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TAXONOMY OF INVENTORY POLICIES FOR SUPPLY-CHAIN EFFECTIVENESS

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ABSTRACT

In this research, the concept of *taxonomy* is applied to inventory management in a supply-chain. Through classification and standardization of issues related to inventory management problems, it is shown how inventory models and techniques can be generalized across diverse application environments represented by autonomous business entities that form the supply-chain.

INTRODUCTION

Managing inventory of a supply-chain is a complex task due to diversity of product and process characteristics, demand patterns, and stocking profiles for stock keeping units (s.k.u.) at it's various members [Chandra, 96a]. In this environment, *when* and *how* much of a s.k.u. to order is primarily based on:

- maintaining inventories to support service levels targeted by the supply-chain and each member,
- managing homogeneous classes of inventories in the supply-chain, and
- the impact of variables common to supply-chain.

Implicit in the above inventory management decision-making process for the supply-chain is the notion of *taxonomy* which promotes classification and standardization as it's problem-solving approach. To elaborate on this concept, a taxonomic representation of inventory policies in the United States textile industry is described. First, inventory classifications to material flow in the textile supply-chain and the associated inventories at individual textile sectors are assigned. Next, appropriate production planning and control (PPC) philosophies for managing inventories at textile sectors are identified. To facilitate PPC, products in the supply-chain are partitioned into homogeneous classifications based on common characteristics and demand patterns. Generic models to implement inventory decision rules to address, constant (or level), time-varying (or chase), and mixed demand patterns associated with s.k.u. categories are proposed. Finally, application of these inventory models to the textile supply-chain network are discussed [Chandra, 96b].

INVENTORY CLASSIFICATION OF MATERIAL FLOW IN THE TEXTILE SUPPLY-CHAIN

Inventory management in the textile supply-chain requires managing inventories at an aggregate level. Table 1 describes the inventory classification of material flow in the textile supply-chain. Fiber production is a continuous manufacturing process, where batches are introduced in order to achieve economies of scale and/ or production efficiencies. However, batches of production cause inventory (or cycle stock).

Production of textile fabric from fiber may impose sequence dependencies *between* processes, or create goods-in-transit for a multi-echelon assembly line set-up. Decoupling stocks may also be created, if for example, an end-product of one process (Greige goods), and a raw material for the next process (fabric coloring), is warehoused to achieve production economies. Material flow at the next stage, is in the form of textile fabric components, required to produce an apparel. Anticipation inventories may be created for apparels with seasonal demand. Work-in-Process inventories may be created for apparels requiring assembly of various components. Finally, the consumer demand pattern, product characteristics, and customer service levels dictate maintaining safety stocks of apparel to avoid stockouts.

Table 1. Inventory Classification of Material Flow in the Textile Supply-Chain

Inventory Classification	*Purpose*
Cycle Stock	Inventory-on-hand due to batches of production, created on account of 1. economies of scale, 2. manufacturing process requirements, and 3. process flow management
Work-in-Process	Inventory-on-hand due to an assembly line or multi-level (echelon) distribution system
Decoupling Stock	Inventory due to a warehousing (stocking) policy
Safety Stock	Inventory-on-hand to extend customer service
Anticipation Inventories	Inventory-on-hand due to anticipated seasonality of demand or supply

From the above inventory classification of material flow, it is easy to observe the type of inventory build-up at various textile sectors, as shown in Table 2.

Table 2. Type of Inventory Build-Up at Textile Industry Sectors

Textile Sector	*Type of Inventory Build-Up*
Retailer	Safety Stock; Anticipation Inventories
Apparel	Anticipation Inventories; Work-in-Process
Textile	Cycle Stock; Work-in-Process; Decoupling Stock (Greige goods)
Fiber	Cycle Stock; Work-in-Process

PROFILE OF INVENTORY DECISION-MAKING IN THE TEXTILE SUPPLY-CHAIN

Management of inventories at various textile sectors is proposed as part of an overall PPC philosophy which integrates inventory policies with appropriate procurement policies and scheduling heuristics [Chandra, 96a]. Table 3 offers details on this.

Table 3. Classification of Production-Planning-Control Philosophies for Textile Sectors

Textile Sector	*Primary Focus*	*PPC Philosophy*
Retailer	High customer service by maintaining reduced levels of inventories	Economic-order-quantity and reorder point
Apparel	Effective coordination of material	Material requirement planning; Quick response

	component and labor needs	
Textile	Minimization of setup times and inventories; High capacity utilization	Just-in-time; Economic-order-quantity
Fiber	High utilization of installed capacity	Multi-stage Economic-order-quantity and reorder point

In implementing inventory decisions a number of factors pertaining to cost, demand, service, ordering characteristics, and supply are necessary to be considered. For the textile supply-chain, we propose that these be limited to only direct costs, replenishment lead time, and demand patterns specific to each textile sector. Table 4, summarizes these factors.

Table 4. Inventory Management Decision Variables

Factor	*Description*
Cost - Fixed -Variable . Unit Production or Purchase . Unit Carrying	 The ordering cost associated with a replenishment. It is insensitive to the size of replenishment The price paid to the supplier to acquire a unit of s.k.u. The cost of holding inventory in stock per unit of s.k.u.
Service	The replenishment lead time required to obtain the s.k.u. for satisfying customer demand. This is the time from placement of order to the time it is received in the warehouse
Demand	The demand for an s.k.u. can assume various patterns depending on product characteristics, consumer behavior, etc. Demand patterns considered are: 1. constant demand over a period of time, 2. time-varying demand, and 3. a mixed pattern of constant, and time-varying demands for the planning horizon

The large number and diversity of s.k.u. in the textile supply-chain makes it impractical and cost prohibitive to manage inventory decisions for each s.k.u. We propose a classification scheme as per Table 5 to rank order s.k.u.s into categories based on their percent contribution to the total size and value of inventory in the textile supply-chain.

Table 5. S.K.U. Inventory Classification of Textile Supply-Chain Product Set

S.K.U. Inventory Classification	*Percent of Total S.K.U.*	*Percent of Total Value of Inventory*
A	≅ 10	≅ 60
B	≅ 70	≅ 40
C	≅ 20	≅ 2

For this paper, we limit our discussion of inventory management decisions to only A items, described in Table 5. Table 6 lists product inventory characteristics for three representative A items in the textile supply-chain. Each of these items depicts a unique decision environment for interdependent decision

variables. This facilitates designing inventory decision models suited for different types of consumer behavior and related demand patterns, cost structures, and replenishment needs.

Table 6. Categorization of Product Inventory Characteristics in the Textile Sector

S.K.U. Category	*Basic*	*Seasonal*	*Fashion*
Product	Towel	Coat	Sportswear
Life-cycle Stage	Maturity	Saturation (very short life cycle)	Saturation (short life cycle)
Demand Pattern	Level	High variability	Low variability
Volume	Heavy	Moderate	Moderate
Replenishment Lead Time	Short	Long	Long
Planning Horizon	Long	Short	Short
Cost . Fixed . Production or Purchase . Carrying	 Low Low High	 Very high Very high Very high	 High High High

INVENTORY DECISION MODELS

The most important objective of inventory management is to aid decision making for replenishments needed that satisfy a consumer buying behavior pattern. Accordingly, we have proposed following *fixed order quantity system* models [Silver and Peterson, 85] to manage prevalent demand patterns observed in the textile supply-chain:

- a constant demand model to satisfy an approximate level demand,
- a significantly time-varying demand model to satisfy seasonal demand, and
- a time-varying average demand model to satisfy mixed demand.

In a *fixed order quantity* system, orders are placed for the same quantity of a s.k.u. each time it is ordered. However, as to *when* the order is placed is allowed to vary. We discuss the related concept of order point in the section entitled *Application of Inventory Decision Models to the Textile Supply-Chain Network*. Table 7 offers a summary comparison of these models.

Table 7. Classification of Textile Supply-Chain Inventory Management Models

Factor	*Model I*	*Model II*	*Model III*
Demand Pattern	Stable (level) demand	Time varying deterministic demand	A mixture of stable and time-varying demand
Demand Rate	Constant and known for all periods	May vary significantly from period-to-period, but is known	Nearly average, may vary slightly from period-to-period, but is known
Inventory Planning	For level demand	To chase demand	For average demand
S.K.U. Category	Basic	Seasonal	Fashion

We discuss the above models in the context of product inventory characteristics of three representative product categories described in Table 6. We introduce the following notation common to all models:

Notation:

A – fixed cost component (insensitive to replenishment quantity), incurred with each replenishment, in dollars,

D – forecasted demand rate of a s.k.u., in units per unit time,

D(j) – demand for a s.k.u. in period j,

$\overline{\mathbf{D}}$ – average demand rate of a s.k.u., in units per time,

EDDLT – expected demand during lead time, in units,

k – a priority factor assigned to a s.k.u. or s.k.u. category,

L – Lead time period, in units of time,

N – planning horizon, 1,2,…,

OP – order point -- the point at which s.k.u. should be ordered, in units per order,

Q – replenishment order quantity, in units,

SS – safety stock (or buffer) – additional quantity of a s.k.u. held in inventory, to be used in periods when demand for a s.k.u. is greater than its expected supply, in units,

T – time period, 1,2,…,j,

TRC(Q) – total relevant cost per unit time influenced by the order quantity Q, in dollar per unit time,

TRCUT(T) – total relevant cost per unit time,

v – unit variable cost of a s.k.u., in dollars per unit,

r – carrying charge, the cost of having one dollar of a s.k.u. tied-up in inventory for a unit time interval, in dollar per dollar per unit time,

VC – variability coefficient of demand for a planning horizon.

Model I. Inventory Decision Rules for the Case of a Level Demand

In this case, we are concerned with how large a replenishment quantity to use under rather stable conditions. Furthermore, there is relatively negligible uncertainty concerning the level of demand.

Assumptions:

- the demand rate is constant and deterministic, that is, the s.k.u. is in the mature stage of its product life cycle,
- the unit variable cost does not depend on the replenishment quantity,
- cost factors do not change appreciably with time,
- a s.k.u. is treated entirely independently of other s.k.u.'s,
- the entire order quantity is delivered at the same time (partial receipts are not considered).

Deriving Economic Order Quantity:

The criterion for determining appropriate order quantity is minimization of costs. Costs to consider are:

- production or purchase cost,
- inventory carrying cost.

The order quantity which prescribes how many units of a s.k.u. should be ordered at a given time, is derived from these standard equations [Silver and Peterson, 85] as follows:

$$\mathbf{EOQ = \sqrt{(2AD/vr)}}$$

$$\mathbf{TRC\ (EOQ) = \sqrt{(2ADvr)}}$$

The concept of order point (OP), which prescribes when the inventory should be ordered is discussed later, in the section entitled *Application of Inventory Decision Models to the Textile Supply-Chain Network*.

Numerical Example:

Consider a s.k.u. X, a bath towel (a *basic* textile product) carried by a retailer in its line-up. The demand for X at 1200 units per year is relatively stable over time. The graph in Figure 1 depicts this demand pattern. The variable cost of X is \$0.4 per unit and the fixed cost per replenishment \$5. Further, the inventory carrying cost of X is \$0.24 per unit per year.

The EOQ for X is given by,

$$EOQ = \sqrt{(2 \times \$5 \times 1200 \text{ units/year}) / (\$0.4/\text{unit} \times \$0.24/\$/\text{year})}$$
$$\cong 354 \text{ units, or a 3.5 month's supply}$$

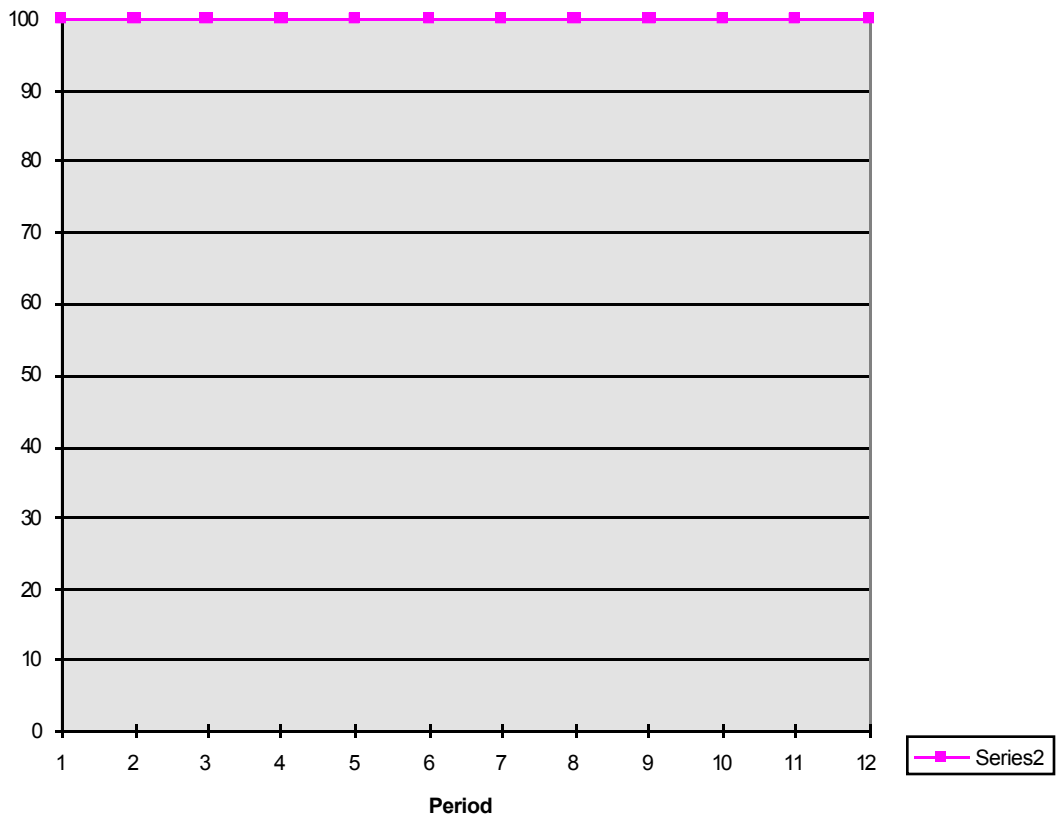
$$TRC\ (EOQ) = \sqrt{(2 \times \$5 \times 1200 \text{ units/year}) * (\$0.4/\text{unit} \times \$0.24/\$/\text{year})}$$

≅ $33.94/year

Let us now suppose that the retailer's management decides to implement the following policy in relation to all *basic* products:

"In view of the competitive situation, we will not allow any stockouts as far as possible. That is, for these products, we will maintain a certain buffer at any given time. In addition, we will adjust lead times on these products to reflect delays due to logistics".

Figure 1. Constant Demand Patterns



A decision rule to calculate the replenishment quantity for this policy direction, is as follows:

$$\mathbf{Q = (SS + \alpha * L)\ D/52}$$

where, α is a factor to account for delay due to logistics. The value of α is derived subjectively from observing the average time consumed by the internal and external logistics involved in managing inventory for a s.k.u. Thus, for a specialized s.k.u., α may be higher because there may be several decisions

involved, such as, design approval, pre-inspection, and post-inspection. However, for a standard s.k.u. design, approval may be required only when the item is initially introduced, and only random sample inspections conducted, hence a lower α.

For item X, let us suppose that the safety stock (SS) to be maintained is 4 weeks and lead time (L) is 12 weeks. Also, α is .2. Thus,

Q = (4 weeks + .2 * 12 weeks) {(1200 units/year)/52 weeks}
≅ 148 units (or ≅ 1.48 month's supply)

TRC (Q) = Qvr/2 + AD/Q
= [148 units x {($0.4/unit x $0.24/$/year)/2] + {($5 x 1200 units/year)/148 units}
= $51.64/year

The difference in two TRC costs ($33.94/year vs. $51.64/year) reflect trade-off between replenishment policies.

Model II. Inventory Decision Rules for the Case of Significantly Time-Varying Demand

In this case, we are concerned with how large a replenishment quantity to use when the demand rate is deterministic and significantly varies with time.

Assumptions:

- s.k.u.'s have a seasonal demand pattern,
- s.k.u.'s have known trends in demand and these trends are expected to continue,
- multi-echelon production (or assembly) operations exploded through their production (or assembly) stages, have requirements that vary with time,
- demand rate may vary from one period to the next significantly, but it is known,
- unit variable cost does not depend on the replenishment quantity,
- cost factors do not change appreciably with time,
- a s.k.u. is treated entirely independently of other s.k.u.'s,
- replenishment lead time is known with certainty so that delivery can be timed to arrive at the beginning of a period,

- the entire order quantity is delivered at the same time (partial receipts are not considered).

Deriving Economic Order Quantity:

The criterion for determining appropriate order quantity is minimization of costs. Costs to consider are:

- Fixed cost,
- Total inventory carrying costs to the end of period T.

The order quantity is derived as follows:

$$\mathbf{Q} = \sum_{j=1}^{T} \mathbf{D(j)}$$

A value of T that minimizes the total relevant costs of replenishment and carrying of inventory is selected by a procedure described in Silver and Meal, (69,73) and represented in the numerical example.

The concept of order point (OP), which prescribes when the inventory should be ordered is discussed later, in the section entitled *Application of Inventory Decision Models to the Textile Supply-Chain Network*.

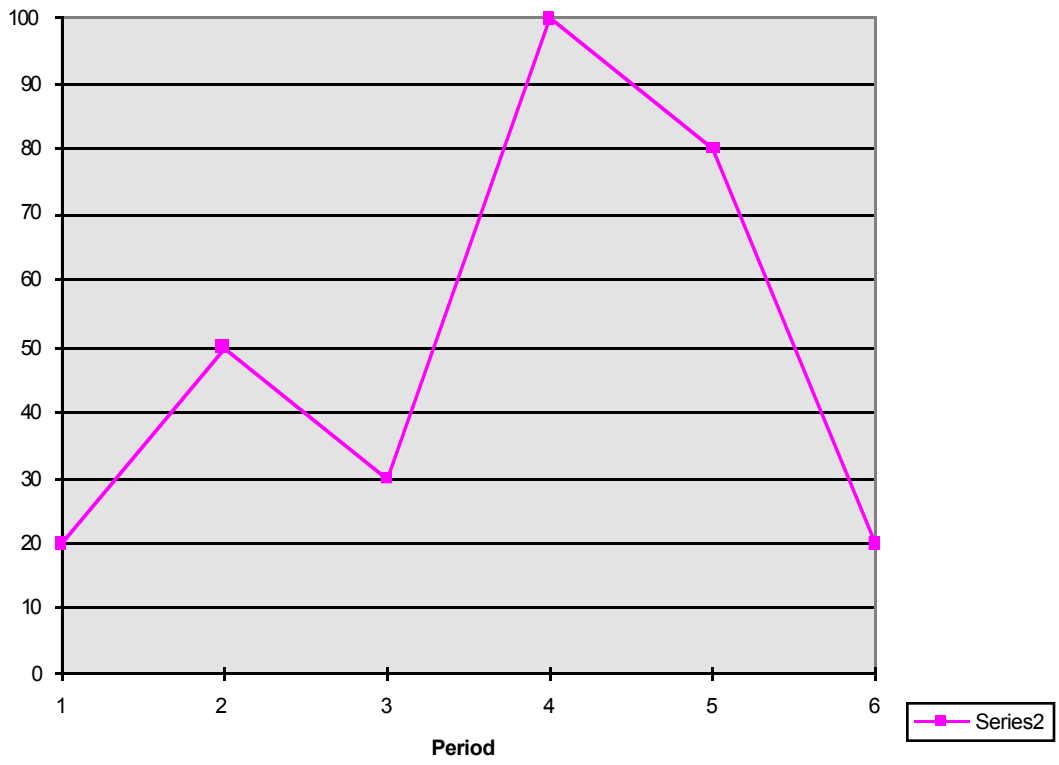
Numerical Example:

Consider a s.k.u. Y, a coat (a *seasonal* textile product) carried by a retailer as a product offering. Let us assume the demand for Y as given in Table 8 and represented by the graph in Figure 2. This pattern depicts a typical case where the s.k.u. has a seasonal demand cycle. The unit variable cost of Y is $2/unit and the fixed cost per replenishment $15. Further, the carrying cost of Y in inventory is $.1/unit.

Table 8. Demand for S.K.U. Y

Period	*1*	*2*	*3*	*4*	*5*	*6*	*Total*
Requirements (D_i)	20	50	30	100	80	20	300
$(D_i)^2$	400	2500	900	10000	6400	400	20600

Figure 2. Significantly Time-Varying Demand Pattern



The decision rule is to evaluate TRUC(T) for increasing values of T until, for the first time,

TRCUT(T + 1) > TRCUT(T)

In this numerical example, we have,

TRCUT(1) = A/1 = $15/1 = $15

TRCUT(2) = {A + D(2)vr}/2 = [$15 + {50 units * $2/unit * $.1/unit}]/2 = $12.5

TRCUT(3) = {A + D(2)vr + 2D(3)vr}/3 = [$15 + {50 units * $2/unit * $.1/unit} + {2 * 30 units * $2/unit * $.1/unit}]/3 = $12.33

TRCUT(4) = {A + D(2)vr + 2D(3)vr + 3D(4)vr}/4 = [$15 + {50 units * $2/unit * $.1/unit} + {2 * 30 units * $2/unit * $.1/unit} + {3 * 100 units * $2/unit * $.1/unit}]/4 = $24.25

From the above,

TRCUT(4) > TRCUT(3) or $24.25 > $12.33

Therefore, a T value of 3 is selected and the associated replenishment quantity becomes,

$$
\begin{aligned}
Q &= D(1) + D(2) + D(3) \\
&= 20 + 50 + 30 \\
&= 100 \text{ units}
\end{aligned}
$$

Next, we evaluate,

TRCUT(5) = A/1 = \$15/1 = \$15

TRCUT(6) = {A + D(6)vr}/2 = [\$15 + {20 units * \$2/unit * \$.1/unit}]/2 = \$9.5

and so on, in order to evaluate TRCUT for selecting a value of T for the second time.

Model III. Inventory Decision Rules for the Case of an Average Time-Varying Demand

In this case, we are concerned with how large a replenishment quantity to use when the average demand rate is deterministic and varies with time.

Assumptions:

- s.k.u.'s have a seasonal demand pattern,
- s.k.u.'s have known trends in demand and these trends are expected to continue,
- multi-echelon production (or assembly) operations exploded through their production (or assembly) stages have requirements that vary with time,
- demand rate may vary from one period to the next slightly, but it is known,
- the unit variable cost does not depend on the replenishment quantity,
- cost factors do not change appreciably with time,
- a s.k.u. is treated entirely independently of other s.k.u.'s,
- replenishment lead time is known with certainty so that delivery can be timed to arrive at the beginning of a period,
- the entire order quantity is delivered at the same time (partial receipts are not considered).

Deriving Economic Order Quantity:

The criterion for determining appropriate order quantity is minimization of costs. Costs to consider are:

- production or purchase cost,
- inventory carrying cost.

The order quantity is derived from this standard equation [Silver and Peterson, 85] as follows:

$$\mathbf{EOQ = \sqrt{(2A\ \bar{D}/vr)}}$$

The demand considered for the above formula is the average demand rate $\bar{\mathbf{D}}$.

The concept of order point (OP), which prescribes when the inventory should be ordered is discussed later, in the section entitled *Application of Inventory Decision Models to the Textile Supply-Chain Network*.

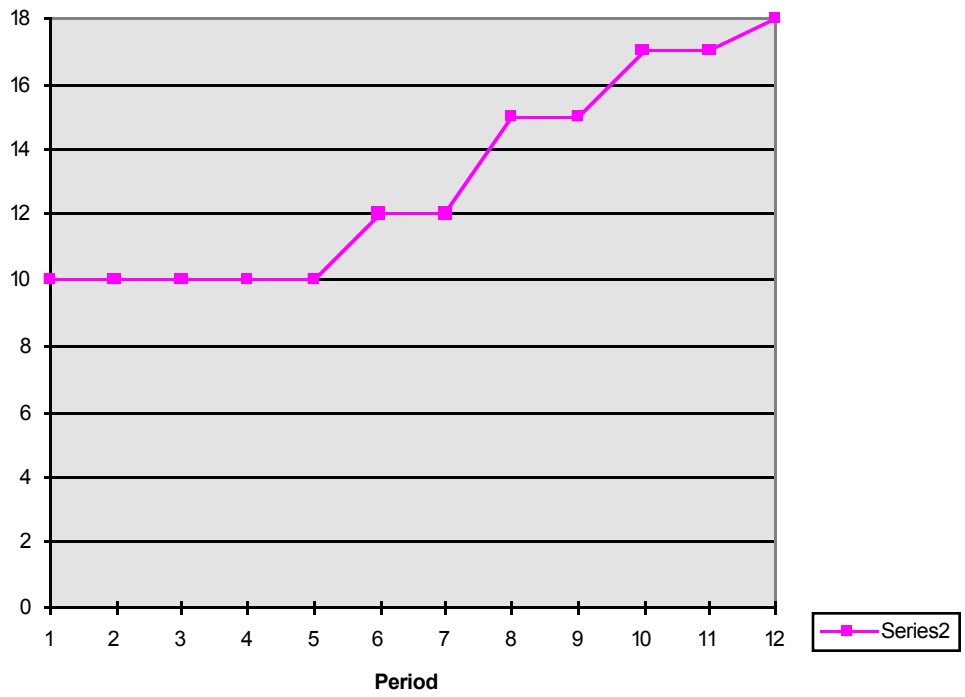
Numerical Example:

Consider a s.k.u. Z, a sportswear (a *fashion* textile product) carried by a retailer in its line of products. Let us assume the demand for Z as given in Table 9 and represented by the graph in Figure 3. This pattern depicts a typical case where the s.k.u. has a mixed demand cycle. The unit variable cost of Z is $1/unit and the fixed cost per replenishment $10. Further, the carrying cost of Z in inventory is $.08/period/unit.

Table 9. Demand for S.K.U. Z

Period	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*Total*
Requirements (D_i)	10	10	10	10	10	12	12	15	15	17	17	18	156
$(D_i)^2$	100	100	100	100	100	144	144	225	225	289	289	324	2140

Figure 3. Time Varying Average Demand Patterr



The EOQ for Z is given by,

$$\mathbf{EOQ = \sqrt{(2A\ \bar{D} / vr)}}$$

or EOQ = √ (2 x \$10 x 13 units/period) / (\$1/unit x \$0.08/unit)
≅ 57 units

where,

$\bar{\mathbf{D}}$ = Total requirements for the planning horizon / 12 periods
= 156 units / 12 periods
= 13 units / period

When the demand pattern using the average demand rate $\bar{\mathbf{D}}$ has appreciable variability, a more accurate approach to take is to express EOQ as a time supply using $\bar{\mathbf{D}}$, that is,

$$\mathbf{T_{EOQ} = EOQ/\ \bar{D} = \sqrt{(2A/\ \bar{D}vr)}}$$

or T_{EOQ} = 4.38 periods

which is rounded to the next integer number of period 5. That is, a five period time supply may be ordered for s.k.u. Z.

CRITERIA FOR INVENTORY MODEL SELECTION

One of the key assumptions in the above inventory models is that demand pattern is known. Without a visual graph of the demand, it may perhaps be difficult to discern variability in demand. To overcome this problem, we propose the following rule-of-thumb to evaluate variability of demand [Silver and Peterson, 85] in the supply-chain:

VC = (Variance of demand per period) / (Square of average demand per period)

Expressed notationally,

$$\mathbf{VC = \left([\{N \sum_{j=1}^{N} [D(j)]^2\}] \ / \ [\sum_{j=1}^{N} D(j)]^2 \right) - 1}$$

The rule of thumb is as follows:

If VC < 0.5, Model I may be used,

If 0.5≤VC< 0.2, Model III may be used, and

If VC ≥ 0.2, Model II may be used.

For instance in the numerical examples used for illustrating various models above, the VC can be calculated as follows:

Model I: VC = $[12 * (120000) \ / \ (1200)^2] - 1$
= [1440000 / 1440000] - 1
= 0

Model II: $VC = [6 * (20600) / (300)^2] - 1$
$= [123600 / 90000] -1$
$= [1.37] -1$
$= 0.37$

Model III: $VC = [12 * (2140) / (156)^2] - 1$
$= [25680 / 24336] -1$
$= [1.05] -1$
$= 0.05$

APPLICATION OF INVENTORY DECISION MODELS TO THE TEXTILE SUPPLY-CHAIN NETWORK

The application of the above inventory decision models to the textile supply-chain network [Chandra, 96b], should be in the spirit of our earlier assertion that inventory management decisions for a s.k.u. must be consistent with overall objectives of the textile supply-chain while still satisfying their individual sector goals. That is, depending on the production philosophy adopted at the supply-chain level, inventory management decisions must recognize the interdependence between stockouts and service levels for a s.k.u. We discuss this relationship below.

In the case of a *push* production philosophy, the ability of the system to absorb effects of a stockout are much higher than in a *pull* production philosophy. This is because, in planning for inventory between intermediate stages in the former, a longer term view of production is taken, whereas in the latter, planning for immediate downstream stage(s) is usually the case. By assigning a s.k.u. a service level in a *pull* production philosophy, the importance of service is recognized in fulfilling raw-material demand at various stages of manufacture. In this manner, stakes to achieving a stockout in the system are artificially raised. As a corollary, order point is raised. Service level is a means to comply with either manufacturing policy or marketing policy, that may influence how raw-materials are to be provided at intermediate stage(s) of manufacture in a *pull* production philosophy. Accordingly, s.k.u.'s may be differentiated by assigning priorities in accordance with their importance at various stages of material flow in the supply-chain.

A rule-of-thumb proposed for setting order point (OP) [Gaither, 96] in the textile supply-chain is as follows:

For a *pull* production philosophy

$$\mathbf{OP = EDDLT + SS}$$

where,

SS = k (EDDLT)

and k is a relative service level priority assigned to a s.k.u. One such interpretation of s.k.u. service level priority is offered in Table 10. This is a subjective way to assign ranking utilizing an ordinal scale, where integers from 0 to 3 denote such ranking. The decision maker may choose a ranking scheme suited to his/her preference.

Table 10. S.K.U. Service Level Prioritization

Service Level	*Service Level Description*	*Service Level Weight*
1	Normal	.1
2	Urgent	.2
3	Critical	.5
4	Highly Critical	1
5	Extremely Critical	2
6	Super Critical	3

For a *push* production philosophy

OP = EDDLT + SS

where,

SS = √ (EDDLT)

We illustrate deriving OP in the case of the inventory decision models presented earlier with following examples:

Case 1. *Pull* production philosophy at the supply-chain level, with:

I. Constant, and average demand for a s.k.u. that has a *critical* service level (that is, k=.5 from Table 10).

OP = EDDLT + k (EDDLT)
= {(average demand in units per period) * (average lead time in period)}
+ k[{(average demand in units per period) * (average lead time in period)}]
= {(13 units / weeks) * 2 weeks} + [.5 * {(13 units / weeks) * 2 weeks}]
= 26 units + 13 units
= 39 units

II. Significantly time-varying demand for a s.k.u. that has a *critical* service level (that is, k=.5 from Table 10).

OP = EDDLT + k (EDDLT)
$= \sum^{N}$ {(demand in units for period j) * (lead time in period j)}

$j=1$

$$+ \sum_{j=1}^{N} [k[\{(\text{demand in units for period } j) * (\text{lead time in period } j)\}]]$$

= [{(20 units / in week 1) * 1 day} + {(50 units / in week 2) * 1.5 days}
+ {(30 units / in week 3) * .5 day} + {(100 units / in week 4) * 2 days}
+ {(80 units / in week 5) * 1.5 days} + {(20 units / in week 6) * .5 day}]
[.5 * [{(20 units / in week 1) * 1 day} + {(50 units / in week 2) * 1.5 days}
+ {(30 units / in week 3) * .5 day} + {(100 units / in week 4) * 2 days}
+ {(80 units / in week 5) * 1.5 days} + {(20 units / in week 6) * .5 day}]]
≅ 95 units

Case 2. *Push* production philosophy at the supply-chain level, with

I. Constant, and average demand for a s.k.u.

OP = EDDLT + √(EDDLT)
= {(average demand in units per period) * (average lead time in period)}
+ √[{(average demand in units per period) * (average lead time in period)}]
= {(13 units / weeks) * 2 weeks} + [√ {(13 units / weeks) * 2 weeks}]
= 26 units + 6 units (rounded off to the next integer)
= 32 units

II. Significantly time-varying demand for a s.k.u.

OP = EDDLT + k (EDDLT)

$$= \sum_{j=1}^{N} \{(\text{demand in units for period } j) * (\text{lead time in period } j)\}$$

$$+ \sum_{j=1}^{N} [\sqrt{[\{(\text{demand in units for period } j) * (\text{lead time in period } j)\}]}]$$

= [{(20 units / in week 1) * 1 day} + {(50 units / in week 2) * 1.5 days}
+ {(30 units / in week 3) * .5 day} + {(100 units / in week 4) * 2 days}
+ {(80 units / in week 5) * 1.5 days} + {(20 units / in week 6) * .5 day}]
[√[{(20 units / in week 1) * 1 day} + {(50 units / in week 2) * 1.5 days}
+ {(30 units / in week 3) * .5 day} + {(100 units / in week 4) * 2 days}
+ {(80 units / in week 5) * 1.5 days} + {(20 units / in week 6) * .5 day}]]
= 72 units (rounded off to the next integer)

The variation in OP in the two cases above explains the essence of the production philosophies and the inventory levels required to implement them.

CONCLUSION

In this paper we have presented an integrated approach to inventory management in a supply-chain system through the example of textile industry. Our approach recognizes strategic importance of inventory management in supply-chain and hence the approaches offered for inventory decision making tie both global and local objectives of the supply-chain. The variation in demand due to consumer behavior

towards a s.k.u. is specifically reflected in the proposed inventory decision models. Finally, by incorporating techniques to fulfill these diverse demands within the overall context of production philosophies employed in the supply-chain, the inventory models are realistic and relevant to the supply-chain.

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