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Investigation of Optimal Locations of Waste Containers for collecting waste from apartment with the Help of special cluster Graph

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Abstract:
In this paper developed a model and to resolve a problem of the collection of waste from the apartment having up to fifth floor. Placed the waste collection containers in the ground and each dustbin is designated as vertex of a graph and each block as a cluster of similar type.
In this paper it is intended cluster analysis and travelling sales man problem to give the facilities to require points and find path in each cluster. Here considered a graph of G (12n+18, 38n+5) be a weighted graph for n ≥1 having 2n+3 clusters for n ≥1.

Keywords: Complete graph, Hamiltonian circuit, Travelling Salesman Problem, Cluster Travelling Salesman Problem

1. INTRODUCTION

In Waste collection method waste are collected from different locations i.e. residences, commercial area and from the collection points. Waste are heaped into the waste collection vehicles and carried into the locations for transformation and disposal.
Waste collection service can be categorized into Primary and Secondary services.
Primary Collection is the process of collecting waste from house to house or from the business places by small vehicles, bicycles etc. and deposited into the communal stations and transfer points.Secondary Collection is the second step of collection of the garbage from the community point to the disposal site with the help of larger vehicles

In Flats, building complexes occupants are not directly involved in the waste collection. The waste collector takes the container to the Garbage Van and place it into the original location. Collection process is time consuming as well as expensive.

2. Definition

Definition of Travelling Sales man and Cluster Travelling sales man problem: Before going to explain the whole works of research, here going to state the definition of TRAVELING SALESMAN PROBLE (TSP) and CLUSTER TRAVELING SALESMAN PROBLE (CTSP) The problem states (1889) that a salesman must visited all cities only one time and returned to the city from where he started his tour with minimum cost. In addition to this a CTSP has been existed which states that the whole cities are divided into some clusters and one can search the least cost route as a whole after obtaining the least cost of each cluster

3. Related Work

Using genetic algorithm on a stack multicomputer cluster the efficiency of the parallel computation of the travelling sales man problem is studied.[1]. Circulant graphs minimum vertex cover is calculated from a complete graph and application is given in removal of dead lock of process [2].Two experiments on an effect of cluster location & cluster distribution on performance of the TSP. The different types of direction of solution of travelling salesman problem have been found [3]. A variation of travelling sales man problem is the ordered clustered travelling salesman problem in this vertices are divided into clusters and least cost Hamiltonians tour is calculated[4]. Evaluated the performance of Lin-Kernighan-Helsgaum(LKH) algorithm an CTSP instances that are transformed into standard TSP instances[5]. Various factorization of graph is done and algorithm is designed to solve the travelling sales man problem [6]. Planar sub graph properties are studied and algorithm is developed for

symmetric travelling sales man problem [7]. GIS based technique is developed to find the optimal route of solid waste collection for vehicle [8]. Fuzzy clustering based efficient genetic algorithm is developed for travelling sales man problem [9]. Unsupervised Fuzzy clustering and genetic algorithm is using to solve the parallel computation of travelling sales man problem [10]. Successfully re-formulate TSP into clustering algorithm which could be useful in many military strategy analysis [11]. Established an energy competent dispersed clustering method for wireless adhoc sensor networks [12]. A novel Simulated based cluster algorithm was developed and it gives more correct result and also independent on the starting cluster center [13]. For CTSP a two level genetic algorithm was designed which gives the optimal result [14]. Projected a method using cluster analysis and TSP to provide facilities on demand points and find the path in each cluster [15]. Developed a GIS based algorithm for municipality waste collection [16].Heuristic method is used to so solve the waste collection problem in Eastern Finland[17].Developed TSP as useful tool for various operation research applications and also used as midway of GTSP and TSP convert[18].Develop an approximation algorithm to find the path of Ordered Travelling sales problem[19].

4. New Methodology

To perform Waste collection from the Apartments by using special Cluster Graph two methods are used. Cluster analysis is applied in the first method. In the second method, by the help of travelling salesman problem to find the optimal path in each cluster.

4.1 Pre-processing Phase:

Consider position of waste collection containers as Special cluster of a graph. In cluster graph there are two rows of blocks which are at the 9-18 meters distance [21][22]. Each and every block has a connected path. Distance between the containers considered from following [20].

(i)It is advisable to place the **containers 100-200 m apart** for economic reasons.

(ii)The communal containers are usually staggered such that the effective distance of **100m is maintained.**

(iii)The farthest distance the householder will have to walk is **50 meters**

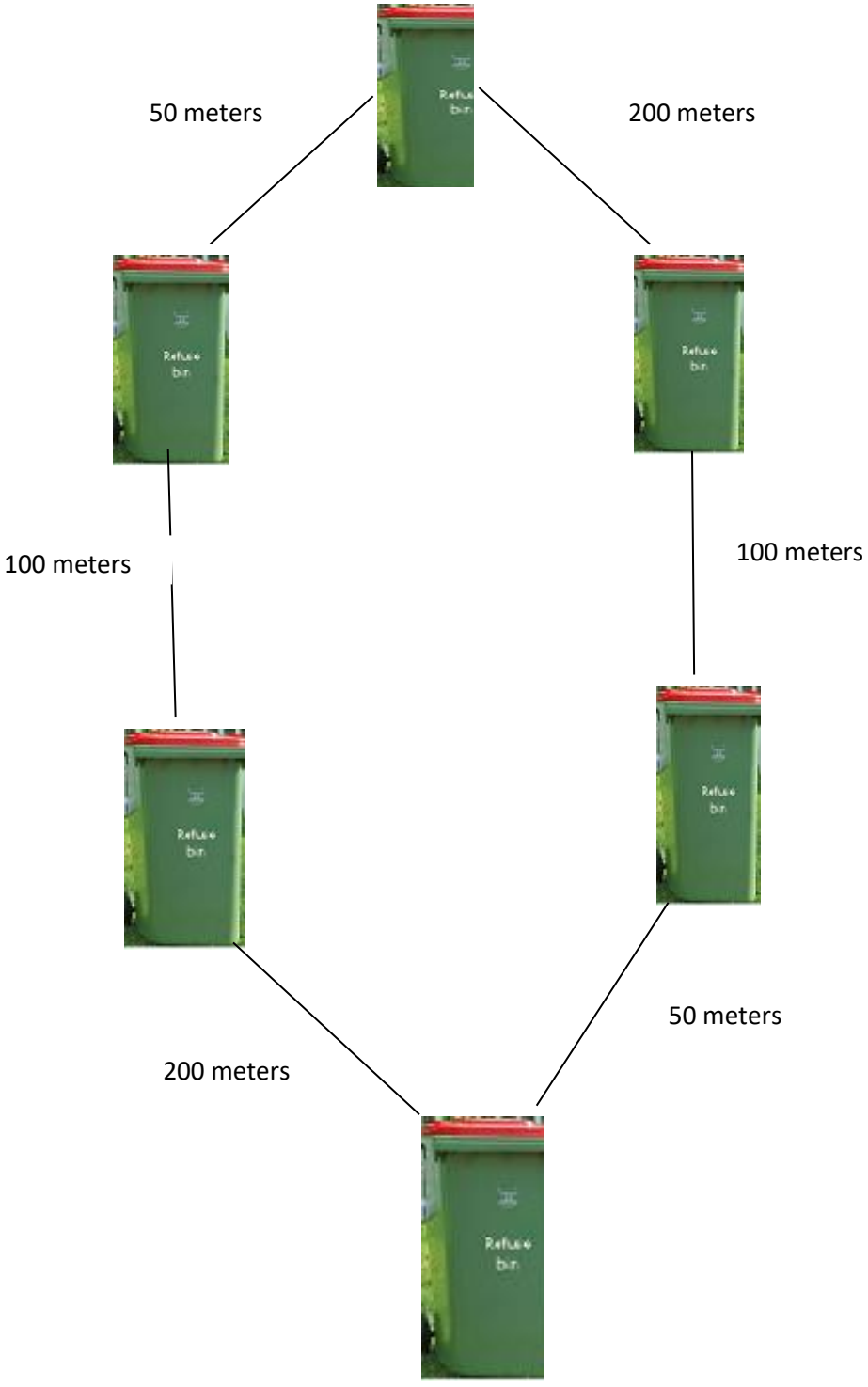
50 meters
200 meters
100 meters
100 meters
200 meters
50 meters

Fig1: Placed the containers alternatively at 200m, 100m and 50 m distances apart

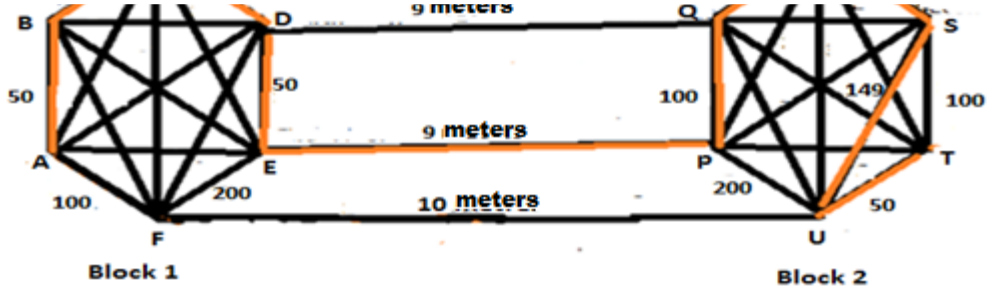

Fig2: Distance Calculation

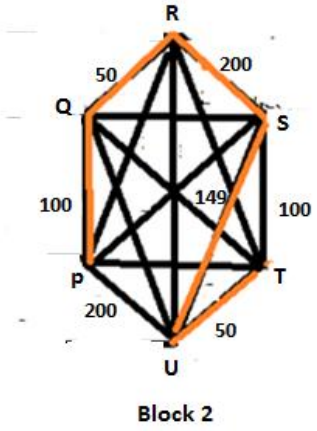

Fig3: Distance Calculation of Block2

In Block 1:
AB=50 M, BC=200 M, CD=100, DE=50, EF=200. These are the positions of waste collection dustbins. We have considered the distance from the following reference.

(https://nptel.ac.in/courses/120108005/5 Unit3: Waste Collection, Storage and Transport pages 10-11)

In Block2:

PQ=100 M, QR=50M, RS=200M, ST=100M, UT=50, SU=149M

The triangle inequality defines that for any triangle, the sum of the lengths of any two sides must be greater than the length of the third side.

We assume costs are symmetric (c(i ,j)=c (j,i) for all i, j) and obey the
Triangle inequality (c(i,j)≤ c(i,k)+c(k,j) for all i,j, k).
Here in the block 2 d (SU) ≤ d(ST)+ d (TU)
Maximum less than 149 < 100+50 (We have taken this value)
Or, 150=100+50 **[**the sum of two sides of a triangle (AB + BC)is equal to the third(AC). This is only possible when the point B lies on the line Segment AC]
This would just give us 2 coincident line segments

Distance from one Block to another:

CR=10 M, DQ=9 M, EP=9M, FU=10M. According to the architect design it has considered the distance between the blocks. Here also considered our blocks are maximum 5 floors.
Distance between the building depend on the building height

Height of the building	Distance between the building
9 storeys and above	12-24 m
Up to 8 storeys	9-18m
Up to 4 storeys	6-12m

Table1: Rule of Standard Apartment Design

This Table values are available in the Rule of Standard Apartment Design Guides [24][25].

Before going to implementation of algorithm it should follow the following conditions.

Condition I: Waste collector move from the one block to another only when all the dustbins of a block is visited.

Condition II: Order of the blocks visited and the path of the one dustbin to another and one block to another has to follow the TSP and CTSP properties.

4.2. Theoretical Investigation:

4.2.1 Theorem: For the complete weighted graph G (12n+18, 38n+50) for n≥1 having 2n+3 clusters for n≥1, the total **path length is 1116n+1480 or 4(279n+370)**

Proof: Considering five clusters (five Blocks of an Apartment) in the figure-1. Each cluster has six vertices (six number of waste collection containers of an Apartment). Clusters are 9-18metres distance [21][22](we are considering 9 and 10metres two different paths) apart from each other and vertices are 50,100 and 200 metres distance from each other[20]. Accordingly assigned the weight to all the graph and got a shortest path for the weight of figure-3, figure-4, figure-5 and figure-6 is**2596**, **3712**, **4828** and **5944 metres** respectively.

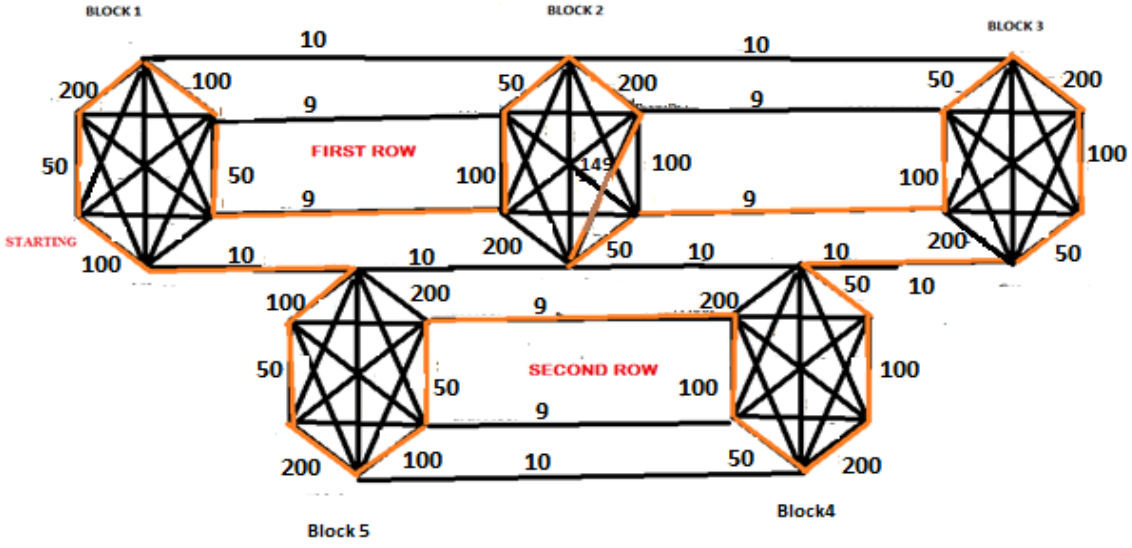

fig 4: 2n+3 number of blocks where n>=1
here n=1 2.1+3=5 nos of blocks(clusters)

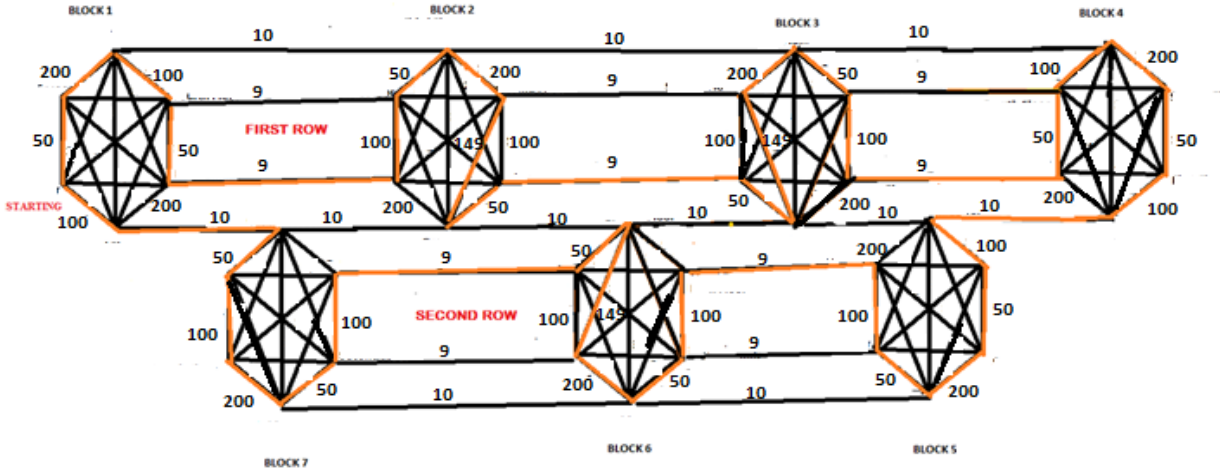

fig 5: 2n+3 nos of blocks where n>=1
here n=2 2.2+3=7 nos of blocks(clusters)

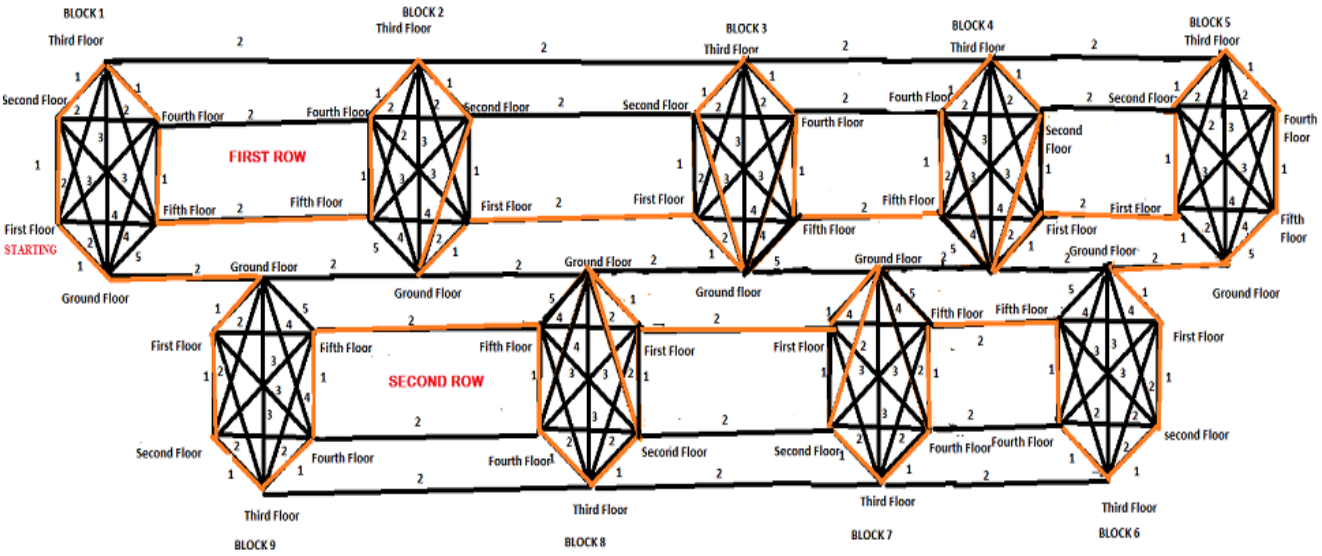

fig 6:2n+3 nos of blocks where n>=1 here n=3 2.3+3=9 nos of blocks(clusters)

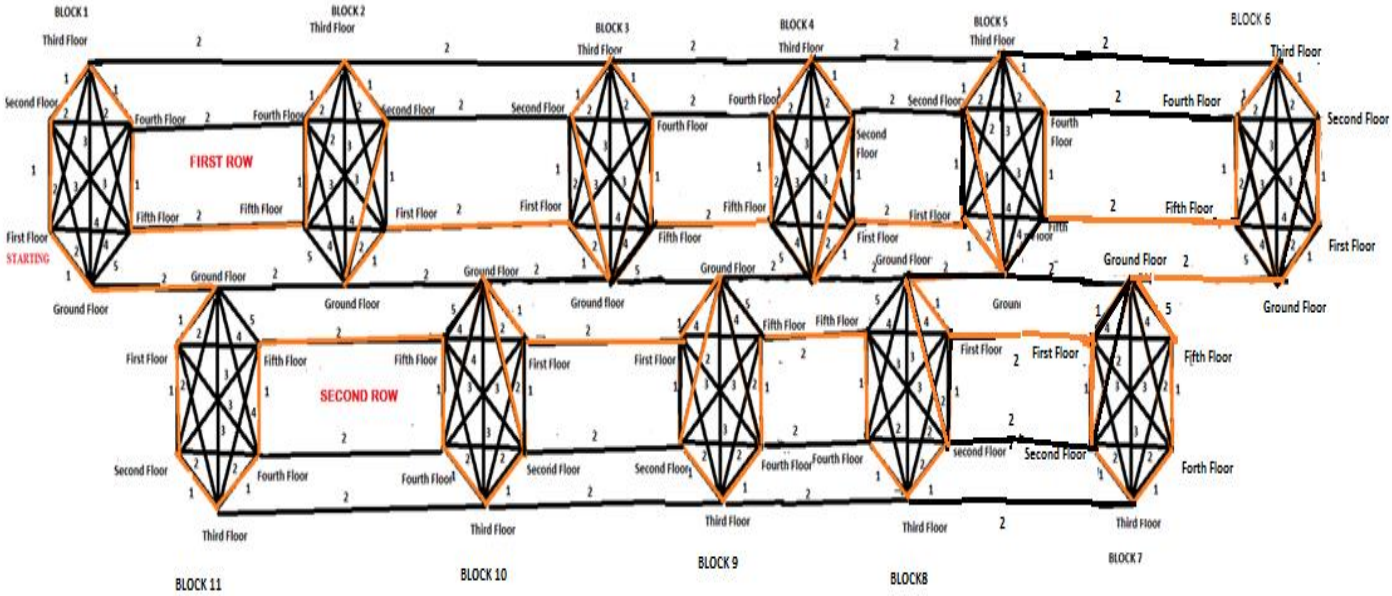

fig 7: 2n+3 nos of blocks where n>=1 here n=4 2.4+3=11 nos of blocks(clisters)

Let minimum weight 16n+24 wh
2k+3 clusters for k≥1, the total p
graph G(12k+18,38k+50) is G(12

38k+50) for k≥1 having
1, the form of the given
50)=G(12k+30,38k+88)

and cluster 2(k+1)+3=2k+5.But our theorem states for the values of n≥1.Here n=k+1≥1 => k≥1 which is true for 2k+5 and for the graph G (12k+18, 38k+50)

4.3 **Algorithm:**

Input: Cluster graph.

Output: Shortest path of cluster graph.

Step 1: Consider 2n+3 numbers of blocks where n>=1

Step 2: Start from the ground floor of the FIRST BLOCK but the waste collection starts from the 1st floor to the 5th Floor according to the minimum weight.

Step3: After 5th floor, waste collector move to another block through a path and waste collector collect the waste from one floor to another by using minimum path between the floors.

Step4: After the FIRST ROW blocks are visited, waste collector required move to the SECOND ROW block through the ground floor to another row's block ground floor.

Step5: Continue step 2 to step 6 until and unless all the floor are not visited of both the blocks.

Step6: Finally we exit from the ground floor LAST BLOCK of the SECOND ROW to the ground floor FIRST BLOCK of the FIRST ROW to complete the TSP.

5. Experimental Outcome: Some experimental result of Complete graphs **G (12k+18, 38k+50)** given below.

Value(n)	Total Clusters (2n+3)	Cluster no	Weight in cluster	Weight in between two cluster	Total weight
n=1	5	1	5	2	7
		2	6	2	8
		3	9	2	11
		4	5	2	7
		5	5	2	7

TOTAL WEIGHT =40

Table 2. Shows minimum weight of cluster 2n+3 graph for n≥1

Value(n)	Total clusters 2n+3	Cluster no	Weight in cluster	Weight in between two cluster	Total weight
n=2	7	1	5	2	7
		2	6	2	8
		3	6	2	8
		4	5	2	7
		5	5	2	7
		6	6	2	8

		7	9	2	11

TOTAL WEIGHT=56

Table 3. Shows minimum weight of cluster 2n+3 graph for n≥1

Value(n)	Total Clusters 2n+3	Cluster no	Weight in cluster	Weight in between two cluster	Total weight
n=3	**9**	1	5	2	7
		2	6	2	8
		3	6	2	8
		4	6	2	8
		5	9	2	11
		6	5	2	7
		7	6	2	8
		8	6	2	8
		9	5	2	7

TOTAL WEIGHT =72

Table 4. Shows minimum weight of cluster 2n+3 graph for n≥1

Value(n)	Total clusters 2n+3	Cluster no	Weight in cluster	Weight in between two cluster	Total weight
n=4	**11**	1	5	2	7
		2	6	2	8
		3	6	2	8
		4	6	2	8
		5	6	2	8
		6	5	2	7
		7	9	2	11
		8	6	2	8
		9	6	2	8
		10	6	2	8
		11	5	2	7

TOTAL WEIGHT=88Table 5. Shows minimum weight of cluster 2n+3 graph for n≥1

6. Conclusion:

Here in the paper discussed CTSP to find out the minimum path by using graph G (12n+18, 38n+5). Applied this graph to find out the shortest route in Apartment consisting of two rows of blocks. In the research tried to model and to solve a problem of the collection of waste from the apartment having up to fifth floor and each floor is designated as vertex of a graph and each block as a cluster of similar type. Finally in the paper calculated the shortest route so that collector can collect the waste by following this route to save the time and with less effort.

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