ABSTRACT

Today, customers look beyond the initial procurement cost of the product. They are ready to buy products that are priced higher. It is evident from the observations that the products from manufacturers like Motorola, Nokia, Sony, Nissan, Ford, Philips, Dell, and so on have good and everlasting market share, though their prices are quite higher than the similar products from their competitors. The foremost reasons for the readiness of the customers/users to buy the products with higher initial prices are: availability of spares at an affordable cost that lead to product usage at longer periods, durability of the product and hence minimum downtime and consistency in product quality. Therefore, the manufacturers need to give due consideration for the above right at the time of developing the products and services so as to be in the business for longer period.

The total cost of ownership (TCO) is a tool and philosophy to understand the true cost of a particular good or service. The strength of TCO is to provide and understand the future costs that may not be noticeable when an item is initially developed. TCO models emerge as effective ways to develop new products that meet competitive challenges and satisfy customer demands. This thesis considers the TCO for newer product development as the major realm of research. Variety of cost components are deliberated in TCO models. The major cost elements of TCO such as procurement cost,
replacement cost and down time cost have direct relationship with the reliability of the product. Hence TCO models based on reliability can be useful to select the suppliers and level of redundancy for the product. Besides, the line of reasoning shows that Reliability Based Total Cost of Ownership (RBTCO) models can integrate quality, service and maintenance related costs along with the initial price of the product. On the above considerations, in this research, RBTCO models have been developed for a procurement decision making and product development decision making for the elements of the product with the following objectives.

**RBTCO for optimal supplier selection (Model 1):** Determination of optimal supplier selection of the elements of a product with an objective of minimum TCO subjected to minimum required product reliability and maximum permissible weight.

**RBTCO for optimal redundancy allocation (Model 2):** Determination of optimal redundancy allocation of the elements of a product with an objective of minimum TCO subjected to minimum required product reliability and maximum permissible weight.

The mathematical formulations of RBTCO for optimal supplier selection (Model 1) and optimal redundancy allocation (Model 2) fit into zero one Integer Programming Problem and Non Linear Integer Programming problem, respectively. Both the above models belong to NP-hard category. To solve such NP-hard problems, exact search algorithms may degenerate to
complete enumeration. For that reason, exact approaches are limited to solve only moderately sized problem instances, due to the exponential increase in CPU time when problem size increases. Therefore, meta-heuristic approaches have emerged as a promising alternative approach for such hard problems. Two meta-heuristic algorithms, a Genetic Algorithm (GA) and Simulated Annealing Algorithm (SAA), are proposed to evolve optimal solutions for both the models. The complete enumeration of the solution space is calculated in order to demonstrate the computational efficiency of the proposed algorithms. The summary of the study and analysis is presented below:

- Consideration of reliability in TCO model for supplier selection decision is one of the way to develop new products to meet competitive challenges and satisfy the customer’s expectations.

- RBTCO model helps the manufacturer to fix the price and warranty period. Moreover, the requirement of spares can be estimated and their availability can also be ensured.

- Decision based on RBTCO model strengthens the proposal that all procurement and product development decisions should include the impact of future costs and not just the procurement cost.

- The proposed algorithms, GA and SAA, are proven to give optimal or near optimal solution with reasonable computational effort by comparing the optimal solutions obtained by enumeration.

- Future research directions are also discussed.