













**Table 4:** Testing hypothesis of ten-city problem without staying overnight using T-Test

VRP without Staying Overnight				
	DE-T	DE-E	DE-I	DE-M
DE	>	>	>	>
DE-T	-	<	>	>
DE-E	-	-	<	>
DE-I	-	-	-	>
DE-M	-	-	-	-
VRP with Staying Overnight				
	DE-T	DE-E	DE-I	DE-M
DE	>	>	>	>
DE-T	-	>	<	<
DE-E	-	-	<	<
DE-I	-	-	-	>
DE-M	-	-	-	-

From this 10-city test, we can conclude that the improve differential evolution (IDE) in the process of recombination with four applying ways Vector transition process (DE-T), Vector exchange process (DE-E), Vector insertion process

(DE-I) and Vector Mix process (DE-M) is able to come up with a better answer than the regular DE and Vector Mix process (DE-M) can access the best answer.

**Showing testing 50-city problems :**

**Table 5:** Test instances

	VRP without Staying Overnight					VRP with Staying Overnight				
	DE	DE-T	DE-E	DE-I	DE-M	DE	DE-T	DE-E	DE-I	DE-M
Case 1	54,180	51,821	50,800	51,389	50,418	50,101	49,389	49,312	47,999	48,585
Case 2	51,010	50,750	49,924	50,527	50,973	50,718	50,648	48,620	49,928	49,325
Case 3	49,867	48,820	49,847	49,466	47,105	49,224	48,531	47,997	48,661	46,949
Case 4	49,214	48,630	47,032	47,228	45,367	45,554	46,984	44,276	44,503	45,104
Case 5	48,961	49,270	47,411	47,616	48,524	47,749	48,627	47,478	47,604	46,560

**Table 6:** Testing hypothesis of 50-city problem without staying overnight using T-Test

VRP without Staying Overnight				
	DE-T	DE-E	DE-I	DE-M
DE	>	>	>	>
DE-T	-	>	>	>
DE-E	-	-	<	>
DE-I	-	-	-	>
DE-M	-	-	-	-
VRP with Staying Overnight				
	DE-T	DE-E	DE-I	DE-M
DE	<	>	>	>
DE-T	-	>	>	>
DE-E	-	-	<	>
DE-I	-	-	-	>
DE-M	-	-	-	-

From this 50-city test, we can conclude that the improve differential evolution (IDE) in the process of recombination with four applying ways Vector transition process (*DE-T*), Vector exchange process (*DE-E*), Vector insertion process

(*DE-I*) and Vector Mix process (*DE-M*) is able to come up with a better answer than the regular DE and Vector Mix process (*DE-M*) can access the best answer.

**Showing testing 100-city problems :**

**Table 7:** Test instances

	VRP without Staying Overnight					VRP with Staying Overnight				
	DE	DE-T	DE-E	DE-I	DE-M	DE	DE-T	DE-E	DE-I	DE-M
Case 1	104,511	103,580	101,846	104,536	104,595	97,236	97,459	98,598	98,526	943,657
Case 2	108,276	106,045	108,214	109,418	106,950	104,633	97,836	103,904	100,571	101,708
Case 3	139,735	138,710	134,575	139,409	137,300	117,196	118,129	115,049	115,357	116,513
Case 4	118,164	118,164	115,498	116,001	116,889	107,564	106,459	107,691	105,932	106,742
Case 5	109,022	108,555	106,027	105,347	104,944	105,309	102,957	105,171	105,930	103,361

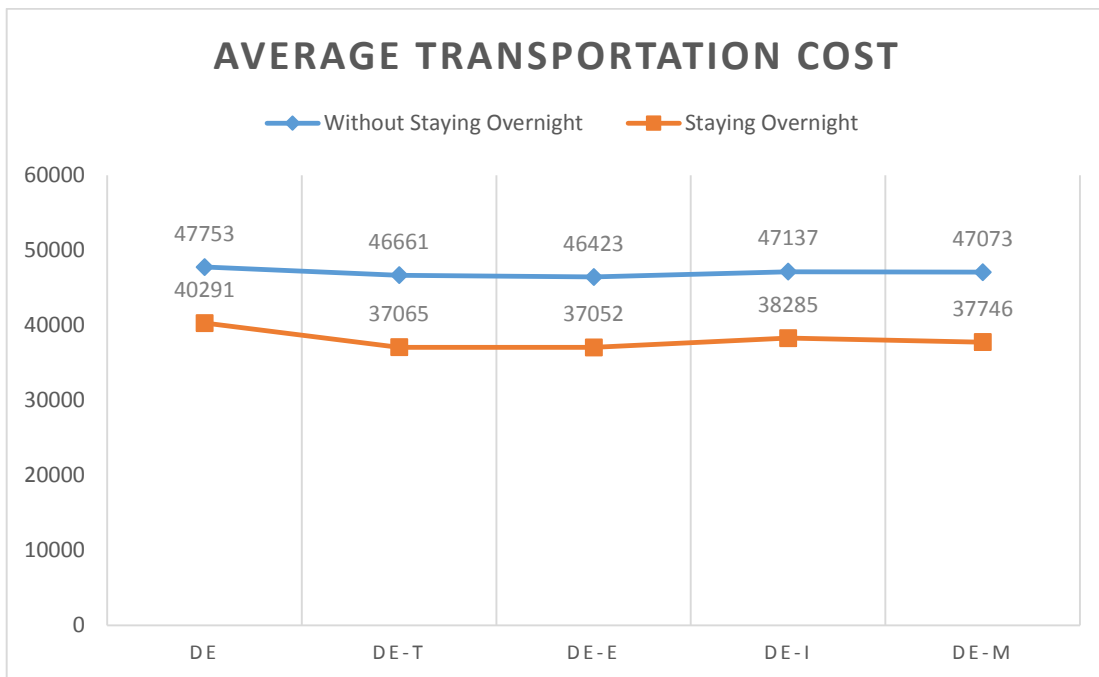
**Table 8:** Testing hypothesis of 100-city problem without staying overnight using T-Test

<b>VRP without Staying Overnight</b>				
	DE-T	DE-E	DE-I	DE-M
DE	>	>	>	>
DE-T	-	>	>	>
DE-E	-	-	<	<
DE-I	-	-	-	>
DE-M	-	-	-	-
<b>VRP with Staying Overnight</b>				
	DE-T	DE-E	DE-I	DE-M
DE	>	>	>	>
DE-T	-	<	<	>
DE-E	-	-	>	>
DE-I	-	-	-	>
DE-M	-	-	-	-

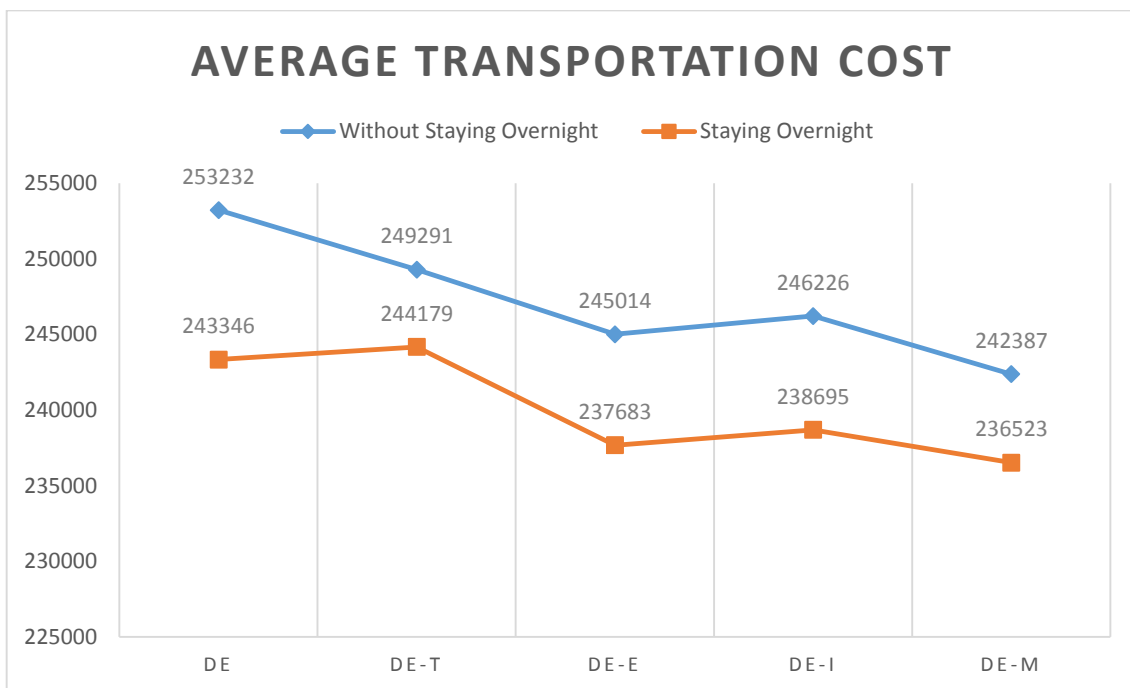
From this 50-city test, we can conclude that the improve differential evolution (IDE) in the process of recombination with four applying ways Vector transition process (*DE-T*), Vector exchange process (*DE-E*), Vector insertion process (*DE-I*) and Vector Mix process (*DE-M*) is able to come up with a better answer than the regular DE and Vector Mix process (*DE-M*) can access the best answer.



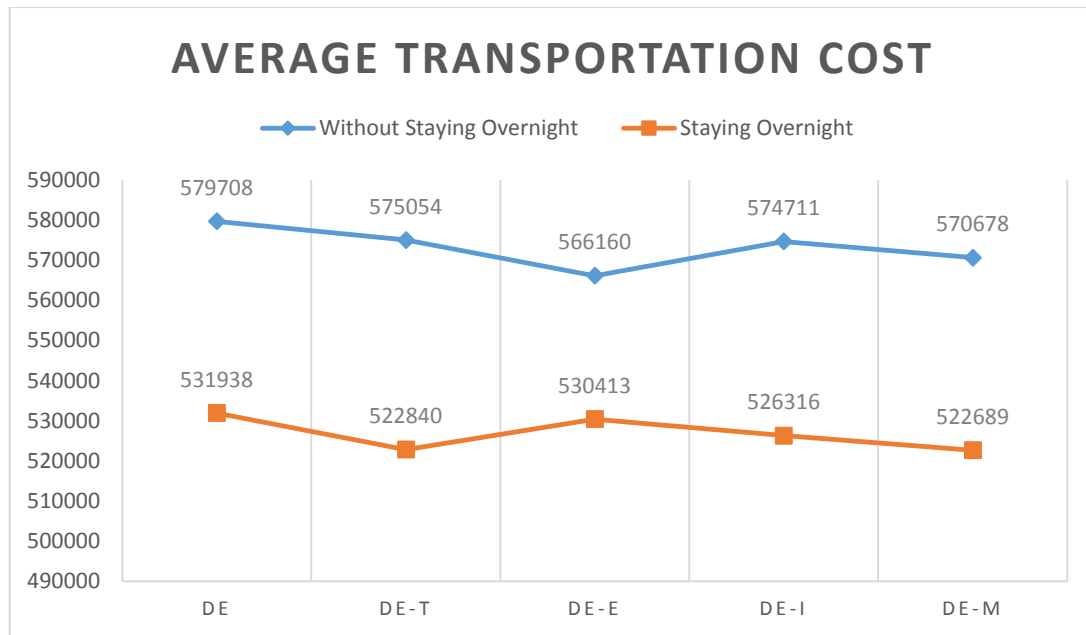
**Showing algorithm testing graphs in comparison :**



**Graph 1:** Showing the average lowest costs in testing 10-city problems



**Graph 2:** Showing the average lowest costs in testing 50-city problems



**Graph 3:** Showing the average lowest costs in testing 100-city problems

**Table 9:** Comparing algorithm

Case / Method	Best Practice	Total Cost (F = 0.1, CR = 0.9)				
		DE	DE-T	DE-E	DE-I	DE-M
1	475,150	222,260	224,199	227,710	227,274	222,448
2		225,892	226,697	224,821	226,997	224,085
3		228,573	223,217	227,141	224,748	226,265
4		223,274	226,143	225,674	225,569	224,813
5		226,677	226,659	225,259	228,858	223,388
Average		-	225,335	225,383	226,121	226,689

**Conclusion of testing adapted DE :**

Using heuristics, the improved differential evolution (IDE) is more effective in terms of accessing the best answer than the regular differential evolution (DE). The most effective method is Vector Mix process (DE-M) in adapting the process of recombination. Moreover, VRP – CTST with staying overnight can save a lot more money than the normal VRP-T. All of the answers from these tests will be used in making a decision on reducing the total transportation costs of maintaining medical equipment in the health promoting hospitals in UbonRatchathani, Thailand.

**DE of VRP- CTST**

In this part, we present the test result using heuristics improved differential evolution (IDE) in order to reduce the total transportation costs of maintaining medical equipment in the

health promoting hospitals in UbonRatchathani, Thailand, which the costs per year is 475,150 Baht.

Using the parameters F = 0.1 and CR = 0.9 from Table 9, we found that the DE-M method has the lowest cost at 222,448 Baht. The average cost is 224,200 Baht. We can arrange 39 routes in total with the distance of 8,041 kilometers. There are 83 working days and 44 nights to stay over, and we can decrease the cost by 52.24%.

**CONCLUSION**

In this research, we present the best practice, classical differential evolution algorithm (DE) and improved differential evolution algorithm (IDE) to solve continuous routing problems, which allow continuous transportation without limitation of truck operation hours and returning locations. In this system, drivers are allowed to take routine breaks at

designated rest areas without having to return to the hub. We compared between the best practice, DE and IDE. We found that the DE-I has the lowest cost of 222,448 Baht.

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