APPLICATION OF INVENTORY MANAGEMENT SYSTEM BASED ON DIFFERENT DEMAND & COST CONDITIONS

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Abstract

A buffer of inventory on hand is comforting and costly. If you hold a lot of items in inventory, you're locking away a huge amount of cash unnecessarily. These items can be lost, stolen, or damaged, or they can deteriorate and they can become obsolete, particularly when products are improved or changed often. They occupy space, which could else be devoted to operations. All of this represents financial cost to the business. This study scales to justify Just-in-Time (JIT) operations and by using methodologies to determine boundaries and thresholds under which JIT can be best applied. These Methodologies can be used to determine Quantifiable threshold limits where the application of JIT may be Questionable because JIT may not always be the successful way of Inventory management. This paper's objective is to compare the cost advantages under different demand and cost conditions and helping one to clearly identify where JIT system has a cost advantage over Economic Order Quantity (EOQ) system and under what conditions the EOQ System provides an advantage over the JIT System. Using 3 models Fazel model, Fazel- Fischer- Gilbert Quantity discount model, Schniederjans and Qing model the Economic order Quantity system and Just-in-Time System and compared to find out cost difference at different levels of demand conditions and to determine which Inventory Management System should be adopted.

Keywords: **EOQ System, Just-in-Time (JIT), Fazel model, Fazel- Fischer- Gilbert Quantity Discount, Schniederjans and Qing model**

I. Introduction

In the 1970s, when Japanese manufacturing companies were trying to improve their systems, Taiichi Ohno of Toyota developed a guiding philosophy for manufacturing that minimized waste and improved quality called Just in Time (JIT), which advocates a lean approach to production, and uses many tools to achieve this overall goal. Just-in-Time" means making "only what is needed, when it is needed, and in the amount needed." For example, to efficiently produce a large number of automobiles, which can consist of around 50,000 parts, it is necessary to create a detailed production plan that includes parts procurement. Supplying "what is needed, when it is needed, and in the quantity needed" according to this production plan can eliminate waste, inconsistencies, and unreasonable requirements, resulting in improved productivity. When items are ready just in time, they aren't sitting idle and occupying space. This means that they aren't costing you anything to hold onto them example storage cost and the risk of theft or loss due to holding the inventory is reduced to a maximum level, and they're not becoming obsolete or deteriorating. However, without the buffer of having items in stock, you must tightly control your manufacturing process so that parts are ready when you need them by this we can be very responsive to customer orders – after all, you have no stake in "forcing" customers to have one particular product, just because you have a warehouse full of parts that need to be used up. And you have no stake in trying to persuade customers to take an obsolete model just because it's sitting in stock making it a pull system of production. The Economic Order Quantity (EOQ) is the number of units that a company should add to inventory with each order to minimize the total costs of inventory—such as holding costs, order costs, and shortage costs. The EOQ is used as part of a continuous review inventory system in which the level of inventory is monitored at all times and a fixed quantity is ordered each time the inventory level reaches a specific reorder point. The EOQ provides a model for calculating the appropriate reorder point and the optimal reorder quantity to ensure the instantaneous replenishment of inventory with no shortages. It can be a valuable tool to make decisions about how much inventory to keep on hand, how much to order each time, and when to reorder to incur the lowest possible costs. The EOQ model assumes that demand is constant, and that inventory is depleted at a fixed rate until it reaches zero. At that point, a specific number of items arrive to return the inventory to its beginning level. Since the model assumes instantaneous replenishment, there are no inventory shortages or associated costs. Therefore, the cost of inventory under the EOQ model involves a tradeoff between inventory holding costs (the cost of storage, as well as the cost of locking up capital in inventory rather than investing it or using it for other purposes) and order costs (any costs associated with placing orders, such as delivery charges, inspection charges). Ordering a large amount at one time will increase a business's holding costs, while making more frequent orders of fewer items will reduce holding costs but increase order costs. The EOQ model finds the quantity that minimizes the sum of these costs.

II. Literature Review

(Schniederjans, M.J. and Cao, Q. (2001), "An alternative analysis of inventory costs of JIT and EOQ purchasing", International Journal of Physical Distribution & Logistics Management, Vol. 31 No. 2, pp. 109–123) This argued that those "fixed costs" items were not fixed when a change from EOQ system is made to JIT system and thus should not be missing out from the EOQ–JIT cost difference function. Schniederjans and Cao (2001) further argued that in situations where plants adopting the JIT operations experienced or could take advantage of physical plant space square feet reduction, to include the physical plant space factor into the EOQ–JIT cost difference function would substantially increase the EOQ–JIT indifference point. When using JIT as opposed to the EOQ system there is significantly less Space used because the inventory that we will hold at a particular point of time when compared to the EOQ model of inventory Management system is less thereby causing a reduction to the existing physical plant space. This would again force "... a new round of additional facility space costs favoring a JIT system ..." (Schniederjans and Cao 2001, p.117). Schniederjans and Cao (2001) further suggested that saving space and using it to house additional increasing amounts of inventory to meet larger annual demand were juxtaposed issues. Schniederjans and Cao (2001) then concluded that the inclusion of a single cost item that was omitted by Fazel (1997) would prove that the JIT system was always preferable to an EOQ system (Schniederjans and Cao 2001). However, Schniederjans and Cao (2001) had difficulty to either scientifically or empirically ascertain the capability of an inventory facility to hold the EOQ–JIT cost indifference point's amount of inventory. The most important advantage of an EOQ system is its ability to handle the unexpected demand. This paper expands the Fazel's EOQ model, to take into account out-of-stock risk, which was not considered by previous researchers, and shows that it is possible for an EOQ system to be more cost effective than a JIT system when the out-of-stock risk associated with the JIT purchasing system is high or the annual demand is either too low or too high
(Fazel, F. (1997), "A comparative analysis of inventory cost of JIT and EOQ", International Journal of Physical Distribution and Logistics Management, Vol. 27 No. 8) Fazel computed the cost difference between EOQ and just-in-time and estimate the demand and purchase price and demand Indifference points between the 2. The developed a model to estimate demand above which EOQ is then costly than JIT and maximum unit purchase price below which JIT is preferable. It implies that there are some hidden cost for JIT model, there hidden costs are created by removing inventories by employing the Justin time system the inventory relevant costs are not removed but is transferred to the suppliers, he explains this in his statement

"hidden holding costs and Ordering costs we not fully eliminated but an transferred to suppliers and a price increase happens in purchasing Price". According to Fazel Manufacturing Companies that use their classical EOQ models are increasingly faced with a decision of whether or not to switch to the JIT system. This is a complex decision requiring careful examination of each system and to possible impact on a variety of cost factors.

III. Research Methodology

JIT originated in Japan. Its introduction as a recognized **technique-philosophy-way of working** is generally associated with the Toyota motor company, JIT being initially known as the "Toyota Production System". JIT is very much a mindset or way of looking at a production system that is distinctly different from what traditionally had been done previous to its conception. Within Toyota Taiichi Ohno is most commonly credited as the father of this way of working. The beginnings of this production system are rooted in the historical situation that Toyota faced. After the Second World War the president of Toyota said "Catch up with America in three years, otherwise the automobile industry of Japan will not survive". At that time one American car worker produced approximately nine times as much as a Japanese car worker. Taiichi Ohno examined the American industry and found that American manufacturers made great use of economic order quantities - the traditional idea that it is best to make a "lot" or "batch" of an item (such as a particular model of car or a particular component) before switching to a new item. They also made use of economic order quantities in terms of ordering and stocking the many parts needed to assemble a car.

Ohno felt that such methods would not work in Japan - total domestic demand was low and the domestic marketplace demanded production of small quantities of many different models. Accordingly Ohno devised a new system of production based on the **elimination of waste**. In his system waste was eliminated by:

Just-In-Time	***Items only move through the production system as and when they are needed.***
Autonomation	***Automating the production system so as to include inspection - human attention only being needed when a defect is automatically detected whereupon the system will stop and not proceed until the problem has been solved.***

In this system inventory (stock) is regarded as an unnecessary waste as too has to deal with defects.

Oh no regarded waste as a general term including time and resources as well as materials. He identified a number of sources of waste that he felt should be eliminated:

Overproduction	***Waste from producing more than is needed.***
Time spent waiting	***Waste such as that associated with a worker being idle whilst waiting for another worker to pass him an item he needs (e.g. Such as may occur in a sequential line production process)***
Transportation/Movement	***Waste such as that associated with transporting/moving items around a factory.***
Processing Time	***Waste such as that associated with spending more time than is necessary processing an item on a machine.***
Inventory	***Waste associated with keeping stock.***
Defects	***Waste associated with defective items.***

Just-in-time (JIT) in a manufacturing operation

Just-in-time (JIT) in a manufacturing operation, component parts arrive *just-in-time* to be picked up by a worker and used. So at a stroke we can eliminate any inventory of parts, they would simply arrive *just-in-time*! Similarly we can produce finished goods *just-in-time* to be handed to a customer who wants them. So, at a conceptual extreme, JIT has no need for inventory or stock, either of raw materials or work in progress or finished goods. We could move an existing system towards a system with more of a JIT element than it currently contains. For example, consider a manufacturing process - whilst we might not be able to have a JIT process in terms of handing finished goods to customers, so we would still need some inventory of finished goods, perhaps it might be possible to arrange raw material deliveries so that, for example, materials needed for one day's production arrive at the start of the day and are consumed during the day - effectively reducing/eliminating raw material inventory. Adopting a JIT system is also sometimes referred to as adopting a **lean production system.**

Just in time and Economic order system EOQ

JIT is preferred when:	***EOQ is preferred when:***
	Lead Time is short and the cost of an order is high
Cost of an order is low	Cost of an Order is Medium or high
	Cost of an order is low but lead time is long
Daily Demand is high	Daily Demand is Low
	Daily Demand is high and lead time is medium or long
	Product value is low
	Product value is medium or high and lead time is long
Risk is high	Risk is low
Carrying cost per unit is high	Carrying cost per unit is Low

Benefits of JIT	***Benefits of EOQ***
Reduction in inventory	Inventory level Continuously monitored
Improved Quality	Safety stock is comforting
Shorter lead times	Hedge against uncertain demand
Low set uptime	Hedge against uncertain Supply
Increased Productivity	Economize on Ordering costs
Increased machine utilization	Reduced order processing
Greater flexibility	The total cost is the least
Zero deviation from Schedules	It is an optimal order size
Work in progress reduced	Strong relationship with Vendors
Continuous Improvement	Saves time
Focus on defect prevention	Allow flexible production Schedules
Focus on simplifying production process	Safeguard against lead time variations
Emphasizes on cross functional working	With greater Quantity the purchase Price tends to be lesser
Total preventive maintenance	To maintain independence of operations
Line balancing	Output based Strategy
Production leveling	Organization efficiency
Reduced space requirements and overheads	Reduced total costs
Reduced cost increased profit margin	
Reduced wastage	

Evaluating the system of Inventory management that should be used:

Function Name	***Fazel Model***	***Fazel, Fischer, and Gilbert Quantity discount EOQ model Ordering System with variable discounts***
Order Quantity	Q = $\sqrt{\frac{2KD}{H}}$	$Q^{**} = \sqrt{\frac{2KD}{H-2\pi_E D}}$ Necessary condition $(H-2\pi_E D\,)>0$
TotalEOQ cost	$TC_E = \sqrt{2KDH} + P_E D$	$TC_{Eqd} = \frac{KD}{Q} + \frac{QH}{2} + (P^O{}_E - \pi_E Q)D$ (For Q $\leq Q_{max}$)
Total JIT Cost	$TC_J = P_J$ D	$TC_J = P_J$ D
Cost difference	Z=$TC_E - TC_J$	Z_{qd}=$TC_{Eqd} - TC_J$
Annual Demand Indifference	$\boldsymbol{D_I} = \frac{\mathbf{2K\ H}}{(\boldsymbol{P_J} - \boldsymbol{P_E})^{\mathbf{2}}}$	$D_I = \frac{2K\ H}{(P_J - P^O{}_E)^2 + 4K\pi_E}$

Other functions used	
Maximum JIT Price	$P_{JMax} = \sqrt{\frac{2KH}{D}} + P_E$
Total cost for quantity discount EOQ model where the order quantity discount is fixed	$TC_{Eqd} = \frac{KD}{Q} + \frac{QH}{2} + (P^{min}{}_E)D$ (Q> Q_{max})
Schniederjans and Qing model	
Revised Total annual purchasing cost under a JIT ordering system	TC_{JR}=$P_J\,D - CN$
Cost difference for Revised Quantity discount	Z_{qdR}=$TC_E - TC_{JR}$

Abbreviations	***Meaning***
D	Annual demand
K	Ordering cost
H	Annual carrying cost per unit
Q	Order quantity
π_E	Constant representing rate at which the price of the item decreases with increase in order quantity
TC_E	Total annual cost at an optimal EOQ Order Quantity
TC_{Eqd}	Total annual cost Using a Quantity discount Under EOQ Order Quantity System
TC_J	Total annual purchasing cost under a JIT Ordering system
TC_{JR}	Revised Total annual purchasing cost under a JIT ordering system Schniederjans and Qing model
P_E	Purchase cost Per Unit Under EOQ Order Quantity System
P_J	Product Unit Price under a JIT Ordering system
$P^O{}_E$	Initial purchase cost per Unit with no Quantity discount Under EOQ Order Quantity System
$P^{min}{}_E$	Fixed purchase cost per unit when order Quantity exceeds a certain minimum level ofQ_{max}
Q_{max}	Maximum quantity that can be purchased& still receive a Quantity discount whose rate is π_E
Z	Total cost difference between the EOQ and JIT systems
Z_{qd}	Total cost difference between the Quantity discount EOQ and JIT systems
Z_{qdR}	Revised Total cost difference between the Quantity discount EOQ and JIT systems
D_I	Annual demand level where the costs for both systems are equal
C	Annual cost own and Maintain a square foot of facility
N	Number of Square feet saved initially by adopting a JIT system.

IV. Data Analysis

Fazel Model Illustration

Demand	K (Ordering Cost)	H (Carrying Cost per unit)	JIT PRICE	EOQ PRICE1	EOQ PRICE2
10000	150	50	24.6	24.35	24
20000	150	50	24.6	24.35	24
30000	150	50	24.6	24.35	24
40000	150	50	24.6	24.35	24
50000	150	50	24.6	24.35	24
60000	150	50	24.6	24.35	24
70000	150	50	24.6	24.35	24
80000	150	50	24.6	24.35	24
90000	150	50	24.6	24.35	24
100000	150	50	24.6	24.35	24
41666.67	150	50	24.6	24.35	24
240000	150	50	24.6	24.35	24

Demand	Maximum JIT Price	Q	Total JIT cost	EOQ Total cost with P1	EOQ Total cost with P1	Cost difference With P1	Cost difference With P2
10000	25.575	244.949	246000	255747.45	252247.45	9747.45	6247.45
20000	25.216	346.410	492000	504320.51	497320.51	12320.51	5320.51
30000	25.057	424.264	738000	751713.20	741213.20	13713.20	3213.20
40000	24.962	489.898	984000	998494.90	984494.90	14494.90	494.90
50000	24.898	547.723	1230000	1244886.13	1227386.13	14886.13	-2613.87
60000	24.850	600.000	1476000	1491000.00	1470000.00	15000.00	-6000.00
70000	24.813	648.074	1722000	1736903.70	1712403.70	14903.70	-9596.30
80000	24.783	692.820	1968000	1982641.02	1954641.02	14641.02	-13358.98
90000	24.758	734.847	2214000	2228242.35	2196742.35	14242.35	-17257.65
100000	24.737	774.597	2460000	2473729.83	2438729.83	13729.83	-21270.17
41666.6	24.950	500.000	1025000	1039583.33	1025000.00	14583.33	0.00
240000	24.600	1200.00	5904000	5904000.00	5820000.00	0.00	-84000.00

The actual annual demand where the 2 systems have equal cost values (D_I)is 240000 for EOQ Price 1 and 41666.67 For EOQ Price 2.The interpretation is that at Under this threshold a JIT ordering system is less costly and preferable and for and demand above this threshold an Economic Order Quantity (EOQ) ordering system is More preferable due to the cost benefits. The Maximum JIT price defines the maximum per unit price that an organization can pay for tm inventory item and still operate cost effectively under a JIT Ordering system, If the per Unit price for the given D (annual demand) falls below the JIT maximum price it would be advisable that the Organization follow JIT system to reduce the annual inventory cost and If the price rises above the JIT maximum price then the Organization should revert to an EOQ system to reduce total annual inventory cost.

Fazel, Fischer, and Gilbert Quantity discount EOQ model Ordering System with variable discounts Illustration

Initial purchase cost per unit under a Quantity discount EOQ Order system is $24 and the minimum price is $22.4.

Demand	K (Ordering Cost)	H (Carrying Cost per unit)	JIT Price	EOQ Price	Discount
10000	50	300	25.6	24	0.0001
20000	50	300	25.6	24	0.0001
30000	50	300	25.6	24	0.0001
40000	50	300	25.6	24	0.0001
50000	50	300	25.6	24	0.0001
60000	50	300	25.6	24	0.0001
70000	50	300	25.6	24	0.0001
80000	50	300	25.6	24	0.0001
90000	50	300	25.6	24	0.0001
100000	50	300	25.6	24	0.0001
11627.91	50	300	25.6	24	0.0001

Demand	Q	Annual Ordering Cost	Annual Holding Cost	Annual Purchasing Cost	Total JIT cost	EOQ Total cost	Cost difference
10000	57.928	8631.338	8689.267	239942.072	257262.677	256000	1262.677
20000	82.199	12165.525	12329.924	479835.601	504331.050	512000	-7668.950
30000	101.015	14849.242	15152.288	719696.954	749698.485	768000	-18301.515
40000	117.041	17088.007	17556.172	959531.835	994176.015	1024000	-29823.985
50000	131.306	19039.433	19695.965	1199343.468	1238078.866	1280000	-41921.134
60000	144.338	20784.610	21650.635	1439133.975	1481569.219	1536000	-54430.781
70000	156.447	22371.857	23466.983	1678904.874	1724743.715	1792000	-67256.285
80000	167.836	23832.751	25175.441	1918657.310	1967665.501	2048000	-80334.499
90000	178.647	25189.283	26797.110	2158392.173	2210378.567	2304000	-93621.433
100000	188.982	26457.513	28347.335	2398110.178	2452915.026	2560000	-107084.974
11627.91	62.5	9302.325	9375	278997.093	297674.418	297674.418	0

Initial purchase cost per unit under a Quantity discount EOQ Order system is $24 and the minimum price is $22.4, the difference of $1.6 at a rate of 0.0001 allows a range of 16000 units which will be the Q_{max}. The actual annual demand where the 2 systems have equal cost values $(D_I)$is 11627.91 units This value falls within 16000 unit range and does not violate the necessary condition where $(H - 2\pi_E D\,)$> 0 that is (300-2(0.0001)(11628)>0.The interpretation is that demand <(D_I)JIT system should be used to minimize costs and for demand >(D_I) the Quantity discount EOQ 0rdering system should be used.

<u>Schniederjans and Qing model</u>

This is a revision of the Fazel Fischer and Gilbert model which seeks to revise the JIT annual cost component to recognize the realistic advantage of physical Plant space reductions caused by a reduction in incoming work in progress, and Finished goods inventory. JIT can reduce 30% of plant up to 80% of the total space of an existing Plant. This model includes square reduction that attributable to JIT by adjusting the TCJ component to be reduced by the reduction created by reducing the plant size which is found by multiplying cost per square foot into the number of square feet saved by JIT ordering system. C is computed from Overhead cost (i.e. material handling cost, facility insurance, facility taxes etc.). N is best determined When a change from EOQ system is made to JIT system.

Demand	K (ordering cost)	H(Carrying Cost per unit)	JIT PRICE	EOQ PRICE	Discount	Cost Per Foot	JIT Reduced
10000	50	300	25.6	24	0.0001	100	125000
11000	50	300	25.6	24	0.0001	100	125000
12000	50	300	25.6	24	0.0001	100	125000
13000	50	300	25.6	24	0.0001	100	125000
14000	50	300	25.6	24	0.0001	100	125000
15000	50	300	25.6	24	0.0001	100	125000
16000	50	300	25.6	24	0.0001	100	125000
17000	50	300	25.6	24	0.0001	100	125000
18000	50	300	25.6	24	0.0001	100	125000
19000	50	300	25.6	24	0.0001	100	125000
20000	50	300	25.6	24	0.0001	100	125000

Demand	Q	$P_J D - CN$	Annual Ordering Cost	Annual Holding Cost	Annual Purchasing Cost	EOQ Total cost	Cost difference
10000	57.93	-12244000	8631.34	8689.27	239942.07	257262.68	12501262.68
11000	60.78	-12218400	9049.59	9116.44	263933.15	282099.17	12500499.17
12000	63.50	-12192800	9448.81	9525.01	287923.80	306897.62	12499697.62
13000	66.12	-12167200	9831.33	9917.28	311914.05	331662.65	12498862.65
14000	68.63	-12141600	10199.02	10295.11	335903.91	356398.04	12497998.04
15000	71.07	-12116000	10553.44	10660.04	359893.40	381106.87	12497106.87
16000	73.42	-12090400	10895.87	11013.35	383882.52	405791.74	12496191.74
17000	75.71	-12064800	11227.42	11356.12	407871.30	430454.84	12495254.84
18000	77.93	-12039200	11549.03	11689.30	431859.73	455098.05	12494298.05
19000	80.09	-12013600	11861.49	12013.67	455847.83	479722.98	12493322.98
20000	82.20	-11988000	12165.53	12329.92	479835.60	504331.05	12492331.05

The result can be seen that at every level of Demand the cost difference favors the Just in Time system. When the Cost Savings by JIT is considered in the total annual cost, JIT ordering system are clearly the cost efficient system to me because the cost difference between JIT and EOQ is so huge that computing the cost difference become close to redundant.

V. Findings

The models ***Fazel Model andFazel, Fischer, and Gilbert Quantity discount EOQ model Ordering System with variable discount***are helpful in finding thresholds under which each model is most cost effective The basic EOQ and Quantity distant model were both compared to the JIT ordering System. By including the reduced footage cost-advantage to the JIT side of the comparison model, a JIT System was found to be preferable to an EOQ system for any annual demand level. Each model has its own area of use JIT and EOQ Quantity discounts can be taken advantage of to reduce total inventory cost. In a condition where there is no square feet reduction under a JIT system, Fazel Model and Fazel, Fischer, and Gilbert Quantity discount EOQ model Ordering System withvariable discount model may be helpful in providing very helpful thresholds to determine the Feasibility of JIT.For that demand $less\ than\ (D_I)\ Demand\ Indifference\ level$ JIT system should be used to minimize costs and for demand $greater\ than\ (D_I)\ Demand\ Indifference\ level$ the Quantity discount EOQ ordering system should be used to be cost effective.

This comparison helps the Organization the advantage as well as disadvantages of both the systems. One limitation of the study is its deterministic nature of the values, which is the parameters of this model require fixed values. JIT is a dynamic and always charging environment. To deal with the uncertainties and variability of the JIT environment tools such as Simulations can be used.

VI. Conclusion

Though switching from EOQ model to The JIT seems to be efficient in removing problems and wastes, there are a lot of things to take into consideration.JIT purchasing of raw materials is one important technique of the JIT philosophy. However, JIT purchasing is not always more cost effective than the EOQ purchasing system. This paper helps in comparing costs associated with the different systems.By expanding the classical EOQ model, this study suggests that it is possible for an EOQ purchasing system to be more cost effective than a JIT purchasing system in the scenarios where demand is too low, or where demand is extremely large and the order costs cannot be economically split, or the out-of-stock costs associated with the JIT purchasing system is high.

Change can be very difficult but the long term gain with respect to productivity, Quality, increased profit margin, reduced cost, increased customer satisfaction is worth the short tom discomfort . Therefore the various systems have to be evaluated at different cost and demand conditions to identify whereJIT system has a cost advantage over Economic Order Quantity (EOQ) system and under what conditions the EOQ System provides an advantage over the JIT System taking into account risk and other Qualitative factors also into consideration.

References

[1] Schniederjans, M.J. and Cao, Q. (2000), ``A note on JIT purchasing vs. EOQ with a price discount: an expansion of inventory costs'', International Journal of Production Economics, Vol. 65, pp. 289-94.
[2] Schniederjans , M.J. and Cao, Q. (2001), "An alternative analysis of inventory costs of JIT and EOQ purchasing", International Journal of Physical Distribution & Logistics Management, Vol. 31 No. 2, pp. 109–123)
[3] Fazel, F. (1997), "A comparative analysis of inventory cost of JIT and EOQ", International Journal of Physical Distribution and Logistics Management, Vol. 27 No. 8)
[4] Schniederjans , M.J. and John R . Olson (1999) "Economic Justification and threshold for Just-In-Time implementation " Advanced Topics in Just-In-Time Management, pp. 13-32)
[5] Voss,C.A. (1990), international trends in manufacturing technology: JIT Manufacture, Springer-Verlag, UK.
[6] Wantuck, K.A. (1989) Just in Time for America, The Forum, Milwaukee, WI.