



What is the “right” inventory management approach for a purchased item?

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Abstract

Purpose – How should a firm decide which of four choices – i.e. inventory speculation, inventory postponement, inventory consignment, and reverse inventory consignment – is most appropriate to adopt for a given purchased item in a particular context? This paper seeks to identify and explain the critical factors that drive this decision.

Design/methodology/approach – By conducting a review of relevant literature and deriving anecdotal observations from four case studies.

Findings – This decision is influenced by three factors – customer demand or usage requirements, nature of the supply line and bargaining power of a firm relative to the supplier.

Research limitations/implications – From the perspective of science, the conduct of both empirical research to augment the reported anecdotal evidence and conceptual research along a number of directions (e.g. to juxtapose the research findings in existing theories, to examine variations of the four “pure” inventory management approaches, or to consider the vantage point of the supplying firm rather than that of the buying firm) is encouraged.

Practical implications – As for the perspective of practice, the critical factors serve as the basis for the articulation of a decision framework – one that should help firms not only pin-point the most relevant issues concerning a particular purchased item but also to avoid the costly mistake of selecting a less-than-ideal inventory management approach.

Originality/value – These critical factors, along with the proposed decision framework, extend prior research which has focused only on choosing between the inventory speculation approach and the inventory postponement approach.

Keywords Inventory management, Purchasing, Decision making

Paper type Research paper

1. Introduction

Purchased goods inventory and the management of such inventory are non-trivial concerns for firms wishing to remain competitive and survive in the marketplace. Consider the fact that the typical manufacturing firm spends, on average, 56 cents out of every dollar of revenue (i.e. 56 percent of revenue) to cover the direct cost of purchased goods, with this percentage figure being even higher for the typical wholesaler or retailer (Monczka *et al.*, 2002; Handfield, 2002). Add to this figure the indirect cost of having to manage inventory of purchased goods (which has been estimated to be 30-35 percent of the value of purchased goods – see Chase *et al.*, 2004) and the total cost of purchased goods inventory can be quite alarming. What this means, of course, is that, for any time period, a firm carrying \$20 million in purchased goods inventory would, accordingly, incur an additional \$6-7 million in material handling and inventory holding costs – direct and indirect costs that, once reduced,



can significantly improve the firm’s net profits. We should, therefore, not be surprised to learn that firms – from manufacturing to wholesale to retail – are intensifying their search for more efficient and effective inventory management approaches to minimize not only their direct investments in purchased goods inventory but also the indirect cost incurred in managing such inventory.

Indeed, the “right” inventory management approach for any purchased item must not only address the cash tied up in physical inventory but also the costs of planning, storing, and handling such an item. In fact, within the same firm, the “right” inventory management approach for a particular purchased item may not be the “right” inventory management approach for another purchased item. Moreover, across firms, the “right” inventory management approach for a particular purchased item in one firm may not be the “right” inventory management approach for the same purchased item in another firm.

To illustrate these observations, consider the following four brief examples. In the case of IKON Office Solutions, an office-equipment and total “document workflow” solutions provider, the firm forecasts and carries inventory of repair items in advance of demand, so that its 7,000 service technicians can complete any service request on their very first visit (Albright, 2002). Conversely, if we examine Dell’s “build-to-order” business model, we would find that Dell waits until customer orders are firm before placing its own purchase orders for subsystems and components in the case of new computing systems or accessories (Jacobs, 2003; Murphy, 2003; Richardson, 2003).

Hence, whereas IKON’s inventory management approach is to speculate and own physical inventory in advance of demand, Dell’s inventory management approach is to postpone and not own physical inventory until demand has actually occurred. In both cases, the ownership and location of physical inventory are “coupled” decisions – either the buyer owns and carries physical inventory (e.g. IKON) or the supplier owns and carries physical inventory (e.g. Dell).

Consider now the case of AutoZone, Inc., an automobile parts retailer with over 3,000 locations nationwide, which is aggressively pursuing pay-on-scan agreements with its suppliers wherein the repair and maintenance parts on the shelves of AutoZone stores and hub locations are actually owned by their respective suppliers (AutoZone, 2003). Only when an item has been scanned and sold would AutoZone then pay the supplier, with payment terms of up to 90 days after the sale (Boorstin, 2003; Fahey, 2003). On the contrary, working with XanEdu, a division of ProQuest specializing in the acquisition, compilation, and delivery of supplemental reading materials, the W. P. Carey MBA – Evening Program pays upfront for a specific number of digital copies of course packs to be held by XanEdu on its secure website for students to access for use in a particular MBA course offering.

Interestingly, compared to IKON and Dell, both AutoZone and the W. P. Carey MBA – Evening Program have “decoupled” the question of who owns the inventory from the question of where the inventory is being held. In the case of AutoZone, automobile parts suppliers maintain ownership of the repair and maintenance parts but consign such inventory to be physically located at the customer locations (i.e. AutoZone stores and hub centers). In the case of the W. P. Carey MBA – Evening Program, the program owns the course packs but consigns such inventory to be digitally located at its XanEdu supplier.

As these four examples illustrate, there is not a “one-size-fits-all” inventory management approach that is right for every firm or for every context. Under what conditions, then, would a firm adopt an inventory speculation approach (as typified by IKON), an inventory postponement approach (as typified by Dell), an inventory consignment approach (as typified by AutoZone), or a reverse inventory consignment approach (as typified by the W. P. Carey MBA – Evening Program)? The answer to this question depends fundamentally on a solid appreciation and comprehension of a set of critical factors that should drive the decision to adopt one inventory management approach over another, particularly when all four inventory management approaches are considered concurrently.

To date, while research has identified how to choose between an inventory speculation approach and an inventory postponement approach (Zinn and Bowersox, 1988; Pagh and Cooper, 1998), no research has been published on how to choose when all four inventory management approaches are equally viable options. A common set of critical factors that could help firms decide which of the four inventory management approaches to implement for any particular purchased item is, therefore, not readily available. Consequently, efforts to develop, justify, and define such a set of critical factors to improve the choice of inventory management approach for a particular purchased item would be particularly welcome and would contribute to both practice and science.

In the sections to follow, we first begin, in Section 2, by briefly describing what these four inventory management approaches are, what their pros and cons may be, and what the literature has to say about selecting one approach over another. We then identify, define, and explain the three critical decision factors in Section 3 before proceeding in Section 4 to delineate how they, in conjunction, affect the choice of which inventory management approach to adopt for purchased goods items. In Section 5, we demonstrate the utility of the decision framework developed in Section 4 by using it to understand the inventory management approach implemented with respect to:

- spare parts at IKON Office Solutions;
- computer components at Dell Computer;
- retail automotive parts at AutoZone; and
- course packs at the W. P. Carey MBA – Evening Program at Arizona State University.

We highlight in Section 6 the contributions of the proposed decision framework to existing literature, as well as future research on this topic. Finally, we provide concluding remarks in Section 7.

However, before proceeding, three important assumptions underlying the motivation for the question being asked in this paper and the quest for the answer to this question deserve a few words of explanation. First, the question – given inventory speculation, inventory postponement, inventory consignment, and reverse inventory consignment, which of these four inventory management approaches is most appropriate for managing inventory of a particular purchased item – presumes that the decision to source the item has already been made. Second, the question being asked, moreover, considers all four options as viable and, as such, does not consider supply chain contexts which naturally limit the choice to fewer than these four

inventory management approaches. For example, such a question may not be relevant in manufacturing environments wherein just-in-time delivery has been negotiated with suppliers. Third, the question we are asking takes for granted that the item being purchased is of a critical nature to the firm. Otherwise, if the item is of little significance to the firm, it may not merit the critical assessment offered by the answer (i.e. the decision framework being derived) and may, automatically, constrain the choice set to fewer than all four inventory management approaches. For a manufacturing environment, such an item would be critical when the unavailability of units of this item would slowdown and even shutdown production. Likewise, in retailing, for an item to be critical, the unavailability of units for sale would mean not only lost sales but also loss of good will.

2. Inventory management approaches: description, pros/cons, and choice

Generally speaking, there are four basic approaches to managing inbound inventory of raw materials, components, sub-systems, or retail inventory (henceforth referred to simply as purchased items). These four inventory management strategies can be differentiated by disentangling the question of who owns the purchased items from the question of where these items are physically held (Table I).

2.1 Inventory speculation

The inventory speculation approach is, by far, the most frequently encountered inventory management approach in practice (Zinn and Bowersox, 1988; Pagh and Cooper, 1998). With this approach, a firm would purchase items and physically hold such items within its storage facilities before demand or usage requirements for these items are known with certainty (Bucklin, 1965). This choice comes with many benefits, not the least of which is the ability to respond quickly to demand or usage needs and the ability to protect itself against fluctuations in prices. In addition, with this approach, a firm can also avail itself of volume discounts and reduced inbound transportation costs from buying in bulk (Bucklin, 1965; Zinn and Bowersox, 1988; Pagh and Cooper, 1998). However, the inventory speculation approach is not without its cost disadvantages. Besides the opportunity cost and financial burden of having cash tied up in physical inventory, there is also the incurrence of high inventory holding costs, given the need for storage, material handling and tracking, and given the threat and expense of inventory obsolescence, particularly when operating in highly volatile competitive environments.

2.2 Inventory postponement

In contrast to inventory speculation, a firm, operating under an inventory postponement approach, would deliberately delay the purchase and the physical possession of inventory items until demand or usage requirements are known with certainty (Bucklin, 1965). By doing so, a firm can minimize the risk of inventory obsolescence, reduce the opportunity cost of having capital tied up in such items, and avoid incurring inventory storage and tracking expenses since these items are physically located with the supplier. However, such an approach does have its drawbacks. There is, foremost, the risk of lost sales because the firm may not be able to respond in as timely a manner as having these items readily available within its own storage facilities (Zinn and Bowersox, 1988; Pagh and Cooper, 1998). Furthermore,

Table I.
Inventory management
approaches

Inventory management approach	Who owns inventory?	Where is inventory located?	Benefits	Risks
Inventory speculation	Buyer	Buyer	Inventory on-hand to fill customer orders Protection against future price increases Volume discounts and reduced inbound transportation expense	Inventory investment opportunity cost Inventory storage, handling and tracking expense Inventory obsolescence expense
Inventory postponement	Supplier	Supplier	No inventory obsolescence expense No inventory investment opportunity cost No inventory storage, handling and tracking expense	Lost sales when inventory is not available in time to meet customer demand Higher inbound transportation expense Subject to future price increases
Inventory consignment	Supplier	Buyer	Inventory on-hand to fill customer orders No inventory investment opportunity cost No inventory obsolescence expense	Inventory storage, handling and tracking expense Subject to future price increases
Reverse inventory consignment	Buyer	Supplier	Inventory on-hand at supplier location Protection against future price increases No inventory storage, handling and tracking expense	Inventory investment opportunity cost Inventory obsolescence expense

transportation and materials handling costs from having to purchase in smaller batch sizes would likely result (Xu *et al.*, 1994), as would the risk of price increases.

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2.3 Inventory consignment

A firm operating under an inventory consignment approach would physically hold purchased items in inventory but, in this arrangement, ownership of these items would reside with its supplier (Simchi-Levi *et al.*, 2000; Coughlan *et al.*, 2001). Only after the items have been either used in production or have been sold to customers would the firm then make payments to the appropriate suppliers. By following this approach, the firm would benefit from having relatively immediate access to items to meet demand or usage needs without investing financial capital or risking obsolescence expense (Kandel, 1996; Corbett, 2001; Valentini and Zavanella, 2003). Unfortunately, in addition to the expense of storing, handling and tracking these purchased items, a firm could also be subject to price fluctuations, with the price of the items on hand increasing between the time when they were physically received and when they were put to use or sold.

2.4 Reverse inventory consignment

In contrast to inventory consignment, a firm operating under a reverse inventory consignment approach, rare as it may be, would pay for and own but would not take physical possession of inventory of purchased items. Rather, the items would reside physically within the supplier’s network of storage facilities. At the firm’s request, such items would be transferred either into the firm’s production facilities or directly to the firm’s customer. Not surprisingly, the benefits of an inventory consignment approach mirror the drawbacks of a reverse inventory consignment approach, and vice versa. With reverse inventory consignment, not only is the risk of future price increases mitigated but the storage and storage-related costs also become trivialized. Rather, the disadvantages with this approach are the opportunity cost of capital tied up in physical inventory and the risk and expense of inventory obsolescence.

2.5 Is one approach better than another?

Prior research with respect to this question has, in fact, provided some insights when the choice of inventory management approach is limited to selecting either inventory speculation or inventory postponement. According to Zinn and Bowersox (1988), when the dollar value per unit of a purchased item is high and when sales volume for units of this item fluctuates greatly, inventory postponement would be preferred over inventory speculation. Conversely, according to Pagh and Cooper (1998), inventory speculation would be a “better approach” than inventory postponement when a purchased item is a relatively standard product in early stages of the product life cycle and faces low demand uncertainty and low customer order-to-delivery time but high-delivery frequency. Unfortunately, the extant literature is silent when the choice set is expanded to include not only inventory speculation and inventory postponement but also inventory consignment and reverse inventory consignment.

On the other hand, much has been written in literature extolling the benefits of the inventory consignment approach – benefits including improved information sharing and coordination and reduced supply chain costs (Corbett, 2001; Valentini and Zavanella, 2003). Interestingly, the underlying assumption in much of the literature

appears to suggest that inventory consignment would be the preferred choice when considered against inventory speculation or inventory postponement. However, such an assumption has yet to be explicitly conceptualized, properly justified, and empirically validated, irrespective of whether or not reverse inventory consignment is added to the choice set. As such, the extant inventory consignment literature also falls short of providing a comprehensive assessment as to which of the four inventory management approaches is most appropriate under what conditions, an objective that motivates the research reported herein.

To properly answer this question, it is imperative, therefore, that all four options of inventory speculation, inventory postponement, inventory consignment, and reverse inventory consignment be considered together within some common decision framework. Such a decision framework should identify and define a set of common factors and underlying drivers, which, when varied, would help firms learn to select the most appropriate inventory management approach for a particular purchased item and context. Without such a decision framework, a firm, in the worst case, would have to be subjected to three costly trial-and-error decisions before arriving at the most appropriate choice of inventory management approach.

3. Decision factors and underlying drivers

With this shared understanding of what each of the four inventory management approaches entails, what the advantages and disadvantages of each include, and what the literature has to offer as far as selecting one approach over another, we can now direct attention to three critical factors that should determine, for a firm, what the most appropriate inventory management approach might be. These three decision factors customer demand or usage requirements, nature of the supply line, and bargaining power should be considered conscientiously when selecting the “right” inventory management approach to adopt because they influence which firm should own the inventory of items and where these items should be located.

3.1 Customer demand or usage requirements

The first decision factor, customer demand or usage requirements, pays deliberate attention to the needs of the customer. Note that the customer could be an internal entity in need of the item being sourced (e.g. production function), an external entity to which the firm supplies a finished good with the sourced item embedded (e.g. another firm), or the final consumer in the retail setting. Obviously, for any firm hoping to survive in the long run, being able to achieve a high degree of customer satisfaction is critical (Innis and LaLonde, 1994; Bienstock *et al.*, 1997). What a firm selects as its inventory management approach can, in fact, contribute either positively or negatively to this outcome.

3.1.1 Lead-times. One underlying aspect to appreciate in terms of customer demand or usage requirements is the relationship between the customer order-to-fulfillment lead-time (CLT) and the sum of the supplier order-to-fulfillment lead-time (SLT), the firm’s cycle time (CT), and the delivery-to-customer lead-time (DTC). CLT denotes the amount of time a customer is willing to wait, once an order has been placed, to be satisfied by the firm. SLT denotes the amount of time the firm is willing to wait for its own wishes to be met by its suppliers in producing what the customer wants once the customer order is received. CT denotes the amount of time it takes the firm to

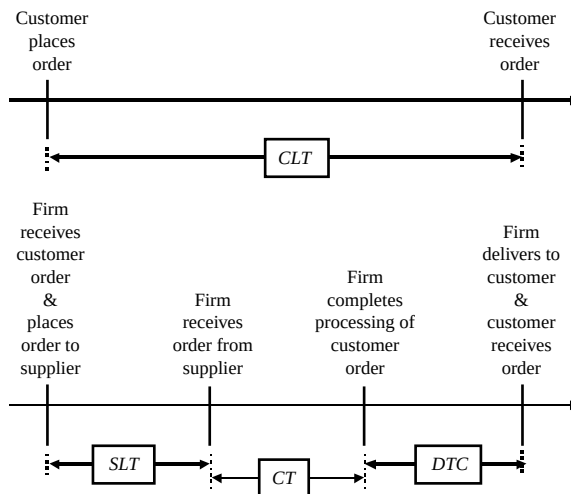
manufacture and process a customer order. Finally, DTC denotes the amount time it takes the firm to deliver a completed customer order to the customer (Silver *et al.*, 1998). Figure 1 shows the definitions for these various lead-times pictorially and depicts ideally that $CLT = SLT + CT + DTC$.

As an example, consider the case of a build-to-order business typified by many firms in the personal computer industry, who operate primarily as final assemblers. The average customer, placing an order for a personal computer system by phone or over the internet, is willing to wait up to ten days from when he or she places the order for the personal computer system to when he or she receives the product. – i.e. $CLT = 10$ days. Suppose the final assembler, upon receipt of the customer order, places its orders for the various parts, components, and/or subsystems, with the bottleneck supplier requiring a three-day lead time – i.e. $SLT = 3$ days. The bottleneck supplier of a firm is, by definition, going to take longest in terms of being able to fulfill the firm's order for the particular part, component, or subsystem. Once the bottleneck part arrives at the final assembler, it takes two days for the finished product to be assembled and tested – i.e. $CT = 2$ days. Once complete, the finished product is shipped with the shipping time being three days – i.e. $DTC = 3$ days. In this example, $CLT = 10$ days and $SLT + CT + DTC = 8$ days. Therefore, the amount of time it would take to satisfy the customer is less than the amount of time the customer is willing to wait, once an order has been placed.

For another example, consider a retail operation which sells automotive parts and restocks these parts from a distribution center. A typical customer who does not find what he or she wants will likely walk away and go to another store – i.e. $CLT = 0$ days. This would be true regardless of whether the “other store” is a competitor or a member store of the same retail chain. Suppose that the restocking time, once an order

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Legend

CLT: Customer order-to-delivery lead-time
CT: Firm's cycle time

SLT: Supplier order-to-fulfillment lead-time
DTC: Delivery-to-customer lead-time

Figure 1.
Lead-times

to restock has been initiated, is 24 hours – i.e. $SLT = 24$ hours. Once the order comes into the retail store, the order is checked within a 30-minute time period (i.e. $CT = 0.5$ hours). Once checked, it takes another 30 minutes to load them onto the shelves, so effectively $DTC = 0.5$ hours. Conversely, one can also argue that $CT = 1$ hour and $DTC = 0$ hours. What is important is not what pieces of “time” belong to which variable but how time from the customer’s perspective relates to the total “time” of trying to fulfill the customer’s wants and needs.

By relating these lead-times, the firms in both examples can determine how critical it would be to actually have units of the purchased item physically located and available within its own storage facilities, irrespective of the ownership question. With the personal computer example, given that $CLT > SLT + CT + DTC$ (i.e. $10 > 3 + 2 + 3 = 8$), the final assembler can afford to wait until the demand signal is known before placing orders for the various items making up the finished product. If, on the other hand, $CLT = 6$ in the case of the personal computer example, then it would be prudent for the final assembler to have the various items on-hand to be able to satisfy demand. The same logic would apply in the case of the automotive parts retailing operation.

Hence, when CLT is less than the sum of a firm’s SLT , CT , and DTC for a particular bottleneck item in a manufacturing setting (Kraljic, 1983), or any item that must be available on demand in a retail setting, then the firm must have a stockpile of the item readily available or else risk losing the customer to a competitor. Conversely, if CLT were to greatly exceed the sum of a firm’s SLT , CT , and DTC , then there would be less immediacy and urgency to taking physical receipt of inventory.

3.1.2 Predictability of customer demand or usage requirements. A second aspect to appreciate is the predictability of customer demand or usage requirements – an issue that speaks to the relative ease of forecasting demand not only with respect to quantities demanded or required but also with respect to timing of demand or requirements. When demand or usage is easily predictable (and, hence, easy to forecast), plans can be put in place to identify when it would best to purchase items without sacrificing the ability to effectively address demand or usage needs. These plans should, as a result, allow a firm to minimize the amount of stock it owns for any given demand period (Lee *et al.*, 1997; Song *et al.*, 2000). However, when demand or usage cannot be easily predicted with accuracy, having physical possession of these items, whether they are owned by the firm or by the supplier, would make more sense and would ensure the ability to respond as needed to demand or usage requirements.

3.1.3 Stability of customer demand or usage requirements. A third and last consideration, related to the predictability factor, is the stability of customer demand or usage requirements – that is, how quickly would customer demand or usage requirements change for the preferences embedded in the purchased item? The answer to this question clearly has significant implications for whether or not certain items should be owned by the firm.

Thus, when changes are frequent and dramatic, because of new product technology or evolving consumer tastes, not unlike those we see in the consumer electronics sector, then owning large inventory quantities of the “older version” can be detrimental to a firm’s financial bottom line. Given such a scenario, a firm would likely want to delay inventory purchase commitments to as late as possible so as to minimize and avoid this potential obsolescence risk (Song *et al.*, 2000). Conversely, when customer preferences for a product do not change quickly, irrespective of how fast or frequently the

underlying product technology or styling changes occur, the risk a firm would face is simply one of owning stock longer than may originally be expected, as opposed to the risk of owning stock that can no longer be used to meet demand or usage needs.

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3.2 Nature of the supply line

3.2.1 Reliability of the supply line. The second major decision factor, nature of the supply line, encourages a firm to understand its supply context in a comprehensive and systematic manner. Besides SLT, a firm should have an informed gauge as to the reliability of the supply line. When supply sources for a particular item are not reliable, the item would likely not be as readily available when needed, regardless of whether SLT is less than or greater than CLT (Ramasesh, 1991; Song *et al.*, 2000). Facing this situation, a firm may well want to locate these purchased items within its physical grasp, if not through ownership then through physical location, in order to protect itself against such a risk. On the other hand, when supply sources for a particular item are easily available, quite typical of commodity items, the risk of an empty supply pipeline decreases dramatically, and there would be less of a necessity to take physical possession of these items before demand is known.

3.2.2 Supplier performance. A second aspect of the supply line concerns the issue of supplier delivery and quantity performance. When a particular supplier performs poorly in terms of expected delivery time or delivery quantity, a firm would not be able to predict with confidence as to whether or not a shipment would arrive on-time to be used to satisfy customer demand or usage requirements or whether or not the quantity shipped would be enough or of the right type to cover customer demand or usage requirements (Benton and Krajewski, 1990; Song *et al.*, 2000). Stocking these purchased items internally within the firm’s boundaries would, therefore, be an attractive and viable option to safeguard against delivery delays or delivery inaccuracies. In contrast, when confidence in the ability of the supplier to deliver as committed is high, and assuming that SLT is acceptable, then the criticality of having physical stock located within its own organizational boundaries becomes significantly minimized.

3.3 Bargaining power

The third and final decision factor is for the firm to understand its relative bargaining power over that of its supply base (Emerson, 1962; Pfeffer and Salancik, 1978; Maloni and Benton, 2000). Certainly, if a firm within a specific buyer-supplier relationship were to hold bargaining power, this would greatly enhance its ability to dictate to and make certain demands of a specific supplier.

3.3.1 Number of available suppliers. Whether or not a firm has bargaining power is, first of all, directly proportional to the number of available suppliers from which it can source a particular item. Hence, the larger this number is, the more likely it is that such a firm would be able to demand certain types, as well certain levels, of service, under the explicit or implicit threat of shifting its business for a particular item from one compliant supplier to another (Pfeffer and Salancik, 1978; Handfield, 1993; Heide, 1994). Such a firm, therefore, would likely be able to insist on short delivery time windows or mandate multiple deliveries over a fixed time period, effectively postponing the imperative of having to purchase and own items before demand or usage requirements become known (Cox, 2001a). This firm may even be able to have a specific vendor consign a quantity of items in question to the firm, paying for them after sales or production usage.

3.3.2 Uniqueness of purchased item. Second, the uniqueness of the item being supplied should also affect how much relative bargaining power a firm has over its supply base. Unless a firm owns the intellectual property associated with an item being purchased, the more unique the purchased item is – perhaps because of proprietary design – the less bargaining power a firm would have over the supplier (Heide, 1994; Cox, 2001b). Bargaining power, in fact, would now shift to the vendor actually supplying units of the purchased item, and it would, therefore, be prudent for the firm to purchase and commit to inventory of this item as soon as demand can be reasonably forecasted. Doing so, the firm would be able not only to protect against future price fluctuations but also to ensure a steady source of supply.

4. An “Inventory Management Approaches” decision framework

When considered in a conscientious and comprehensive manner, the three decision factors and their underlying drivers described above can help firms decide which of the four inventory management approaches would be the “right” one to adopt (Table II).

Let us consider, for example, the choice of inventory speculation for a purchased item. With respect to customer demand or usage requirements, demand or usage needs while difficult to predict in terms of quantity and timing, are relatively stable in terms of preferences. At the same time, CLT is quite restrictive, with the sum of SLT, CT, and DTC exceeding CLT. With respect to the nature of the supply line, reliability, supplier delivery, and quality are suspect and generate unfavorable delivery conditions. Finally, with respect to bargaining power, there are few available suppliers for a highly unique retail item or production input. Given these conditions across the three decision factors, owning and physically holding on to inventory of the purchased item would be the logical and “ideal” inventory management approach to adopt.

We must caution, however, that Table II is intended to serve the purpose of guidance, since it highlights conditions with respect to customer demand or usage requirements, nature of the supply line, and bargaining power that consistently lead to a logical and “ideal” choice. In practice, we may not see consistent conditions across the three decision factors. As an illustration, consider a purchased item whose demand or usage needs are easy to predict and relatively stable, while $CLT < SLT + CT + DTC$. There are many suppliers to choose from, and the purchased item is basically a commodity item. The supply line is quite reliable; however, all suppliers tend to suffer from poor delivery and quality performance. What, then, would be the appropriate inventory management approach to adopt? Although Table II does not provide an immediate answer, it can be deployed to analyze the context so that an informed decision can be made.

5. The decision framework in action

To further demonstrate the utility of the decision framework in Table II, let us briefly profile four cases alluded to earlier and examine, in greater detail, the rationale underlying the adoption of the specific inventory management approach in each instance.

5.1 IKON Office Solutions and inventory speculation

IKON Office Solutions “integrates imaging systems and services that help businesses manage document workflow and increase efficiency . . .” (see www.ikon.com/about/).

Customer requirements	Decision factors and underlying drivers		Inventory management approach
	Nature of the supply line	Bargaining power	
CLT < SLT + CT + DTC Difficult to predict customer demand or usage requirements Stable customer preferences	Unreliable supply line Unpredictable delivery and quantity performance	Few suppliers to choose from Supplier provides a unique product	Inventory speculation (Firm owns and holds inventory)
CLT > SLT + CT + DTC Easy to predict customer demand or usage requirements Rapidly changing customer preferences	Reliable supply line Predictable delivery and quantity performance	Many suppliers to choose from Supplier provides a non-unique product	Inventory postponement (Supplier owns and holds inventory)
CLT < SLT + CT + DTC Difficult to predict customer demand or usage requirements Rapidly changing customer preferences	Unreliable supply line Unpredictable delivery and quantity performance	Many suppliers to choose from Supplier provides a non-unique product	Inventory consignment (Firm holds but supplier owns inventory)
CLT > SLT + CT + DTC Easy to predict customer demand or usage requirements Stable customer preferences	Reliable supply line Predictable delivery and quantity performance	Few suppliers to choose from Supplier provides a unique product	Reverse inventory consignment (Firm owns but supplier holds inventory)

Notes: CLT – customer order-to-delivery lead-time; SLT – supplier order-to-fulfillment lead-time; CT – firm’s cycle time; DTC – delivery-to-customer lead-time

Table II.
An “Inventory
Management Approach”
decision framework

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IKON competes against Xerox, Pitney Bowes, and Danka, for example, as well as some of its own suppliers such as Canon, Ricoh, and Hewlett-Packard (IKON Office Solutions 2003 Annual Report).

In this business, when office equipment breaks down, the typical client demands a quick resolution, often expecting the service technician to have repair parts readily available upon diagnosis of breakdown problem without having to schedule a second visit. With approximately 7,000 service technicians in the field, this equates to 7,000 stocking locations of multiple repair parts that are carried in anticipation of potential usage that IKON acknowledges is extremely difficult to predict (Albright, 2002).

Because some suppliers are also in the same business of providing document workflow control, IKON finds itself in a less-than-ideal buyer-supplier relationship, with suppliers having an incentive to take over IKON's clientele when opportunities arise. Add to this the fact that a broken piece of branded office equipment requires a repair part that can only be sourced from the original equipment manufacturer (i.e. the supplier) means that different repair parts are likely to be uniquely tied to specific suppliers.

5.2 Dell Computer and inventory postponement

In an industry that typically makes products (i.e. personal computing systems) to stock, Dell Computer instead employs a highly successful build-to-order strategy to tailor a computing system to the desires of the customer (Margetta, 1998). This competitive strategy has not only allowed it to surpass its competitors in terms of business performance but has also made Dell the benchmark for other industries to mimic.

For it to be "lean," Dell refuses to speculate and carry inventory of many purchased items used in building the various Dell-branded computing systems and models. Rather, Dell would receive orders steadily throughout the day and then respond to the changes in incoming customer order patterns accordingly by updating its production schedule every two hours. The production schedule updates, in turn, prompt purchase orders for components (i.e. parts and subsystems), with these purchased items being consistently delivered within 90-minutes of a purchase order placement.

Personal computing systems, whether or not Dell-branded, are products assembled from purchased items with multiple, readily-available sources of supply. Because of Dell's leadership position in personal computing systems (Dell Computer 2003 Annual Report), it has the luxury of being able to screen suppliers to whom it awards its business, with selected suppliers typically having to demonstrate the ability to continually satisfy expectations pertaining to delivery and quality performances (Jacobs, 2003; Murphy, 2003; Richardson and Sowinski, 2003).

5.3 AutoZone, Inc. and inventory consignment

AutoZone, based in Memphis, Tennessee, is a large automobile parts retail chain, operating more than 3,306 stores in the US (www.autozone.com). AutoZone describes its business as "acyclical" and caters to more than 215 million registered vehicles for approximately \$60 billion dollars of business (AutoZone 2003 Annual Report).

Because AutoZone strives to provide excellent customer service, so that no customer walks away without finding what he or she needs, the typical AutoZone store can expect to carry between 20,000 and 22,000 different stock-keeping-units (SKUs),

despite an average inventory turnover ratio of 1.5. At hub locations, the total number of SKUs easily exceeds 100,000 units (Boorstin, 2003; Howell, 2003). In fact, a 2003 estimate of items across AutoZone stores and hub locations places the dollar figure as high as \$1.5 billion (Fahey, 2003), with the majority of these items being owned by AutoZone suppliers until they are sold by AutoZone to a customer.

While automobiles differ from brand to brand and model to model, there are, nonetheless, many common parts (e.g. light bulbs, automobile cleaning suppliers, air filters, etc.). The parts themselves tend to be non-unique and readily substitutable, and therefore, available from many suppliers (Boorstin, 2003; Fahey, 2003).

5.4 W. P. Carey MBA – Evening Program and reverse inventory consignment

The W. P. Carey MBA – Evening Program at Arizona State University ranks seventeenth among part-time MBA degree programs, according to the recent April 2004 US News & World Report survey, and graduates approximately 250 students each year. A typical course in the Evening Program would require students to read copyrighted supplemental materials, in addition to assigned textbooks, with these supplemental materials often bound together as a course pack.

As a service to its students, the Evening Program staff purchases, for each course, enough digital copies of the course pack from XanEdu, a third-party provider with capability to obtain copyright releases from multiple publishers and to bind them together for resale. Since the number of students enrolled in the Evening Program for a particular course is known in advance of purchase, there is virtually no uncertainty as to the number of copies that the Evening Program has to purchase from XanEdu. Once purchased (i.e. created by XanEdu), students can get access to the digital copy using a secured username and password. Through this arrangement, the Evening Program eliminates the headache of having to provide physical storage and material handling for over 1,000 paper copies of four different course packs before the beginning of each trimester[1].

While XanEdu is one of several suppliers capable of providing course packs to the Evening Program, it has negotiated access to and distribution rights for publishers of potential supplemental readings that are typically used in business education, making it extremely efficient in obtaining copyright permission releases. In addition, XanEdu has demonstrated, in the past, an ability and willingness to handle the rare instances where last-minute (i.e. extremely close to a course start date) changes to a course pack have to be incorporated.

6. Discussion

That “inventory” is necessary for the proper conduct of business is well-accepted. Likewise, that the approach a firm adopts to manage its inventory would impact its financial well-being and long-term viability is a foregone conclusion. A firm must, therefore, decide wisely since the wrong decision can lead to increased inventory costs at decreased service levels.

In this paper, we focused on the question of how to best manage inventory of a critical item which a firm has already decided to purchase from a supplier who is not working with the firm in a just-in-time environment. More specifically, we can decouple this question into two related sub-questions:

- (1) Where should inventory of a purchased item be located, within the boundaries of a firm or at a supplier?
- (2) Who should own such inventory – the firm or its supplier?

The answers to these two questions highlight four inventory management approaches (Table I) to consider for each purchased item – from inventory speculation to inventory postponement to inventory consignment to reverse inventory consignment, each with its own advantages and disadvantages.

To make the “right” choice, we encourage each firm to appreciate in a systematic fashion three categories of decision factors and their underlying drivers and to apply the decision framework in Table II to the specific context facing the firm (i.e. specific item being purchased). Doing so should help avoid making the costly mistake of using a less-than-ideal inventory management approach, as well as pinpoint the most critical issues concerning a particular purchased item needed for the conduct of business.

We must emphasize that this choice is not intended to be implemented indiscriminately to all items that a firm purchases. For each item being purchased, a firm needs to apply the decision framework in Table II to determine the most appropriate inventory management approach to implement.

6.1 Contributions

Not surprisingly, if one were to compare the decision framework in Table II to earlier results and insights offered by Zinn and Bowersox (1988) and Pagh and Cooper (1998), we would find similarities, particularly in terms of several of the underlying decision drivers (e.g. nature of demand, willingness of the customer to wait, nature of the item being purchased). At the very least, one can interpret these similarities as reinforcing previously reported findings.

However, Table II does make two unique and related contributions. As noted already, the previously reported results and insights help firms to choose between just two inventory management approaches for a purchased item – i.e. choose either an inventory speculation approach or an inventory postponement approach. Unfortunately, when inventory consignment and reverse inventory consignment are also available as viable options, the literature is not as informative. In this respect, the decision framework in Table II contributes to the literature by explicitly considering a more complete set of choices with respect to inventory management approaches for any particular purchased item.

Moreover, in this consideration, the decision framework identifies a more complete set of decision factors and underlying drivers to help firms make an appropriate decision regarding the inventory management approach to implement for a particular purchased item. Besides the nature of demand, the willingness of the customer to wait, and the nature of the item being purchased, the decision framework also highlights the influence that the power asymmetry in a buyer-supplier context and the nature of supply line have on selecting one inventory management approach over another. As such, a second contribution of the research is the augmentation of the list of decision factors and underlying drivers governing a firm’s decision with respect to the choice of an inventory management approach for a particular purchased item.

6.2 Future research

Several future research opportunities can be identified based on the decision framework articulated in Table II. Foremost is the need to juxtapose these results with existing theories, whether within or beyond the supply chain management discipline. For example, given bargaining power as a decision factor, Resource Dependence Theory (Pfeffer and Salancik, 1978) may be a useful theoretical lens to conceptually defend the normative statements concerning the role of power in the choice of inventory management approach for a particular purchased item. Similarly, Transaction Cost Economics (Williamson, 1985), with the dimensions of asset specificity, uncertainty, and frequency, may provide theoretical justification for such decision drivers as uniqueness of the purchased item or supplier delivery and quality performance.

Second, future research may also examine variations of the “pure” forms of inventory management approaches, considering, for example, the decision factors that would entice a firm and its supplier to choose to co-locate inventory of a purchased item in a storage facility that is either jointly owned or jointly contracted with a third party. Equally interesting would be research seeking to understand the reasons why a firm and its supplier would enter into more complex arrangements in which the supplier would agree to oversee the inventory replenishment responsibility (e.g. “Vendor-Managed Inventory or VMI” arrangements – see Waller *et al.*, 1999; Cetinkaya and Lee, 2000; Dong and Xu, 2002), irrespective of who owns the inventory or where the inventory is stored.

Third, an opportunity for further investigation may arise from reversing the perspective from which the current decision or more complex decisions are considered. Perhaps, viewing the current decision from a supplier’s perspective may lead to the uncovering of additional decision factors and underlying drivers that would influence the choice of an inventory management approach for a particular purchased item. More interestingly, taking a supplier’s perspective may uncover barriers to the normative choice of an inventory management approach suggested by the proposed decision framework in Table II, which, of course, was conceptualized from the perspective of the firm sourcing the purchased item.

Finally, empirical research is needed to augment the anecdotal evidence for the purpose of validating the decision framework. Such empirical research may take the route of confirmatory case studies (Edwards, 1998; Johnston *et al.*, 1999; Hillbrand *et al.*, 2001), large-scale survey research of firms which have implemented each of the four inventory management approaches for a purchased item, and even experiments involving professional buyers subjected to various in-basket treatments that reflect different decision factors.

7. Conclusion

As long as inventory investment decisions have the power to impact the profitability of a firm and its success in the marketplace, as long as customers continue to demand improved response and service levels, and as long as the imperative for a firm to reduce non-value added activities and costs remains, interest in discovering how to improve a firm’s efficiency in terms of managing inventory will likely persist. In this paper, we ask an important question – i.e. how best to manage inventory of a purchased item that is critical to the firm? In answering this question, we offer, as a starting point, the

decision framework in Table II – one that is conceptually derived from anecdotal data – with the hope that it can not only provide some pragmatic guidance as to how to tackle this question but also augment existing scientific research on this question. We close by encouraging scholars to explore the research opportunities for moving science and practice forward on this question.

Note

1. The Evening Program operates on a ten-week trimester basis, during which students take two courses. Therefore, with first year and second year students, there would be four different courses corresponding to four different course packs. Given an average of 250 students per year, the estimated total number of paper copies would be 1,000.

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