Chapter 3

Literature Review
In this chapter we briefly review the literatures related to the research work in the thesis. The review is divided into three sections. (i) Inventory management literature review (ii) The news vendor problem with pricing literature review (iii) Foreign exchange transaction exposure literature review.

**Inventory management literature review:**  
The inventory management is the most important part of any firm or industry. The popular Economic Order Quantity (EOQ) model of inventory management is the first model which was elaborated by Harris [46] in 1915. The different extensions of the EOQ model which are applicable to real life situations is given in Raymond [96]. The EOQ models are inconsiderate to errors for using the cost and demand parameters [76, 47, 64].

Many inventory models are developed to deal effectively with various situations are based on the EOQ models and thus the importance of EOQ models is unavoidable in inventory management. However, this mathematical modelling procedure of inventory management had very little application in those days because it was a new abstract idea and it needs some time for evolution. The first probabilistic model was developed during World War II, which is now known as “The news vendor problem” or “Christmas tree model” and Whitin [111] was first to show how to tackle with probabilistic inventory models, published in 1953.

The economists Arrow et al. [11], and the mathematicians Dvoretzky et al. [29] have shown the basic key stones of modern inventory management. This was the starting point that the theory of inventory management became a complete academic discipline, and many thousands of papers representing developments and improvement have been published.

In 1970 with the spreading of computers widely over the globe, researcher started using more simulations of mathematical models to represent inventory systems is described in Willis [113]. The main benefit of the simulation technique is that the actual time duration for which the real system operates can be reduced and in almost no time we can analyse performance of the model [109].

Based on common attributes of the researchers, the approaches are grouped in six categories:

1. Models for deterministic optimum inventory policies,
(2) Lot-size optimisation,

(3) Optimisation of various specific management objectives,

(4) Models for optimising highly specialised inventory situations,

(5) Applications of advanced mathematical theories,

(6) Models bridging the gap between theory and practice.

Following a general views of various objectives and constraints faced by decision makers in inventory management, some standard problems were presented and a number of research problems, including erratic and intermittent demand, service parts, uncertainty of future demand and inventory control cost were introduced. The practical solutions presented to these problems would have a major beneficial impact on the practical aspect of inventory management.

The inventory management system can be classified into six categories as follows according to Tinarelli’s survey [105]:

(1) Stochastic models,

(2) Dynamic demand models,

(3) Models for perishables,

(4) Joint-ordering systems,

(5) Capital and/or volume constraints,

(6) Inventory control and devaluation.

**The news vendor problem with pricing literature review:**
The news vendor problem is of great importance in the history of inventory management. An alternative form of NVP had been applied by the economist Edgeworth [30]. As we also know that this model germinated during world war-II and became the hot topic for researcher and academicians. In a global supply chain, the manager of a firm or an individual has to determine the policies for maximizing his expected profit for a perishable product in a single period selling season, i.e he has to find optimum order quantity of the
product when the demand is random and price dependent and he may face the overstocking or shortages of the items. The model formulation and its optimum solution becomes imperative, noted by Porteus [93]. He had explained how to minimize the expected cost of the inventory. In 1955 Whitin [112] developed a news vendor model with pricing. He showed how to maximize the expected profit which is a function of order and price of the product. This fundamental NVP with pricing model is the base model of many inventory models and we also have implemented this approach in developing exchange rate risk models. Porteus [93] reviewed the news vendor problem with stochastic demand very beautifully. The news vendor problem with pricing was first developed by Whitin [112] in which he defined the profit as a function of two parameters namely price(p) and quantity(q) with stochastic demand. He used successive technique to find the optimal solution by first keeping the price fixed and obtained the optimal value of the order quantity(q) as a function of price and then determined optimal price. Mills [72] refined the formulation by explicitly specifying mean demand as a function of the selling price.

The news vendor problem which is the classic inventory model, because of its straightforward but sophisticated structure, can provide an excellent mechanism for analysing how problems in operational management interact with marketing issues to affect decision-making at the firm level. The importance of such analysis is reinforced by the increasing prevalence of time-based competition Stalk Jr & Hout [102] because as time-based competition intensifies, product life-cycles shrink so that more and more products acquire the attributes of fashion or seasonal goods. Thus the news vendor model can be applied to examine a firm who jointly sets a selling price and a stocking quantity prior to facing random demand in a single period.

In NVP with pricing, we consider a firm who wants to maximize its expected profit and determine the optimal policies for ordering and pricing quantity decisions. These policies depend upon the demand which is a random variable. The randomness in demand is price independent and can be modeled either in an additive or a multiplicative fashion. Specifically, demand is defined as $D(p, \xi) = y(p) + \xi$ in the additive case Mills [72] and $D(p, \xi) = y(p) \cdot \xi$ in the multiplicative case Karlin & Carr [55], where $y(p)$ is a decreasing function that captures the dependency between demand and price, and $\xi$ is a random variable defined over the range $[A, B]$. A convenient expression for the profit function is obtained by substituting $D(p, \xi) = y(p) + \xi$ and is consistent with Ernst
(1970) and Thowsen (1975), defining $z = q - y(p)$. This change of parameter from $q$ to $z$ helps in taking ordering quantity decision to maximize the expected profit by comparing
the parameter $z$ with the demand error $\varepsilon$.

Mills [72] had given the expression for $\Psi(p)$ which represents riskless profit, the profit for
a given price and Silver & Peterson [100] gave the loss function $L(z, p)$ which evaluates
the overage cost for each of the expected leftover $\Lambda$ and also underage cost (or shortage
cost) for each of the expected shortage $\Theta$. Then the expected profit is the difference
of the riskless profit in certainty and the expected loss in probabilistic environment.

There are two approaches for maximizing the expected profit, viz. one given by Whittin,
in which he keeps the price ($p$) fixed and determine optimal value of the order quantity
($q$ or $z$) as a function of price ($p$) and then optimizes the expected profit as a function
of single variable $p$. The second approach given by Zabel [119] in which he keeps the order
quantity ($q$ or $z$) fixed and determine the optimal value of the price ($p$) in terms of $z$ and
then maximizing profit as function of $z$. In both the approaches we get the same result
for the optimum order quantity. Ernst [32] reached a similar conclusion under the more
restrictive assumption that $F[.]$ is a member of the PF2 family of distributions and Young
[117] expanded the set of applicable distributions to include the log-normal.

Zabel [118] first demonstrated the uniqueness of $z^*$ in the multiplicative demand case
of the single period problem, but he assumed the penalty cost 0 and considered only two
special forms for CDF $F[.]$, the exponential distribution and the uniform distribution.
Earlier, Nevins [79] reached a similar conclusion regarding $z^*$ (optimal quantity) for the case
when $F[.]$ is a normal distribution when he performed a simulation experiment. Young
[117] extended the result to cases in which $F[.]$ either is a log-normal distribution or a
member of the PF2 family of distributions. Thus, the variance of demand is independent
of price in the additive demand case but is a decreasing function of price in the multiplica-
tive demand case. However, the demand coefficient of variation $VAR[D(p, e)]/E[D(p, e)]$
is an increasing function of price in the additive demand case, while it is independent of
price in the multiplicative demand case. This distinction is important because it estab-
lishes an analytical basis for explaining differences in structure that arise in the results of
the joint stocking and pricing problem when the two modeling alternatives for demand
are analyzed. Recall that Mills [72] defined as a benchmark the riskless price, which rep-
resents the optimal selling price for the special situation in which there is no variation of
demand from its mean. Given this definition, Mills found that $p^* \leq p_0$ ($p_0$ denotes the optimal riskless price), if randomness in demand is modeled within an additive context; but Karlin & Carr [55] found that $p^* \geq p_0$ if randomness in demand is modeled within a multiplicative context. Young [117] verified both of these results by analyzing a model that combines both additive and multiplicative effects, defining the demand function as $D(p, \epsilon) = y_1(p)\epsilon + y_2(p)$. Silver & Peterson [100] have defined safety factor, SF, as the number of standard deviations that stocking quantity deviates from expected demand: $SF = \frac{q - E[D(p, \epsilon)]}{SD[D(p, \epsilon)]}$

**Foreign exchange transaction exposure literature review:**
In a global supply-chain, the exchange rate between two countries gets an exposure to unanticipated changes in the market which leads to foreign exchange rate risk. There are three types of exposures as explained in the section-1.3, namely economic exposure, translation exposure and transaction exposure. Operating exposure considers changes in expected future cash flows caused by unexpected changes in exchange rates and translation exposure manages with the changes in the value of reported owners’ equity in consolidated financial statements due to an unexpected change in exchange rates Eitemann et al. [31], Shubita et al. [99]. The literature of the operation management deals with the operating exposure or economic exposure problems only- See Cohen & Huchzermeier [25], Cruz et al. [26], Goh et al. [41], Z. Liu & Nagurney [68], Dasu & Li [28], Kazaz et al. [56], Huchzermeier & Cohen [52], Lowe et al. [69], Nagurney & Matsypura [78] and they have ignored cases of transaction exposure. On the other hand translation exposure naturally has been concerned with accounting-oriented journals, say-L. M. A. Chan et al. [22], Rambo et al. [95].

In the proposed thesis we consider only the transaction exposure which has major influence on the profit, cash flows and market value of a company or vendor in international supply-chain. This foreign exchange exposure estimates profits or losses incurred when the payment is to be made after the exchange rate changes and not at the time of the placement of an order and the debt is denominated in the foreign currency.

In a global supply chain consisting of one retailer and one manufacturer, both from different countries. As there is a time lag between the payments made while placing the order and the time when the order is realized, risk in the form of the exchange rate fluctuation affects the optimal pricing and order quantity decisions. The main problems that arise
then are: Who bears the risk? and Does it really matter?

Following the traditional conventions of the literature on the subject, the relationship between deterministic demand \( g \) and its error \( \epsilon \), which is probabilistic, is assumed to be either additive Mills [72] or multiplicative Karlin & Carr [55], with the former (latter) exhibiting a constant (variable) error variance and a variable (constant) coefficient of variation. L. M. A. Chan et al. [22], C. Chan et al. [21], Petruzzi & Dada [91], Yao [115] and Yao et al. [116] discuss further the implications of these assumptions and provide a review of the extant works on the field.

The demand function is presented in a very general form. For a unique optimal solution, the only conditions needed are that \( g \) be downward sloping and at least twice differentiable, with respect to price \( p \). Most of the demand distributions normally used in the sales-promotion field, i.e. linear, iso-elastic, log-concave or concave in \( p \) and the like, fulfill this requirement Yao [115]; Yao et al. [116]. Similarly, the stochastic demand component, \( \epsilon \), is also presented in a general form. All that is needed for a unique optimal solution is that it belongs to the GSIFR family, defined over a finite range \([A, B]\) and with a mean of \( \mu \), a standard deviation of \( \sigma \), a density function of \( f(.) \) and a cumulative density function of \( F(.) \). The GSIFR family includes the most widely used demand functions in the literature, such as the uniform, normal, beta, gamma and the like (Yao [115]; Yao et al. [116]).

We also define (i) the expected number of shortages, \( \Phi \) and leftovers, \( \Lambda \), generated by the demand uncertainty and by the retailer’s optimal policies; and (ii) the stocking factor, \( z \), introduced by Petruzzi and Dada [91] and subsequently used by F. J. Arcelus et al. [8, 9, 10] among many others, as a replacement for another decision variable, namely the order quantity.

The cases of foreign exchange transaction exposure when a firm has an accounts receivable or payable denominated in a foreign currency has been reported in Goel [40]. In the global trading the general rule is that either the buyer or the seller has to bear what is commonly known in international finance as transaction exposure, and it is explained in Eitemann et al. [31] and Shubita et al. [99]. The very important news vendor framework with pricing introduced in Petruzzi & Dada [91] and the price dependent demand forms in the additive and multiplicative error structures given in Mills [72] and Mills [72] have been used. The news vendor frame work of foreign exchange transaction exposure is given
in F. J. Arcelus et al. [7] and it is the fundamental platform for our work. The analytic derivation of expected profit and optimal policies are elaborated in Patel & Gor [82] when demand is linear with additive error and in Patel & Gor [84] for iso-elastic demand with multiplicative demand error. We have also developed more general hybrid demand model of foreign exchange transaction exposure in Patel & Gor [83], where we can analyze the effect of combined demand on the foreign exchange risk. In the derivation of the closed form solution of the optimal policies of the foreign exchange risk we have used Whitin’s method [112] to maximize the expected profit function. The sensitivity analysis for different forms of exchange rate error is carried out in Patel & Gor [85, 86, 87, 88] for additive and multiplicative demand errors.