each judgment objective through using a scale ranging from 1 to 9 [12]. The pairwise scale value is obtainable in Table 1.

## 3. RESULTS AND DISCUSSION

The result and discussion are organized into one part for simplicity and readability. The parts try to allocate optimal parking locations in unoccupied areas.

### 3.1 Parking space allocation

Therefore, finding optimal parking spaces is usually very difficult in a city where land is used for different purposes such as for business, residential, commercial activities, service, and manufacturing areas. So, the finding of optimal parking space is not simple, since the allocation of available parking space will depend on the goals of the community which the traffic engineer must take into consideration to solve the parking site selection problem.

### 3.2 Formulation of AHP Model

Finding parking space is a difficult situation for drivers in the city. Analytical hierarchy process models are used to find optimal parking locations from unoccupied alternatives. The main objective of the model is to find optimum vehicle parking space location by considering parking criteria such as location, land purpose, environment effect, land cost, demand, and considering different assumptions.

Notations used in the model:

(i) = types of criteria (location, land cost, environment effect, land purpose, parking demand, and land size). Where, i = 1, 2…… 6 and j = Alternative of unoccupied locations (Yetekatelew Area, Tedros Garage, Amanuel Tsebel, and 18 square area LDP). Where, (j = 1, 2…….4).

### 3.3 Selection criteria nomination

The matrix of the AHP model is (m*m) which means horizontal and vertical criteria are equal with (6*6) matrix and symbolized as the following.

C_11 = C_11 = location, C_11 is corresponding to selection criteriaC_11.

C_21 = C_12 = Land-size, C_21 is corresponding to selection criteriaC_21.

C_31 = C_13 = land-Cost, C_31 is corresponding to selection criteria C_31

C_41 = C_14 = demand, C_41 is corresponding to selection criteria C_41.

C_51 = C_15 = Environmental effects, C_51 is corresponding to selection criteria C_51.

C_61 = C_16 = Land purpose. C_61 is corresponding to selection criteria C_16.

Table 2. Parking location Relative comparison matrix of selection criteria.

| Criteria | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ |
|---|---|---|---|---|---|---|
| $C_{11}$ | 1 | 5 | 8 | 7 | 2 | 4 |
| $C_{21}$ | 0.200 | 1 | 9 | 8 | 3 | 2 |
| $C_{31}$ | 0.125 | 0.111 | 1 | 4 | 2 | 5 |
| $C_{41}$ | 0.143 | 0.125 | 0.250 | 1 | 3 | 6 |
| $C_{51}$ | 0.250 | 0.333 | 0.500 | 0.333 | 1 | 2 |
| $C_{61}$ | 0.250 | 0.500 | 0.200 | 0.167 | 0.500 | 1 |
| Sum | 1.968 | 7.07 | 18.95 | 20.5 | 11.5 | 20 |

The next step in the AHP model is a normalization of Table 2 through dividing each value with the sum value to the normalization of the pair-wise comparison matrix and finding the criteria weight.

Table 3. Standardized relatively comparison matrix of pair-wise criteria

| Criteria | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ |
|---|---|---|---|---|---|---|
| $C_{11}$ | 0.508 | 0.707 | 0.422 | 0.341 | 0.174 | 0.200 |
| $C_{21}$ | 0.102 | 0.141 | 0.475 | 0.390 | 0.261 | 0.100 |
| $C_{31}$ | 0.064 | 0.016 | 0.053 | 0.195 | 0.174 | 0.250 |
| $C_{41}$ | 0.073 | 0.018 | 0.013 | 0.049 | 0.429 | 3.000 |
| $C_{51}$ | 0.127 | 0.047 | 0.026 | 0.016 | 0.087 | 0.667 |
| $C_{61}$ | 0.127 | 0.071 | 1.802 | 0.008 | 0.043 | 0.500 |

The third step is an analysis of criteria weight by summing the normalized value and dividing by several criteria.

Table 4. Calculated criteria weighted value using pair-wise comparison matrix

| **Criteria** | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ | Criteria weight |
|---|---|---|---|---|---|---|---|
| $C_{11}$ | 0.508 | 0.707 | 0.422 | 0.341 | 0.174 | 0.200 | 0.359 |
| $C_{21}$ | 0.102 | 0.141 | 0.475 | 0.390 | 0.261 | 0.100 | 0.228 |
| $C_{31}$ | 0.064 | 0.016 | 0.053 | 0.195 | 0.174 | 0.250 | 0.084 |
| $C_{41}$ | 0.073 | 0.018 | 0.013 | 0.049 | 0.429 | 3.000 | 0.097 |
| $C_{51}$ | 0.127 | 0.047 | 0.026 | 0.016 | 0.087 | 0.667 | 0.051 |
| $C_{61}$ | 0.127 | 0.071 | 1.802 | 0.008 | 0.043 | 0.500 | 0.342 |

The above AHP analysis indicates that an overall score for each location is calculated through enlarging the value with the criteria preference vector with the preceding criteria matrix and summing the result of Yetekalewu area is 0.456, Tedros Garage is 0.300, Amanuel Tsebel is 0.160, and 18square area is 0.084 is an overall parking site score value for each unoccupied area. Therefore, the above analysis four unoccupied parking sites, in order of the magnitude of their scored value through experts' decision and based on AHP model analysis. As the analysis result, yetekatelewu area is the optimum parking location for the city.

Table 5. The overall criteria prioritized and ranked

| Ranking criteria | 0.359 | 0.228 | 0.084 | 0.097 | 0.051 | 0.342 |
|---|---|---|---|---|---|---|
| Criteria | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ |
| Unoccupied locations | location | land-size | cost | demand | Environment | land purpose |
| Yetekatelew Bota | 0.611 | 0.482 | 0.456 | 0.474 | 0.428 | 0.353 |
| Tedros garage | 0.247 | 0.558 | 0.299 | 0.243 | 0.364 | 0.201 |
| Amanuel Tsebel | 0.172 | 0.191 | 0.159 | 0.175 | 0.114 | 0.164 |
| 18square area | 0.082 | 0.059 | 0.105 | 0.107 | 0.094 | 0.165 |

### 3.3 The sensitivity of the Decision

According to the result that given a pairwise comparison matrix A, its maximum Eigenvalue ,λ max, is equal to (m) if and only if the matrix is consistent (and greater than selection criteria otherwise) the proposed Consistency Index (CI) will be checked for the developed AHP model, with their pairwise comparisons for the six parking site selection criteria (Brunneli, 2015).

This matrix, shown as follows, is multiplied by the preference vector for the criteria.

Table 6. Six parking area selection criteria with the average weight value.

| Criteria weight | 0.359 | 0.228 | 0.084 | 0.097 | 0.051 | 0.342 |
|---|---|---|---|---|---|---|
| Criteria | $C_{11}$ | $C_{21}$ | $C_{31}$ | $C_{41}$ | $C_{51}$ | $C_{61}$ |
| Criteria | $C_{11}$ | $C_{12}$ | $C_{13}$ | $C_{14}$ | $C_{15}$ | $C_{16}$ |
| $C_{11}$ | 0.508 | 0.707 | 0.422 | 0.341 | 0.174 | 0.200 |
| $C_{21}$ | 0.102 | 0.141 | 0.475 | 0.390 | 0.261 | 0.100 |
| $C_{31}$ | 0.064 | 0.016 | 0.053 | 0.195 | 0.174 | 0.250 |
| $C_{41}$ | 0.073 | 0.018 | 0.013 | 0.049 | 0.429 | 3.000 |
| $C_{51}$ | 0.127 | 0.047 | 0.026 | 0.016 | 0.087 | 0.667 |
| $C_{61}$ | 0.127 | 0.071 | 1.802 | 0.008 | 0.043 | 0.500 |
| Divided value | 12.500 | 0.672 | 6.083 | 0.833 | 15.000 | 1.086 |

The product of the multiplication of parking area selection criteria with average weight was given as for parking location is 0.488, land size is 0.204, cost of land is 0.084, demand for parking space is 0.073 and the environmental effect is 0.0076. Subsequently the main steps, If consistency index (CI) = 0, then Yetekatelew area would be a perfectly stable decision making in the AHP model. But, Yetekatelew area is not perfectly. The next step is examination of irregularity that is acceptable. An acceptable level of reliability is resolute through comparing the (CI) to an arbitrary index (RI) which is the loyalty index of a randomly produced pair-wise contrast matrix. The RI has the values shown in the table depending on the amount of criteria (m=6) being compared (3). Next, we divide each of these values by the corresponding weights from the criteria favorite vectors and sum up the divided value is 36.074, In the AHP decision making analysis, Yetekatelew area is a perfectly reliable decision, then each of these ratios would be exactly six. The reliable resolute through summing the average value and dividing by several criteria is 6.012.

The consistency index, CI, is computed using the following formula,

$$CI = (6.012-m)/m \quad \ldots\ldots (5)$$

Where, 'm' is the number of criteria compared to the average value is 6.012. And the constancy index (CI).

$$CI = (6.012-6) /4 = 0.003$$

Table 7. RI values for various values of m.

| m | RI |
|---|---|
| 2 | 0 |
| 3 | 0.58 |
| 4 | 0.90 |
| 5 | 1.12 |
| 6 | 1.24 |
| 7 | 1.32 |
| 8 | 1.41 |
| 9 | 1.45 |
| 10 | 1.51 |

The amount of reliability for the pair-wise comparison in the decision-making criteria matrix is determined through calculating the ratio of consistency index (CI) and Random index (RI).

When, number of criterion is (m=6) and from the above standard Table 4, the random index value is (IR=1.24). CI/RI = 0.003/1.24 = 0.0024, the amount of reliability is satisfactory if, (Ci)/ (RI) ≤ 0.1. Therefore, this indicates that the location is Acceptable.

## 4. CONCLUSION

Addis Ababa city was challenged through a shortage of parking areas and an optimal allocation of parking space. Due to these problems, the traffic congestion on the roads is very high, drivers searching parking area for long due to this increase emission into the environment. So this research, try to solve these problems with analysis the existing parking situation of the city and also allocating new parking location. The new parking location is determined by considering local and international parking site selection criteria and with AHP model. As the model analysis result, Yetekatelewu area was selected as the new optimal parking location for the city from unoccupied free space considering various criteria and sub-criteria. This selected parking location is an optimal location for the parking area. Because, adjacent to the final destination for the drivers, nearby to the market area, service providers, and commercial area. And also final checking the uniformity or the fulfillment level of the optimal location with summing the average values and divided with the total number of criteria is 0.003 which is not perfect. But, the acceptance level checked with dividing the constancy index with random index is 0.0024. This indicates that the newly allocated location is acceptable for the parking area.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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