CHAPTER 11

CONCLUSION

11.1 GENERAL

Transportation of goods constitutes an important part of the inbound as well as the outbound logistics of the supply chain management. Since the transportation costs constitute a significant fraction of the total logistics cost, finding the best paths for vehicles that will minimize time or distance, is a frequent decision-making problem and this is commonly known as the Vehicle Routing Problem (VRP). Vehicle Routing Problem with Time Windows (VRPTW) is an important variant of VRP in which the issues must be addressed under the added complexity of allowable delivery times, or time windows, stemming from the fact that some customers impose delivery deadlines and earliest-delivery-time constraints. VRPTW is an NP hard combinatorial optimization problem. Because of the high complexity level of VRPTW and its widespread applicability in real life situations, the development of heuristics which are capable of producing high quality solutions is of prime importance.

In this work, Genetic Algorithm, Ant Colony Optimisation, Simulated Annealing, and Meta Raps based heuristics are developed and implemented for solving SDVRPTW with the objective of minimising the number of vehicles used and the distance travelled. The proposed heuristics search methods are tested with benchmark problems and a case study. The experimental results clearly indicate that the proposed search based heuristics
are effective in solving this type of problem, as seen through a comparison of the obtained results with the best available heuristic.

These Metaheuristic based search methods are extended to solve MDVRPTW. Even though intensive research efforts are in progress for both heuristic and exact optimization approaches in the area of VRP and VRPTW, very limited study has been carried out so far in the case of MDVRPTW. GA, SA, ACO and Meta Raps have been used to solve many combinatorial optimisation problems including certain types of VRP, but to the best of our knowledge this is the first work based on the application of these metaheuristic for solving MDVRPTW. The results obtained are compared with those published in previous works in this area and the solution quality of proposed heuristics is competitive with the best solutions reported for MDVRPTW.

11.2 CONTRIBUTION OF THE RESEARCH

- Algorithms for VRPTW and are considerably more intricate than classical VRP and it calls for efficient algorithm so that immediate requests can be served. These have made them an important candidate for solution using metaheuristics. Hence, this research tries to propose new metaheuristic algorithms based on Genetic Algorithm, Ant Colony Optimization, Simulated Annealing and Meta Raps.

- Metaheuristic-based search methods are extended to solve MDVRPTW.

- Metaheuristic-based search methods have been applied to solve routing problem for inbound logistics operation of Third Party Logistics service provider.
Parameter setting for different metaheuristics developed is done based on the Taguchi method, which is known as a robust design tool for optimizing the process parameters.

The proposed algorithms are tested with the benchmark problems and the experimental results are found to be better and encourage practitioners to apply them to real world problems.

11.3 SCOPE FOR FUTURE RESEARCH

The analytical results indicate that it would be worthwhile to explore the proposed heuristics further, for solving different variants of vehicle routing problems like Vehicle Routing problem with Simultaneous Pickup and Delivery Problem with Time Windows, Vehicle Routing problem with Backhauls and Time Windows, Vehicle Routing problem with Time Deadlines etc.,

This work can be extended by considering different clustering methods to solve the MDVRPTW problem.

Real-time vehicle routing is important in supporting supply chain execution systems, and in minimizing the related logistics risk. Hence a DSS that incorporates algorithms needed for real-time routing, scheduling, and monitoring of the current state of the fleet with a robust database containing both static (customers, geographical information of the road network, and so on), as well as dynamic (orders, quantities, time window information, and so on) data can be developed.
In the case of heuristics, only GA, SA, ACO and Meta Raps are attempted in this work. Other search heuristics like Particle Swarm Optimisation, Free Search can also be attempted.

With respect to the search heuristic, hybrid techniques, developed by combining the properties of one with another can be developed.

The proposed heuristics can be extended to solve vehicle routing problem with time windows with additional constraints like reloading under rush-order constraints, vehicle availability and shift time limit constraints etc.

The proposed metaheuristic can be applied to other combinatorial optimisation problems like Scheduling, Travelling Salesman Problem etc with slight modifications.