Businesses today depend on their supply chains to provide them with what they need to survive and thrive. Every business fits into one or more supply chains and has a role to play in each of them. The pace of change and the uncertainty about how markets will evolve have made it increasingly important for companies to be aware of the supply chains they participate in and to understand the roles that they play. Those companies that learn how to build and participate in strong supply chains will have a substantial competitive advantage in their markets. A supply chain is dynamic and involves the constant flow of information, product and funds between different stages.

A supply chain may be defined as an integrated process wherein a number of various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to fulfills the demand of its consumers. This chain is traditionally characterized by a forward flow of materials and a backward flow of information. For years, researchers and practitioners have primarily investigated the various processes of the supply chain individually. Recently, however, there has been increasing attention placed on the performance, design, and analysis of the supply chain as a whole. From a practical standpoint, the supply chain concept arose from a number of changes in the uncertain environment, including the rising costs of procuring, shortened product life cycles and the globalization of market economies.

Assessing supply chain performance leads to identification of problems and opportunities. Having a strategy and measuring key parts are necessary to understand and take control of supply chain. Put the process, people and technology in place to create competitive advantage, both for today and tomorrow. If one do not, a competitor will. Supply chain success involves process, people and technology. It gives definition to the company purpose. It enables all participants to know what is required. This in turn provides agility to handle exceptions and to adapt to changes. Having those three elements is important to having metrics, ones that are useful across the organization. All three working together in a company provides coordinated, unified effort to use supply chain management as a driving force in customer
satisfaction and in having competitive advantage, with service and productivity. Effectively managing inventories requires proper process, people and technology. It means coordinated management of the supply chain from the supplier’s doors right through to the customer’s docks.

The work presented in this thesis focuses on some contributions to modeling in Procurement - Distribution Coordination in Supply Chain Management. Procurement and distribution in Supply Chain Management is crucial to ensuring that high-quality product arrive at the target population of end users. The performance of the proposed models is shown with the Lingo Programming and model validations on real life data sets existing in retail firms. The results obtained are encouraging and close to the actual values. Notwithstanding the research done and contributions made, the conclusion touches some points of possibility of further research.

This thesis is divided into five chapters. The first chapter explains the overview and basic concepts of supply chain management and optimization techniques related to the understanding of the research work. The existing research and applicability of the research carried in the thesis in procurement-distribution coordination is highlighted in this chapter. Now we briefly conclude the work presented in rest of the chapters and discuss scope of future research. Chapter-2 discusses the problem of a single source supplying multiple products at a single destination. In Section I, we have developed mathematical models to compute optimal order for integrated procurement-transportation problem of supply chain with two modes of transportation namely, Truckload (TL) and Less Than Truck Load (LTL) carriers by introducing all unit and incremental quantity discount structure into analysis. Finite planning horizon and dynamic demand is assumed to make ordering decisions. Section 2 of the chapter incorporates quantity discounts and freight policies for multi items that are perishable in nature, which are supplied from single source to single destinations under fuzzy environment. It is assumed that, single source or a supplier is offering various discounts on the purchase of quantity and are supplying to a destination. A transporter hired by the buyer also offers different policies to choose on distribution of products, thereby buyer is enticed by dual benefit on procurement as well as distribution. A fuzzy optimization problem is converted to crisp mathematical programming problem using membership function. The problems are
Conclusions and Directions for Future Research

solved and cases are presented in both sections to validate the model. Chapter-3 considers transportation from single source to multiple destinations. The model in Section I is targeted towards computing optimal order for integrated procurement-distribution problem. It incorporates quantity discounts and freight policies for multi items that are perishable in nature, which are supplied from single source to various destinations. It is assumed that there is finite planning horizon and dynamic demand to make ordering decisions. Section II incorporates quantity discounts and freight policies for multi items that are perishable in nature, which are supplied from single source to multiple destinations under fuzzy environment. It is assumed that, there is finite planning horizon on which demand and total costs are fuzzy in nature. A fuzzy optimization problem is converted to crisp mathematical programming problem using triangular membership function. The real life cases are discussed to validate the procedures. In chapter-4 we considered multi source multi-destination procurement-distribution supply chain in which a model is proposed to compute optimal ordered quantities for the integrated procurement-distribution problem with all unit discounts on quantity ordered and shipping that discounted quantity with two modes of transportation, namely TL & LTL in Section I. A finite planning horizon and deterministic demand is assumed to make ordering decisions. Section II develops coordinated quantity and freight discount policy for perishable products under uncertain cost and demand information i.e. fuzzy nature. The fuzzification grants authenticity to the model in the sense that it allows vagueness in the whole setup which brings it closer to reality. A case is provided to validate the procedure. Chapter-5 considers the dynamics of two stage supply chain, where, there is single source of supply, an intermediate stoppage, single distributor and multiple destinations of consumption i.e. the integration of procurement and distribution decision making under two stage environment. Different discount policies are offered to procure and transport goods from the one stage to other stage when it is assumed that inventory carrying charge at the stoppage is very high after a pre-specified time. Model will benefit organizations in a long run by helping them determining optimal quantity to be ordered which not only reduces the cost of procurement and transportation costs. A case is presented to testify and validate the procedure. Section II describes the model with uncertainty in demand and cost, when procurement and distribution decisions of supply chain need to be taken. The model incorporates a single supplier transporting its products
to multiple destinations of a retailer. This process becomes tedious, when items are moving with stoppage as on stoppage point inventory carrying cost would also be incurred due to perishable nature of products. Different discount policies are offered to procure and transport goods from the one stage to other stage. By using the fuzzy set theory, optimum decisions are taken and a case is presented to validate the procedure. Clear conclusion from above defined models and cases is that, the minimum integrated procurement and distribution cost can be achieved by including quantity discounts (all unit or incremental discounts) and different freight policies with fixed holding and inspection cost in a finite planning horizon and even in an uncertain environment. There are many potential advantages of quantity discounts with transported policies. Supplier may ask for higher prices when buyer is not ordering full truckload. In that case discounted schemes on purchasing and different transporting policies may be helpful to the buyer. The uniqueness of the models lies in the fact that, it always considers the maximum possible quantity discounts and the freight cost which is lesser amongst TL or LTL or TL & LTL both. The models can be applied to many real life situations as it can include as many items, sources and destinations. Hence we can conclude from our present research that, integration of various functions of different entities is possible, in order to minimize the aggregate cost of purchasing and transportation activities.

Based on the work done, this research makes the contribution to the area of coordinating procurement and distribution models in the complex supply chain especially in a complex retail supply chain involving perishable and non-perishable products while considering the finite horizon period, limited capacity of transportation by trucks and imprecise demand cost information. This research also makes the contribution in developing the solution methods or procedures by proposing the use of mixed integer nonlinear programming method solved by LINGO Software. These models are applied for situation where multiple products (perishable or non-perishable) and multiple players in the complex supply chain are involved. This research has built the models and proposed the solution methods to solve these problem: (1) when products should be procured and/or ordered by a company from other companies, (2) how many products companies should be ordered, and (3) how many transportation units(trucks/cargos) companies should use to deliver products.
from a company to other companies subject to a finite horizon period in a complex retail supply chain. (4) how to handle imprecise demand (5) how to keep minimum inventory in their stores and hence (6) how to minimize the total cost of procurement and distribution. In fact, the results of this study open several opportunities for further research and improvements.

New arena for further study and deep explorations in procurement and distribution has been worked to propose the extension of the existing model by including intermodal transportation options, backlogging and stochastic demand. Other realistic dimensions that can be incorporated into the model are multi-stage systems in different environment, different lead times etc.