An alternative analysis of inventory costs of JIT and EOQ purchasing

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Abstract Recent models comparing inventory costs under just-in-time (JIT) purchasing plans and economic order quantity (EOQ) purchasing plans have tended to favor EOQ purchasing in situations where annual demand of inventory is moderately large. Contends that these cost models are lacking dynamic cost components inherent in virtually all JIT purchasing plans. Presents a series of inventory purchasing cost models that extend prior methodology by Fazel by including relevant physical distribution cost savings. Additional comparative models are presented to further demonstrate how other relevant costs factors can be included in a comparative EOQ/JIT model. A cost comparison with an existing problem from the literature is used to illustrate the informational efficacy of new models.

Introduction
Some theoretical models can lead to startling conclusions that can limit their future use if relevant model components are not considered in their design. In a set of just-in-time (JIT) models presented by Fazel (1997) we feel that the inclusion of additional cost components will lead to substantially different conclusions than those reached by Fazel. A brief review of prior research concerning the development of related models is necessary to understand the model revisions we are proposing in this paper.

The determination of unit order size and frequency of placing orders in the process of purchasing goods has a direct and critical impact on any organization’s distribution and logistic systems (Germain and Droge, 1997). Because these decisions are so critical to an organization’s success, many purchasing agents turn to a wide variety of inventory methodologies to guide their decisions. For many decades the economic order quantity (EOQ) model, first proposed by Harris (1915) has been a fundamental methodology for the development of inventory purchasing models. EOQ continues to be a basic starting point in the development of many inventory purchasing models (Charabarty et al., 1998; Ray and Chaudhuri, 1997). In general, the EOQ models mathematically determine order size and the frequency of orders based on minimizing costs. Such modeling can lead to placing of large-sized and
infrequent orders relative to more modern inventory purchasing methods (Schonberger, 1982, p. 44). In the last few decades an alternative approach called just-in-time (JIT) purchasing has advocated, among other things, smaller-sized and more frequent orders (Schonberger, 1982, p. 159; Schniederjans and Olson, 1999, p. 4). This clear contrast can lead organizations to ponder which approach to purchasing would be the best, or at least a less costly approach to purchasing.

To aid in this decision a great number of research studies have been presented in the literature that seek to compare EOQ and JIT methods of purchasing. Prior research on this subject is both conceptual and methodological. For example, in an early paper by Pan and Liao (1989) the EOQ model was reconverted into a series of JIT purchasing models that could be used in determining inventory deliveries and cost savings. Their models demonstrated how total annual inventory ordering costs could be minimized by placing an optimal number of smaller-sized, more frequent order deliveries under a JIT system. It is important to note that their models showed no limitation on the cost advantages of using JIT based on the model parameter of annual demand.

Early critics on both sides of the issue of which model (i.e. EOQ-based models verses JIT) is the best to use pointed to the weakness of capturing relevant cost information in which to build models. Many researchers demonstrated that JIT would be a cost favored purchasing approach to inventory management (Chyr et al., 1990; Hong et al., 1992; D’Ouville et al., 1992; Grant, 1993). Other researchers had concerns that EOQ and JIT might not be comparable because of costing problems. Jones (1991) stated that most inventory models ignored relevant and important cost information, particularly those dealing with carrying inventory in stock. Johnson and Stice (1993) felt that inventory techniques under-emphasized the costs of maintaining large inventories.

More recent researchers have felt that the economic impact and complex costing structures observed in JIT operations can be accurately captured and measured in models (Brox and Fader, 1997). One such researcher, Fazel (1997), developed a series of innovative models that can be used to directly compare EOQ and JIT systems to determine which is best in a particular cost structure and at a particular annual demand level. Fazel (1997) showed that regardless of an organization’s cost structure, JIT inventory purchasing was only preferable at lower levels of annual demand. Specifically, he demonstrated that at a certain annual demand level, the cost advantages of EOQ purchasing would always be preferable to a JIT purchasing system.

It is this conclusion and the development of the Fazel (1997) models on which the subject of this paper is focused. In the development of Fazel’s models it was assumed that the total costs of inventory under a JIT operation were simply the cost per unit times annual demand. Prior JIT research has shown that important cost information can be left out of comparative models and we believe that Fazel’s models can be improved by including some of these cost
components. Some of these cost items for example could include the cost of money, personal property tax, order processing costs, insurance, and obsolescence. While any one or all of these cost items might rightfully be included in a model, our intent in this paper is to show that the inclusion of but a single additional cost item can have a substantial impact on the conclusions reached by Fazel. One such cost item is the physical plant space that is reduced by eliminating inventory under JIT and thereby reducing overhead costs to finance the factory space. Past and present research on JIT has clearly documented the inevitable reduction in facility square feet. This reduction in facility square footage is caused by the elimination of the space required in storing inventory. JIT consultants and researchers, such as Schonberger (1982, pp. 121-2) and Wantuck (1989, p. 16), have long cited countless examples that prove conversion to JIT will reduce space in plants and factories. More recently Federal Signal, an emergency signal manufacturer in Illinois, initiated a JIT operation that saved 100,000 square feet (roughly 30 percent of the total facility space) of facility inventory storage and production area from their previous EOQ type of system. The company went on in the process of restructuring their layout using JIT principles to rent the space saved to another company, turning what would be a cost into a rental income (Chase et al., 1998). Other examples of facility space reduction reported in the literature include reports of reducing floor space by 30 percent (Voss, 1990, p. 330), by 40 percent (Garg et al., 1997), by 50 percent or more (Jones, 1991), and Hay (1988, pp. 22-3) reported space reductions of up to 80 percent.

The possibility of including the cost of physical space savings has only recently been mentioned in inventory modeling literature. Schniederjans and Olson (1999, pp. 26-30) reported on a paper presentation by Schniederjans and Cao (2000) where they included JIT physical space cost savings in quantity discount inventory models. A basic total cost function and cost difference function for the classic quantity discount model and a JIT model were demonstrated. Unfortunately, the demonstration did not include: formulas that would relate the basic EOQ model and a JIT model with physical spacing cost savings components, formulas for any relevant cost indifference point models under EOQ, formulas for maximum JIT purchasing price models under EOQ, or other extensions of cost component into comparative models.

The purposes of this paper are:

• to include the physical plant or factory space savings cost component as suggested by Schniederjans and Cao (2000) for quantity discount models into Fazel’s (1997) EOQ/JIT cost comparative models; and

• to present a series of additional cost comparative models for use in purchasing management. Specifically, this paper will present the development of comparative EOQ/JIT cost models, including unique cost indifference point and maximum purchasing price models based on the classic EOQ theoretical model.
In addition to developing these new models we will re-examine their impact on the original problem presented by Fazel (1997) and demonstrate their informational value in deciding between EOQ and JIT purchasing systems. We will present a discussion on potentially misleading results by one of Fazel's (1997) models and how changes in parameters can lead to the development of additional comparative models showing the relative advantages of JIT in most inventory purchasing situations.

Model

**EOQ costs**

We will be using the same basic set of total annual cost EOQ models which Harris (1915) proposed and which are presented in Fazel (1997). The total annual cost of an item under an EOQ system \( (TCE) \) is the sum of the inventory ordering costs, inventory carrying costs, and the costs of the actual ordered units, or:

\[
TCE = \frac{kD}{Q} + \frac{Qh}{2} + PE D
\]

where \( k \) is the cost of placing an order, \( D \) is the annual demand for the item, \( Q \) is the fixed order quantity, \( h \) is the annual cost of carrying one unit of inventory in stock, and \( PE \) is the purchase price per unit. In equation (1) the first ratio is the inventory ordering cost term, the second ratio is the inventory carrying cost term, and the last term is the annual purchasing cost component. While other cost components, such as safety stock, can be added to equation (1), they are more commonly and classically dealt with by a modification of a reorder point. We will assume for the purposes of this model that safety stock costs required in an EOQ model are balanced out by other costs incurred in the use of a JIT model.

By taking the first derivative with respect to \( Q \) of equation (1) and setting it equal to zero we can solve the optimum order quantity \( (Q^*) \), or:

\[
Q^* = \sqrt{\frac{2kD}{h}}
\]

This results in a total annual optimal cost under an EOQ purchasing approach of:

\[
TCE^* = \sqrt{2kDh} + PE D
\]

**JIT costs**

Fazel (1997) assumed that carrying and ordering costs (e.g. storage, inspection, transportation, preparation of purchasing orders for each delivery, etc.) were solely reflected in the unit price \( (PJ) \) to the purchaser. Based on this assumption the total annual cost under a JIT system \( (TCJ) \) is given by:

\[
TCJ = PJ D
\]

It is at this point in the derivation of the comparative models that we depart from Fazel's models. It is our contention that \( TCJ \) should be revised
by reducing the cost of storage by the savings of square feet brought on by reduced inventory in a JIT system. Specifically, we feel the total JIT cost function should be revised to include the annual facility cost reduction, given by:

$$TC_j = \text{Annual purchasing cost} - \text{Annual facility cost reduction, or}$$

$$TC_j = P_jD - FN$$

where \( F \) is the annual cost to own and maintain a square foot of facility, and \( N \) is the number of square feet saved by adopting a JIT system. The value of \( F \) is commonly determined for purposes of overhead costing. The value of \( N \) is best determined when a change from an EOQ system is made to a JIT system. Based on the history of JIT implementation, the estimation of \( N \) is not difficult and commonly reported in the literature. Clearly, \( N \) is a dynamic parameter that many organizations make continuous progress toward. Indeed, an ideal goal in JIT is zero inventories, and therefore, zero inventory space. Since the annual facility cost reduction \( FN \) can be saved by adopting a JIT system it should be subtracted from the total annual cost of a JIT system as stated in equation (5). This change will alter all of the subsequent models from those originally presented in Fazel (1997). For comparative reasons we will use the same nomenclature as did Fazel (1997).

Cost difference
To make a comparison between the total costs under EOQ and JIT purchasing systems a \( Z \) model is presented that combines the optimal cost differences between EOQ in equation (3) and JIT in equation (5), given by:

$$Z = \sqrt{2kDh} - (P_j - P_E)D + FN$$

By rearranging equation (6), multiplying and dividing the term under the radical by \( P_E \), and factoring out \( P_E \) from the second term, this leads to:

$$Z = \sqrt{\frac{2kh}{P_E}} C - \left( \frac{P_j}{P_E} - 1 \right) C + \frac{FN}{P_E}$$

where \( C \) is the dollar value of the annual demand \( (C = DP_E) \). The interpretation of this comparative model is quite simple. As long as \( Z \) remains positive a JIT purchasing system is less costly than an EOQ system.

The indifference point
For comparative purposes purchasing managers might find it useful to know the exact indifference point at which the total costs of EOQ and JIT are equal from the standpoint of a particular total dollar level spent on inventory or at a particular total annual unit demand level. Since an EOQ system will be less costly for \( Z < 0 \), the root of equation (7) can provide the indifference point \( (C_{ind}) \).
or the dollar level of demand at which the total cost of EOQ and JIT are equal. This value can be given by:

\[ C_{ind} = \frac{[(P_J/P_E - 1)FN + kh/P_E] + \sqrt{2(P_J/P_E^2 - 1/P_E)FNkh + k^2h^2/P_E^2}}{(P_J/P_E - 1)^2} \]  

(8)

Since \( C = DP_E \), it is also true that \( C_{ind} = D_{ind} P_E \), where \( D_{ind} \) is the quantity of annual demand at \( Z = 0 \), so:

\[ D_{ind} = \frac{[(P_J - P_E)FN + kh] + \sqrt{2(P_J - P_E)FNkh + k^2h^2}}{(P_J - P_E)^2} \]  

(9)

**Maximum JIT purchasing price**

Another useful parameter that can be derived from these models is a maximum purchase price per unit for an inventory item where a JIT system is the most cost-effective. The highest price a purchaser should pay for a single unit of an inventory item, given a specific annual demand \( D \) and under a JIT purchasing system \( (P_{Jmax}) \) is obtained by setting \( Z = 0 \) in equation (6) and solving for \( P_J \), resulting in:

\[ P_{Jmax} = \sqrt{2kh/D} + P_E + FN/D \]  

(10)

For a specific annual demand \( D \), the equation (10) gives the maximum price that a purchaser should pay for a unit of inventory under a JIT system. For prices higher than \( P_{Jmax} \), the EOQ system would be less costly.

One additional model that Fazel (1997) included for comparative purposes was a model that could be used to find the maximum cost advantage of using JIT over EOQ. This maximum cost advantage point \( (D_{max}) \) was presented in Fazel (1997) without explanation of its derivation as simple ratio of \( D_{ind} \) divided by 4. This simple ratio is limited to the Fazel (1997) model and is clearly not applicable to models that contain additional cost elements such as the models proposed in this paper. The actual derivation for \( D_{max} \) can be found by taking the zero-point derivative of equation (6), yielding:

\[ D_{max} = D_{ind} * \frac{kh}{2[(P_J - P_E)FN + kh] + \sqrt{2(P_J - P_E)FNkh + k^2h^2}} \]  

(11)

While equation (11) will generate the same answer for the same values of the four parameters that make it up, it permits additional cost information to be included in \( D_{ind} \) without it incorrectly impacting the determination of the maximum concave point that Fazel's model permits.

While the intent of the models in equations (4) through (11) are the same as those presented by Fazel (1997), their revision to consider the cost savings by
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freed facility space resulted in some cases in a substantially different model. Having completed the first objective of this paper (i.e. the presentation of the models), we will now illustrate their impact on the previous conclusions reached by Fazel (1997).

A comparative example
To make this comparative analysis between the proposed models in this paper and those of Fazel (1997), we will use the same example that appeared in the Fazel paper modified only for the additional space savings parameters introduced in this paper. In that example a company is considering switching from EOQ to JIT purchasing for a single inventory item. The purchasing cost per unit under EOQ is \( P_E = \$40 \), annual carrying cost per unit is \( h = \$12 \) (30 percent of the purchase price), order placing costs are \( k = \$500 \)/order, and the purchasing cost per unit under JIT is \( P_J = \$40.40 \). Fazel (1997) assumed that the cost per unit under JIT would generally be slightly higher than under EOQ as a result of JIT-unique requirements (e.g. more frequent deliveries, unitary packaging, etc.). For the purposes of this paper we will continue to accept this assumption, but feel that such costs are very temporary in the beginning of a conversion from EOQ to JIT and eventually fade as a result of subsequent dynamic improvements in operations that eventually reduce total costs (Schonberger and Schniederjans, 1984). Indeed, Fazel (1997) makes the point that if the cost differential between \( P_E \) and \( P_J \) is eliminated, JIT is always preferable. This is an important point to remember as it relates to the subsequent computations in the following example.

To compare this paper’s models, the values for the annual cost to own and maintain a square foot of facility \( (F) \) and the number of square feet saved by adopting a JIT system \( (N) \) have to be estimated. Let us assume a cost per square foot of facility is only \( F = \$10 \) and the facility in this example has a total square footage of 250,000. Let us further assume that a reduction due to adopting JIT is a 20 percent reduction in square footage. That would mean that the number of square feet saved by adopting JIT is \( N = 50,000 \) (i.e. \( 250,000 \times 0.20 \)). Based on the previously cited research on JIT improvements, all of the assumptions can be considered quite conservative.

Based on these assumed parameters a comparison of the resulting model’s computations with those of Fazel (1997) is presented in Table I.

Discussion of results
While it is expected that by adding a facility space cost savings to the JIT side of the total cost function the total dollar value at the indifference point \( (C_{\text{ind}}) \) would increasingly shift, we can see in Table I that the shift from $3 million to over $63 million is quite dramatic. The fact that the facility space cost savings assumed in this example were very conservative, shows just how substantial the cost advantage of adopting JIT systems can be when the inevitable space savings are incurred. Our interpretation of this difference is that Fazel (1997)
grossly under-estimates the cost indifference points when an EOQ system is compared to a JIT system.

The very substantial positive increase in total unit value at the indifference point \((D_{ind})\) from 75,000 to over 1.5 million units in Table I tends to indicate that only in the very largest annual demand situations will the EOQ system be favorable. The point where the negative value of \(Z\) favors an EOQ system using Fazel’s model is an annual demand \(D_{ind}\) of 75,000 units as presented in Figure 1.

When the space saving costs are included and the revised total costs for the value at the indifference point are computed, the resulting \(D_{ind}\) of 1,595,974 presented in Figure 2 is the new indifference point.

Note the substantial differences in size of the \(D\) annual demand in Figures 1 and 2. Since saving space and using it to house additional increasing amounts of inventory to meet larger annual demand are juxtapose issues, logic dictates, and it is our contention, that a JIT system would virtually always be preferable to an EOQ system. Put another way, the annual demand has to be so large, that the only way inventory could be ordered would be on a continuous, JIT basis. Otherwise, the purchaser would be so inundated with inventory that major

<table>
<thead>
<tr>
<th>Equation No.</th>
<th>f</th>
<th>Description</th>
<th>Comparative Model Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8)</td>
<td>(C_{ind})</td>
<td>Total dollar value at indifference pt.</td>
<td>$3,000,000 (\rightarrow) $63,838,963</td>
</tr>
<tr>
<td>(9)</td>
<td>(D_{ind})</td>
<td>Total unit value at indifference pt.</td>
<td>75,000 (\rightarrow) 1,595,974</td>
</tr>
<tr>
<td>(10)</td>
<td>(P_{\text{max}})</td>
<td>Max. JIT price per unit</td>
<td>$40.39 (\rightarrow) $40.39</td>
</tr>
<tr>
<td>(11)</td>
<td>(D_{\text{max}})</td>
<td>Max. cost advantage under JIT</td>
<td>18,750 (\rightarrow) 18,750</td>
</tr>
</tbody>
</table>

**Table I.**
Comparison of Fazel (1997) and revised EOQ/JIT models

**Figure 1.**
Fazel’s total cost difference, \(Z\)
purchases of additional facility space would have to be acquired, again forcing a new round of additional facility space costs favoring a JIT system.

The maximum purchasing prices ($P_{jmax}$) in Table I for both models are the same, but at substantially different $D_{ind}$ values. The $P_{jmax}$ of $40.39$ in the Fazel model is for a $D_{ind}$ of 75,000 units. The $P_{jmax}$ of $40.39$ in our revised model is for a $D_{ind}$ of 1,595,974 units. If we take the 75,000 unit level and plug it into the $P_{jmax}$ into equation (10) the maximum price under a JIT system can be as much as $46.67. Most important for this paper, is the fact that for every value of annual demand $D$ below the comparatively large $D_{ind}$ of 1,595,974 units, the current price paid for a unit of inventory under JIT (i.e. $4.40$) is always preferable. Indeed, at the maximum cost advantage $D_{max}$ of 18,750 units, the maximum price where JIT would be a preferable system is as large as $66.67. This means JIT systems make even highly priced inventory or items that experience sudden upward shifts in costs preferable to lesser priced items that would be used in an EOQ system.

One final point about the results of this example concerns the possible misleading results from the original Fazel model for the $D_{max}$ value. As we can see in Figures 3 and 4, the true $D_{max}$ value of 18,750 units in this example is equal to the value found by the Fazel (1997) model.

But using the Fazel’s prior model for $D_{max}$ (i.e. $D_{max} = D_{ind} / 4$) would have resulted in an incorrectly overstated value of 398,993.5 units (i.e. 1,595,974/4), regardless of the fact that space saving costs were added. Because the model proposed in equation (11) in this paper adjusts for shifts in the other parameters in the model, it is not prone to the same potential of overstating the value of $D_{max}$ as is the Fazel (1997) model.
Other cost components, models, and implications

Products, firms, and industries where inventory represents a dominant cost component in the total cost to customers will more likely be able to benefit from using JIT ordering systems. For each product, firm, and industry there are potential cost differences that might lessen the importance of one cost component over another in the models presented in this paper. Some of these cost items can be included in a generic sense by altering a type of cost parameter in the model. In Schonberger and Schniederjans (1984) cost components were categorized into seven different types of EOQ-related cost.
opportunities under a JIT system. As presented in Table II the potential impact on costs in an EOQ/JIT model depends on importance or dominance of one or more of these seven categories.

The cost impact examples presented in Table II for modeling purposes are not definitive but are offered here to demonstrate how they can be included in a comparative EOQ/JIT model.

In the first two cost categories (i.e. Purchasing dept. and Economies of scale) in Table II a JIT system can unfavorably increase impact on costs or favorably decrease impact on them by altering $k$ cost of placing an order. For example, JIT can decrease costs by reducing the number of vendors (and therefore the costs of dealing with a larger number of vendors). Unfortunately JIT also tends to have a larger number of smaller orders, which can lead to a greater amount of total shipping costs. To model the possible change in JIT costs of $k$, let $k^*$ be the amount of increase or decrease change in the cost to place an order. To model the increase of costs under JIT would require the total cost function in equation (4) to become:

$$TC_J = \text{Annual purchasing cost} + \text{Increase in ordering costs},$$

or

<table>
<thead>
<tr>
<th>Cost category</th>
<th>Description of type of JIT impact</th>
<th>Impact on costs and model parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Purchasing department</td>
<td>More frequent, smaller orders result in a greater number of orders but a fewer number of purchasing agents</td>
<td>Either unfavorable or favorable impact on $k$, could increase or decrease JIT cost</td>
</tr>
<tr>
<td>2. Economies of scale</td>
<td>Smaller lot sizes increases set up frequency, loses quantity discounts and full truck shipping costs reduction but can aid in reducing order-processing costs</td>
<td>Either unfavorable or favorable impact on $k$, could increase or decrease JIT cost</td>
</tr>
<tr>
<td>3. Opportunity</td>
<td>Cost of capital in inventory reduced</td>
<td>Favorable impact on $P_J$, reduces JIT cost</td>
</tr>
<tr>
<td>4. Material control department</td>
<td>Less inventory means less material control department</td>
<td>Favorable impact on $h$, reduces JIT cost</td>
</tr>
<tr>
<td>5. Shop-floor material storage and handling</td>
<td>Less inventory means less storage space material and less handling, handlers, and equipment</td>
<td>Favorable impact on $h$, reduces JIT cost</td>
</tr>
<tr>
<td>6. Work improvement</td>
<td>Less scrap and rework, improved quality</td>
<td>Favorable impact on $h$, reduces JIT cost</td>
</tr>
<tr>
<td>7. Uneven workload</td>
<td>Production scheduling leveled, less idle time, more efficient production and less material handling</td>
<td>Favorable impact on $h$, reduces JIT cost</td>
</tr>
</tbody>
</table>

Table II. EOQ/JIT cost categories and possible impact on costs under a JIT system
The resulting indifference point \( (D_{\text{ind}}) \) or the dollar level of demand at which the total cost of EOQ and JIT are equal model for this situation would become:

\[
D_{\text{ind}} = \frac{h\left[\sqrt{\frac{(k+k^*)^2}{k}} + \sqrt{k}\right]^2}{2(P_J - P_E)^2}
\]  

To model the decrease of costs under JIT would require the total cost function in equation (4) to become:

\[
TC_J = P_J D - k^*(Q/D)
\]  

In the third cost category (i.e. Cost of capital) in Table II a JIT system will favorably impact costs because inventory (and the investment in inventory) is usually reduced under a JIT system. To model this situation, the original Fazel (1997) model can be used. The only change necessary is to decrease the value of the unit price \( (P_J) \) to the purchaser.

In the fourth through seventh cost categories (i.e. Material control department, Shopfloor, Work improvement, and Uneven workload) in Table II a JIT system tends to favorably impact the costs by decreasing the annual cost of carrying one unit of inventory in stock. To model the possible change in JIT costs of \( h \), let \( h^* \) be the amount of decrease in the annual cost to carry stock. To model this decrease of costs under JIT would require the total cost function in equation (4) to become:

\[
TC_J = P_J D + h^*(D/2)
\]  

The impact and sensitivity to change on the dollar level of demand at the cost
breakeven or $D_{ind}$ tends to favor a JIT system when we change in the $k^*$, $P_J$, or $h^*$ parameters. For example, if we allow a 10 percent increase in $k$ (i.e. $k^* = \$50$ increase) and use equation (13), we would expect a similar percentage reduction in $D_{ind}$. The actual value turns out be 67,670.6 or only about a 9.8 percent reduction from the 75,000 units in Table I. Now if we allow a 10 percent JIT expected reduction in $k$ using equation (15) the resulting $D_{ind}$ is 82,696.6 or a 10.3 percent increase. So while increases in costs due to a JIT system would decrease the demand threshold as expected, decreases in costs due to JIT appear to favorably impact on demand requirements but only slightly more. Similarly, if we allow a 10 percent reduction in holding costs of $h = \$12$ (i.e. $h^* = 1.2$) using equation (17), the resulting shift in $D_{ind}$ goes from 75,000 units to 82,810 or 10.4 percent. One interpretation of the implications of this for purchasing managers is that a JIT system should in almost all situations be favorable to an EOQ system, but that the lack of sensitivity improvements in costs will be in measured proportion to the improvements in items of costs like holding and carrying costs. Where EOQ systems might actually reduce costs, again a measured proportion of improvement will occur.

The sensitivity for $P_J$ is considerably more in favor of a JIT system. Using Fazel’s (1997) formula for $D_{ind}$ and if we reduce the cost difference between a JIT price $P_J$ (i.e. $\$40.40$) down to only $\$40.20$ (a 50 percent reduction from the $P_E$ of $\$40$) the $D_{ind}$ demand level goes from 75,000 up to 300,000 units, which is 300 percent increase in the demand level for the cost break even point. The implication for purchasing managers whose cost of capital in inventory is a large part of their total product costs is clear; JIT can substantially reduce costs over an EOQ system.

**Conclusion**

In this paper, an alternative set of models to those in Fazel (1997) is presented to compare the cost of inventory under EOQ and JIT systems. These new models adjust the comparative cost and demand values proposed by Fazel to include the additional consideration of facility space saving costs that are inherent in the application of a JIT system. The results of the cost comparisons reveal that the addition of only one very commonly occurring cost benefit of using JIT substantially changed the conclusions reached by Fazel (1997). The example presented in this paper has shown that JIT purchasing systems will almost always be a preferable approach for purchasing management. Specifically, that at very high levels of annual demand or at lower levels with price per unit substantially higher than under an EOQ system, the JIT system will still be a more cost-effective purchasing system. Subsequent remodeling to include other categories of EOQ/JIT cost components provide additional support to the assertion that JIT ordering systems will in most cases be superior to EOQ ordering systems.

Just as Fazel (1997) created the theoretical modeling that provided a platform for the models developed in this paper, we suggest that many additional cost
components should be included in the development of future cost comparison models. Since each company has a unique cost structure with specific cost components or drivers, a unique set of revised EOQ/JIT models are suggested for future research. The models and procedure used in this paper can provide a framework approach to the development of such models.

References


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