CHAPTER-5

PROPOSED METHOD -EXPERIMENTAL INVESTIGATIONS

This chapter contains the simulation results of proposed method and a statistical comparison is carried out with existing methods.

5.1 Adaptive Dynamic Genetic Algorithm

In proposed method MWMTSP is formulated with GA to deal the Task allocation on nodes efficiently and effectively. Here grouping is done with respect to nodes and warehouses in random approach by considering Euclidean distance calculation. The main aim of routing here is to implement parallelism and minimize cost time.

The proposed method has been tested on a large set of randomly generated instances with the number of nodes being 25 and 50, the number of warehouses is 10 and each warehouse is made independent of other i.e, task allocation from one cluster doesn't interfere with other.

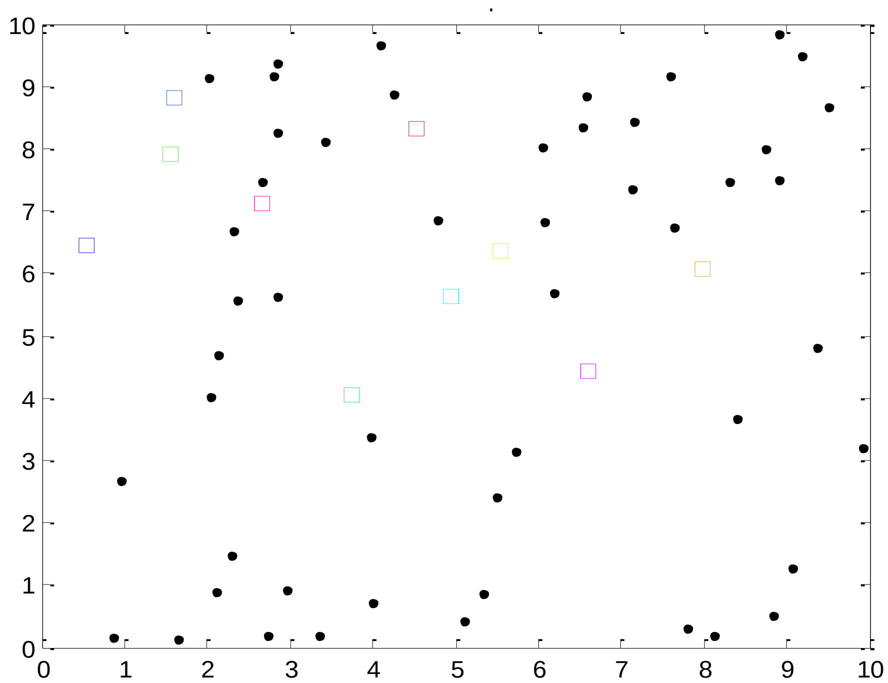

Figure 5.1 (a) Node locations

The best solution of task allocation (minimum sum of all tour lengths) is 16.2055 units for 50 nodes as shown in figure 5.1.

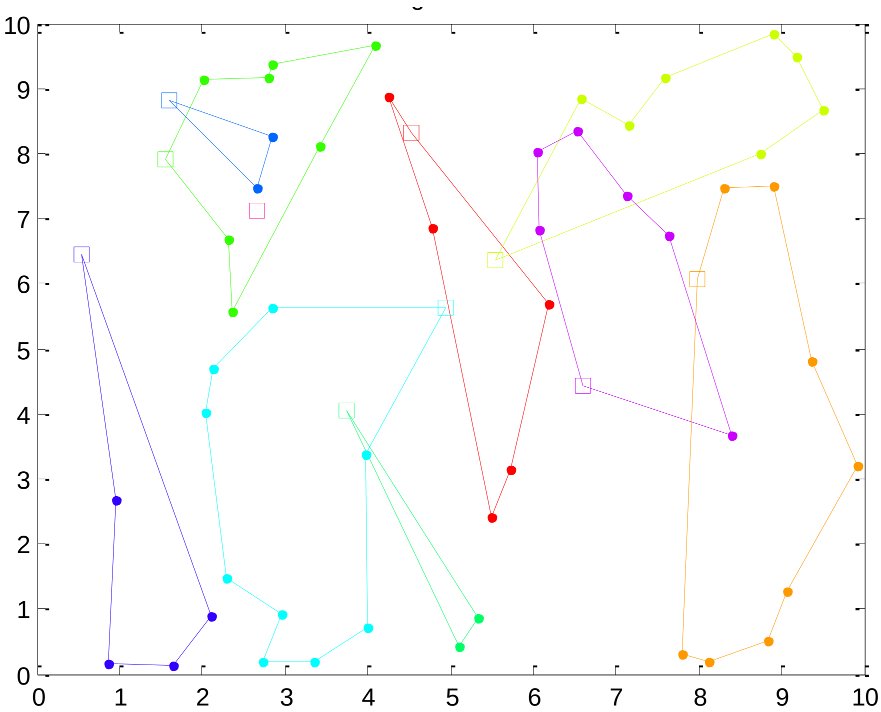

Figure 5.1 (b) Optimum scheduled Task Allocation on Nodes

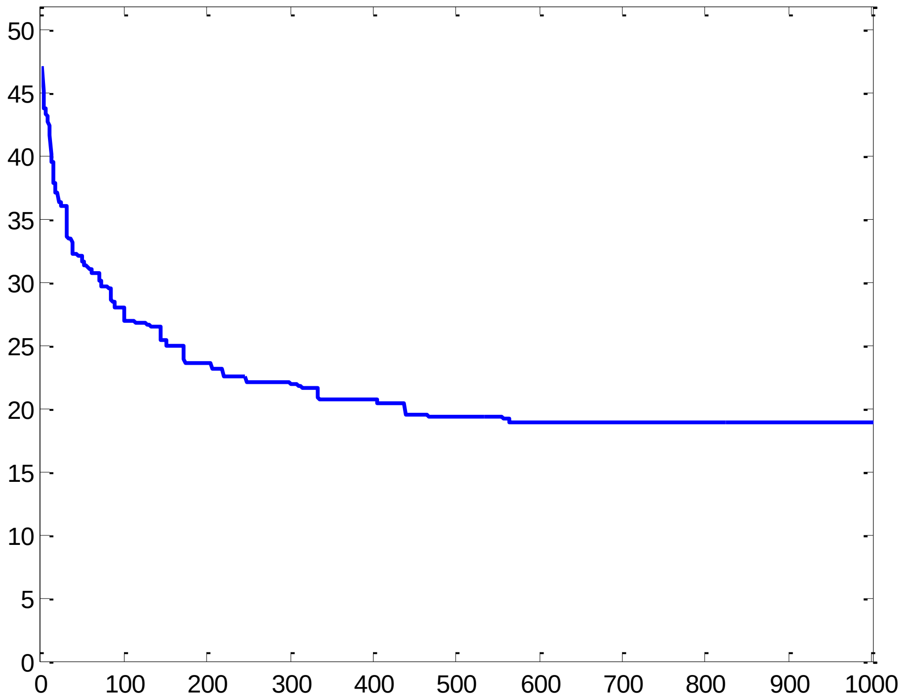

Figure 5.1 (c) Graph representing Best Solution

The table 1 below represents the sequence of tasks scheduled on nodes from respective warehouse (Task Generator) as a particular cluster. The sequence from Warehouse W_1 is 50,1,47,10,3, returns back to W_1 and in W2 12, 2, 23, 7, 49, 40, 21, 26, W2 similarly in all the clusters. The nodes selected by warehouse in some clusters may vary and some warehouses no node is selected as in W_{10}.

Table 5.1: Task allocation on ECUs from respective Warehouses for 50 Nodes

Warehouses	Sequence of Task allocation (Best Tour) on ECUs									
W_1	50	1	47	10	3	W_1				
W_2	12	2	23	7	49	40	21	26	W_2	
W_3	32	41	20	34	42	28	38	W_3		
W_4	17	33	22	19	25	16	36	W_4		
W_5	43	5	W_5							
W_6	29	27	11	15	6	24	46	48	8	W_6
W_7	4	18	W_7							
W_8	9	45	37	13	W_8					
W_9	39	35	14	31	30	44	W_9			
W_{10}	W_{10}									

Further, it is decided to obtain the schedule patterns for nodes varying between 25 to 50 in steps of 5, were investigated. The optimal result with 25 nodes, keeping 10 warehouses as constant parameter were obtained and are shown in figure below. The task allocation on nodes from respective warehouses for 25 nodes is presented in table below.

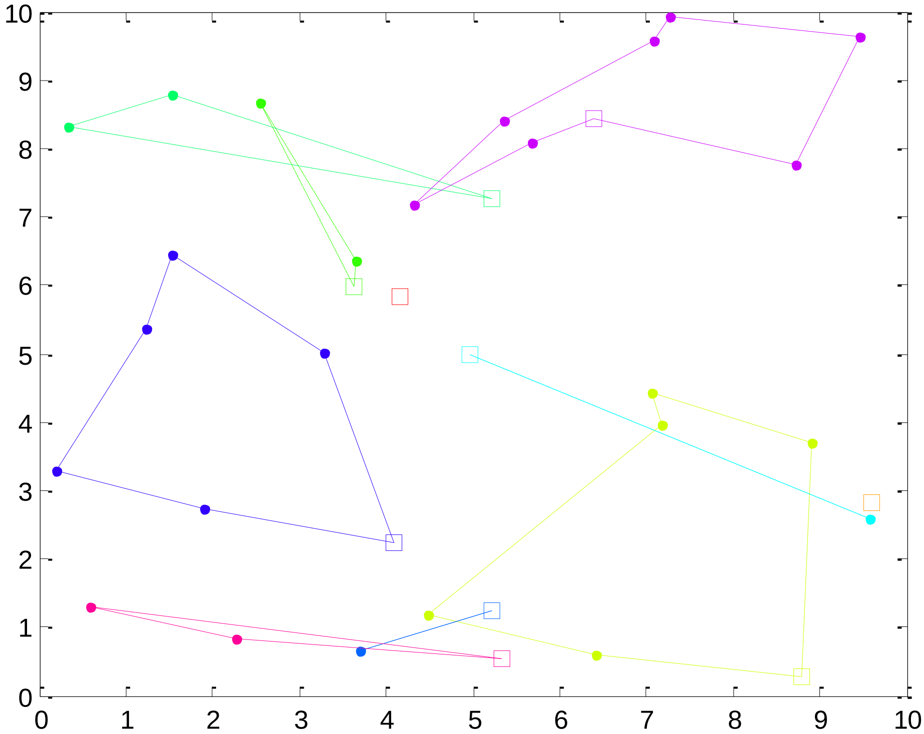

Figure 5.2. (a) Node Scheduling for 25 Nodes

Table 5.2: Task allocation on ECUs from respective Warehouses for 25 Nodes

Warehouses	Sequence of Task allocation (Best Tour) on ECUs								
W_1	14	6	18	W_1					
W_2	20	22	5	W2					
W_3	9	W_3							
W_4	15	W_4							
W_5	21	8	13	2	W_5				
W_6	16	7	1	W_6					
W_7	11	12	3	25	17	47	4	W_7	
W_8	24	19	W_8						
W_9	10	23	W_9						
W_{10}	W_{10}								

From above table it can be observed that warehouses W_3 and W4 are engaged with only one node and W_{10} doesn't allocate the task at all. It is observed that W_7 has largest cluster of nodes connected to it such that in a given time more tasks are executed in that cluster.

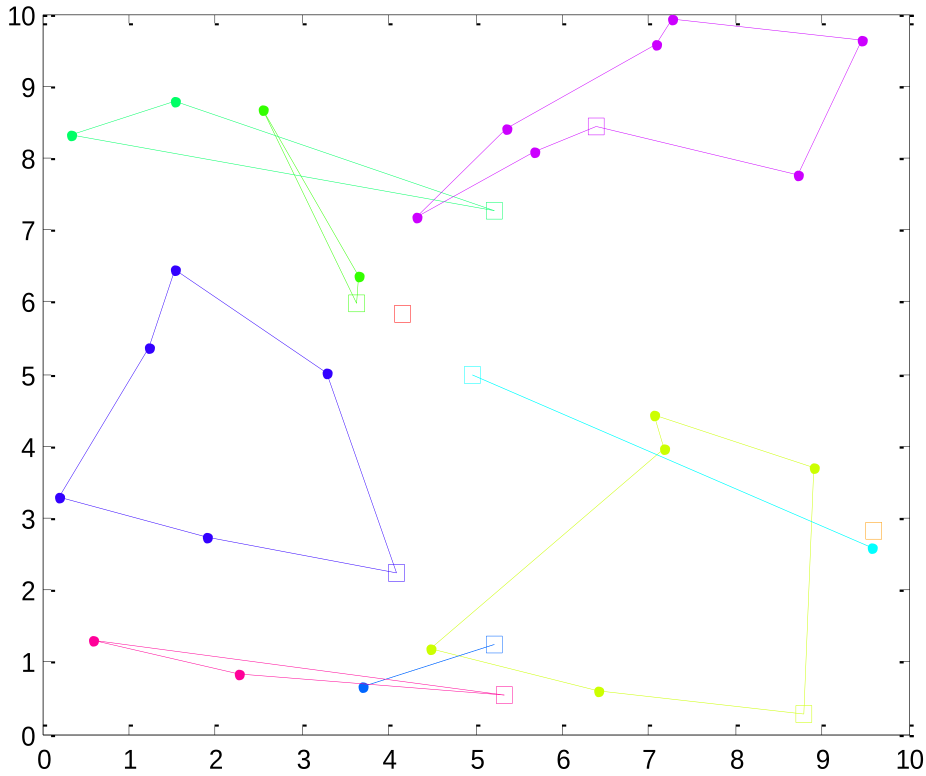

Figure 5.2. (b) Node Scheduling for 30 Nodes

Similarly the above figure shows the node scheduling pattern for 30 nodes with 10 warehouses and the table below shows the sequence of tasks that are allocated on the nodes is presented.

As it can be observed from the table the warehouse W_1 has not been in use that is due to its prior engagement. The new tasks are not generated and hence it is not allocated to or engaged to the nodes.

Table 5.3: Task allocation on ECUs from respective Warehouses for 30 Nodes

Warehouses	Sequence of Task allocation (Best Tour) on ECUs								
W_1	W_1								
W_2	6	9	11	W_2					
W_3	3	2	17	21	18	W_3			
W_4	23	22	W_4						
W_5	30	8	4	28	26	10	W_5		
W_6	19	12	14	W_6					
W_7	7	16	5	1	W_7				
W_8	25	29	W_8						
W_9	20	27	13	W_9					
W_{10}	24	15	W_{10}						

The figure below shows the node scheduling pattern for 35 nodes and table below represents sequence of task allocation or node engagements. The table has two such warehouses which has prior engagements and hence they do not form any cluster, W_1 and W_{10} as given.

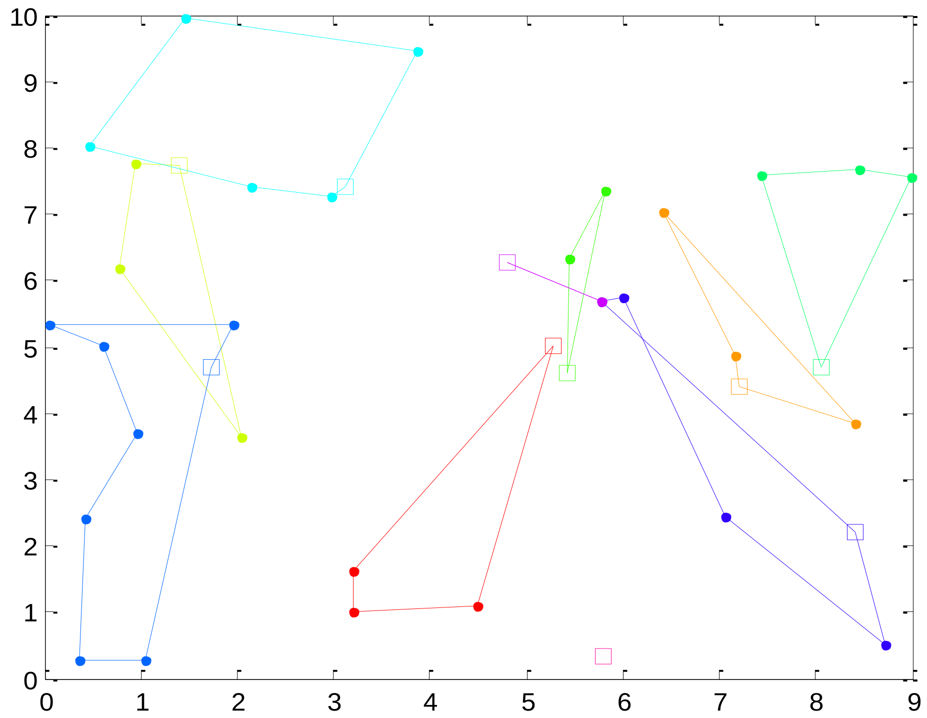

Figure 5.2. (c) Node Scheduling for 35 Nodes

Table 5.4: Task allocation on ECUs from respective Warehouses for 35 Nodes

Warehouses	Sequence of Task allocation (Best Tour) on ECUs									
W_1	W_1									
W_2	22	29	9	W_2						
W_3	23	4	13	5	W_3					
W_4	14	30	11	19	27	W_4				
W_5	33	6	35							
W_6	2	28	8	26	10	W_6				
W_7	3	12	21	W_7						
W_8	20	15	24	32	W_8					
W_9	17	31	25	16	18	W_9				
W_{10}	W_{10}									

The figure below represents the task allocation pattern, for 40 nodes and the table below represents the sequence of task allocations on the nodes. From the table it can be seen that all the warehouses are active and all of them allocating tasks to respective nodes.

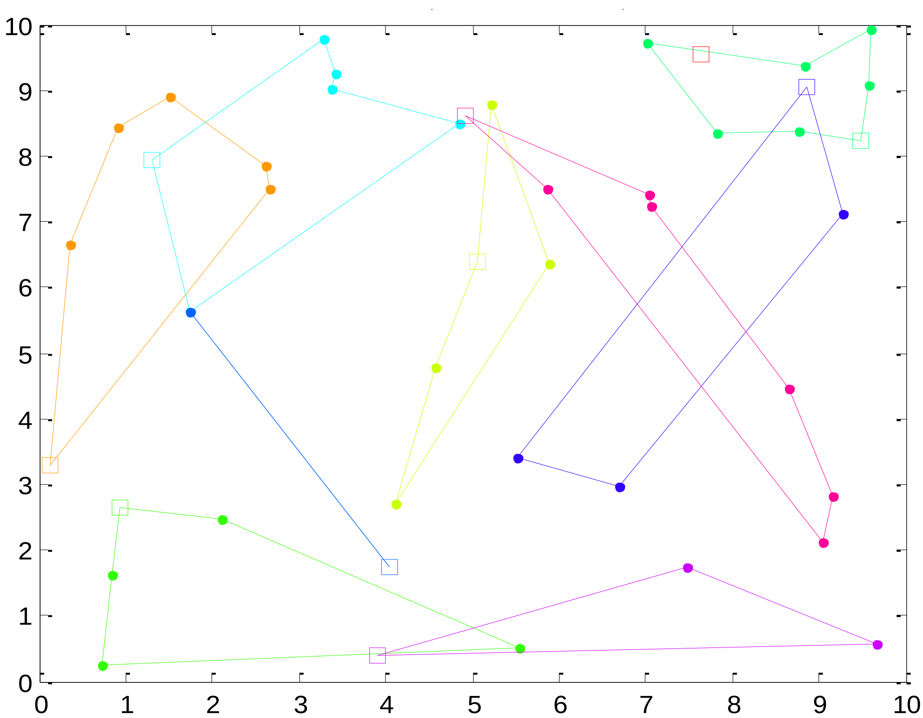

Figure 5.2. (d) Node Scheduling for 40 Nodes

Table 5.5: Task allocation on ECUs from respective Warehouses for 40 Nodes

Warehouses	Sequence of Task allocation (Best Tour) on ECUs								
W_1	26	8	32	11	17	21	W_1		
W_2	16	W_2							
W_3	1	10	7	2	W_3				
W_4	24	29	39	18	W_4				
W_5	4	35	19	9	6	25	W_5		
W_6	12	23	W_6						
W_7	15	22	28	W_7					
W_8	5	W_8							
W_9	14	31	3	13	40	30	W_9		
W_{10}	36	38	33	27	34	37	20	W_{10}	

It is observed that warehouses W_2 & W_8 are allocating tasks to node 16 & 5 respectively. Whereas all other warehouses are having number of tasks allocated for execution.

The optimal result with 45 nodes, keeping 10 warehouses as constant parameter were obtained and are shown in figure below. The figure below is the node scheduling pattern for 45 nodes similar to previous patterns. The nodes selected by warehouse in some clusters may vary and some warehouses no node is selected.

This pattern is also engaged in allocating tasks to number of nodes except $W_{10.}$ The warehouse W_{10} has not allocated any task and said to be engaged with prior assignments. It is observed that W_3 has largest cluster of nodes connected to it such that in a given time more tasks are executed in that cluster.

The experimental investigations carried so far for the proposed method, the best optimal solution is obtained by ADGA when compared with existing method for the nodes concerned.

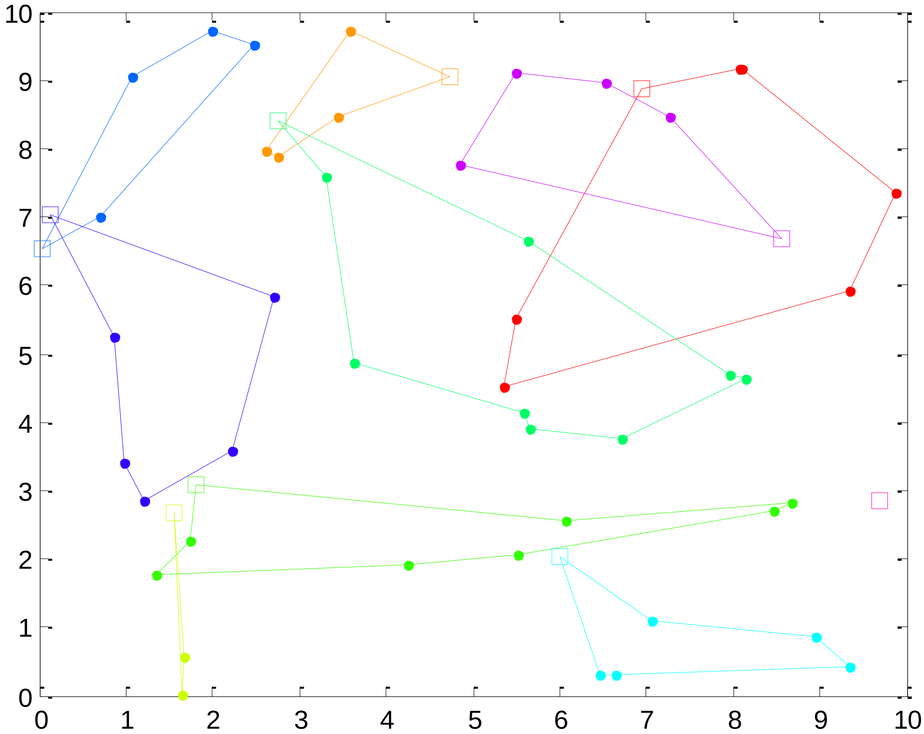

Figure 5.2. (e) Node Scheduling for 45 Nodes

Table 5.6: Task allocation on ECUs from respective Warehouses for 45 Nodes

Warehouses	Sequence of Task allocation (Best Tour) on ECUs									
W_1	23	37	32	29	4	W_1				
W_2	36	7	25	30	W_2					
W_3	28	44	3	33	17	8	34	40	W_3	
W_4	11	31	10	41	5	45	W_4			
W_5	16	15	20	18	6	21	43	W_5		
W_6	42	35	14	1	24	9	W_6			
W_7	27	22	W_7							
W_8	39	13	2	26	12	38	19	W_8		
W_9	19	W_9								
W_{10}	W_{10}									

5.2 Statistical Analysis

For Comparison the values of best solution for 25 nodes and 50 nodes are given in table below. From the table we can say that Adaptive Dynamic Genetic Algorithm gives better results this is due to clustering and as the number of warehouses is increased the best solution for task allocation value can be reduced. Thus the task allocation could be faster on suitable node. The simple Genetic Algorithm result is better than other algorithms. We can see from the table Simulated annealing technique is quite slow because the cooling coefficient is kept at 0.97 if it is reduced further the best solution can be obtained earlier but the possibility of landing in optimal solution is less. The Greedy Nearest Neighbour gives better value than Simulated Annealing and Ant Colony technique; this is due to sorting in short distances but no guarantee of getting optimum solution.

Table 5.7: Comparison of algorithms based on best solution for task allocation

Optimization Methods	Greedy Nearest Neighbour	Simulated Annealing	Ant Colony Optimization	Genetic Algorithm	Adaptive Dynamic Genetic Algorithm
Best Solution for 25 nodes (in Units)	47.03	9334.05	155.156	40.213	9.635
Best Solution for 50 nodes (in Units)	63.36	40003.141	170.3367	55.66	16.205

The values tabulated in Table 5.7 are represented in one graphical plot in figure 5.3 for easy perception of how the proposed algorithm gives best value in comparison with existing algorithms.

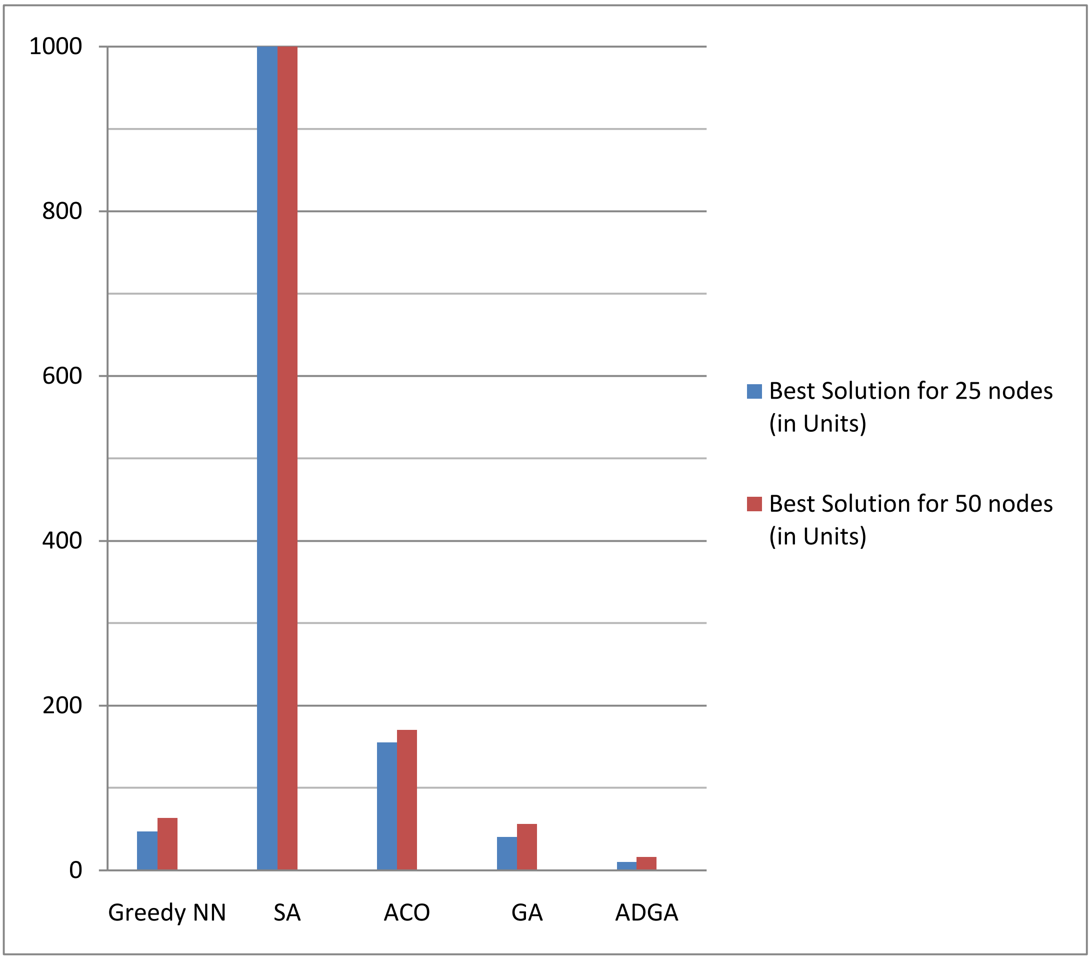

Figure 5.3: Comparison Plot for 25 and 50 Nodes

The experimental investigations have been extended further with nodes 25,30,35,40, 45 and 50 and those results are tabulated in Table 5.8 below. The node allocation figures have been presented earlier in the corresponding sections. But the results of Simulated Annealing have been excluded in the table 5.8 because the values of SA exceed the Graphical representation due to its conceptual basis. Even though the values of SA are included, they will not be useful in comparison with other algorithms.

Table 5.8: Comparison of algorithms for nodes from 25 to 50 based on best solution for task allocation

Optimization Methods	**Greedy Nearest Neighbour**	**Ant Colony Optimization**	**Genetic Algorithm**	**Adaptive Dynamic Genetic Algorithm**
Best Solution for 25 nodes (in Secs)	42.03	88.85	41.213	12.68
Best Solution for 30 nodes (in Secs)	43.61	118.37	50.09	15.25
Best Solution for 35 nodes (in Secs)	61.04	134.49	52.15	15.23
Best Solution for 40 nodes (in Secs)	58.15	127.57	56.82	11.69
Best Solution for 45 nodes (in Secs)	61.8	159.50	56.48	16.46
Best Solution for 50 nodes (in Secs)	63.36	170.3367	62.27	16.76

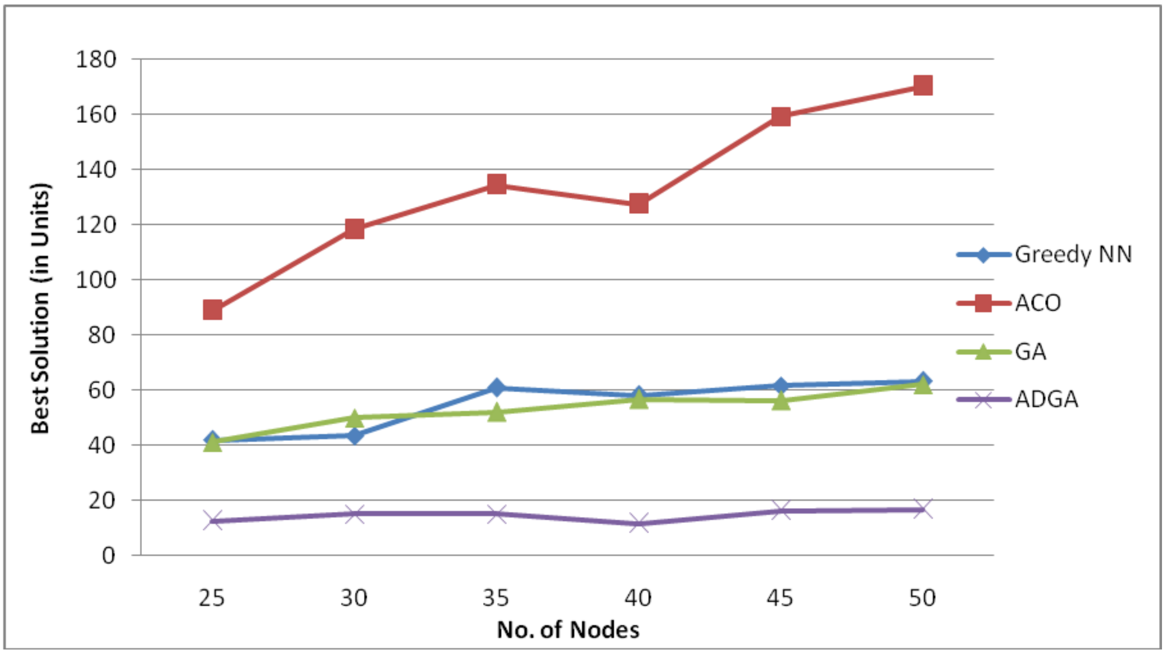

Figure 5.4: Comparison Plot for 25 to 50 Nodes

For a better objective analysis of the all the methods investigated in this research work a plot of stacked line with markers has been used and given in figure 5.4 above. As the values represented in Table 5.8 given on the plot, it is easy to perceive that proposed method ADGA provides best minimum optimal solution for task allocation on nodes.