COMPARISON OF CO-MANAGED INVENTORY AND VENDOR-MANAGED INVENTORY FOR A DISTRIBUTION COMPANY

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ABSTRACT

Inventory is an important asset, whether it be in the form of raw material, work-in-process, finished goods, or supplies. Although inventory plays a significant role in keeping the business operating, it also represents one of the biggest operating costs for most companies.

Vendor-Managed Inventory (VMI) is a collaboration tool used by vendor and customer. It leads to the overall reduction of inventory level, as well as inventory cost, for an entire supply chain. Most of the time, VMI allows the customer to make an adjustment to the proposed order even though this adjustment might not be strictly necessary. The purpose of this research is to investigate the effect of order adjustment on inventory carrying cost.

Key findings on the positive contribution of no-order-adjustment are discussed. The savings, in terms of inventory carrying cost, are computed and compared between the two scenarios, VMI and Co-Managed Inventory. The final suggestion is that the company should consider operating VMI instead of Co-Managed Inventory in order to reduce inventory carrying cost.

บทคัดย่อ

สินค้าคงคลังเป็นสินทรัพย์ที่สำคัญและมีความจำเป็นอย่างมากในทุกบริษัทของทุกหน่วยธุรกิจ ซึ่ง สินค้าคงคลังนี้อาจอยู่ในรูปแบบที่แตกต่างกันไป ไม่ว่าจะเป็น วัตถุดิบ สินค้าระหว่างการผลิต สินค้า สำเร็จรูป หรือ วัสดุซ่อมบำรุง แม้ว่าสินค้าคงคลังเป็นสิ่งสำคัญที่มีผลต่อการดำเนินงานของทุกธุรกิจ อีกนัยหนึ่งคือธุรกิจไม่สามารถดำเนินการต่อไปได้ถ้าขาดสินค้าคงคลังดังกล่าว อย่างไรก็ดี สินค้าคงคลัง ถือเป็นค่าใช้จ่ายในการดำเนินงานที่สูงเป็นอันดับต้น ๆ ของบริษัทเกือบทุกบริษัท

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Vendor Managed Inventory (VMI) คือแนวคิดในการบริหารสินค้าคงคลังโดยให้ผู้จัดจำหน่ายเป็น
ผู้บริหารสินค้าคงคลังแทนลูกค้า ซึ่งเปรียบเสมือนเครื่องมือในการทำงานร่วมกันระหว่างผู้ปฏิบัติงาน
และแนวทางการปฏิบัติงานนี้ก็ได้รับความสนใจเป็นอย่างมากในปัจจุบัน หนึ่งในผลประโยชน์หลักที่
คาดว่าจะได้รับจากการนำแนวทางการปฏิบัติงานนี้มาใช้คือการลดปริมาณของสินค้าคงคลังที่ถือครอง
ทั้งหมดในห่วงโซ่อุปทาน ซึ่งมีผลโดยตรงต่อต้นทุนการถือครองสินค้าคงคลัง

ในทางปฏิบัติบริษัทลูกค้าสามารถทำการแก้ไขคำสั่งซื้อที่ผู้จัดจำหน่ายได้เสนอไปในคราวแรก (ทาง
ทฤษฎีแนวทางการปฏิบัติงานนี้ถูกเรียกว่า Co-Managed Inventory) ซึ่งการแก้ไขดังกล่าวอาจไม่มีความจำเป็น
และยิ่งไปกว่านั้นอาจก่อให้เกิดผลกระทบต่อค่าใช้จ่ายในการจัดเก็บสินค้าคงคลัง ดังนั้น วัตถุประสงค์
หลักของรายงานฉบับนี้ถูกทำขึ้นเพื่อทำการศึกษาผลกระทบของการแก้ไขคำสั่งซื้อต่อค่าใช้จ่ายในการ
จัดเก็บสินค้า

ในท้ายบทจะกล่าวถึงผลลัพธ์ของงานวิจัยเกี่ยวกับผลประโยชน์ของการยกเลิกการแก้ไขคำสั่งซื้อ ซึ่ง
ผลประโยชน์นี้อยู่ในรูปแบบของการลดค่าใช้จ่ายในการจัดเก็บสินค้า การเปรียบเทียบค่าใช้จ่ายที่เกิดขึ้น
ระหว่างสองสถานการณ์ คือ VMI และ Co-Managed Inventory จะเป็นตัวชี้วัดให้เห็นถึงต้นทุนที่ลดลง
และบทสรุปนี้จะถูกนำไปเสนอให้กับผู้บริหาร เพื่อเสนอให้มีการนำเอา VMI ไปใช้แทนที่วิธีการปฏิบัติ
งานเดิม (Co-Managed Inventory)

INTRODUCTION

Inventory is one of the important assets for most companies, but at the same time it also uses up a huge amount of a company's invested capital. Despite its costly expenditure, companies could not operate their businesses in the absence of inventory. Therefore, the core importance of inventory management is to identify the optimum level of having inventory on hand; not too much to over-utilize the capital investment and not too few to create lost sales. The Bullwhip effect creates inventory buildup and often occurs when there is a lack of coordination and information sharing between supply chain members. Collaboration in the supply chain is a core strategy that could control bullwhip and the overall supply chain cost. Vendor-Managed Inventory (VMI) is a collaboration tool used by many firms.

ABC Company is a distribution firm, the sole distributor for Supplier X, which is a big consumer goods manufacturer. ABC is a new company, but is the fourth biggest distributor in the northeastern area for Supplier X, which is a key trading region for Supplier X as it generates the highest regional sales revenue. Therefore, ABC has an important role in making the right products available when and where the customers want.

ABC is a distributor. Its supply chain members in direct contact consist of Supplier X, and its customers which are wholesalers and local retailers (mom and pop shops). ABC has 400 customers scattered within the trading region. The company holds around 200 SKUs to serve customer needs. The product categories are oral care and health care products, each with its own specific sales pattern. Therefore, Supplier X is in a better position to make a smoother sales forecast and inventory control as it knows its own products better. Thus, with the many SKUs, ABC has engaged in a VMI program with Supplier X to reap the benefits of lower inventory monitoring, lower ordering cost, higher product availability, and higher service level.

The VMI collaboration works in the following way:
1. ABC and Supplier X make a mutual agreement on the inventory level to be maintained. The agreement specifies that 20 days of inventory should always be kept.
2. ABC reports its current inventory level to Supplier X weekly, every Monday.
3. Every Monday, if the current inventory falls below 20 days, Supplier X replenishes it b y generating a proposal order which is sent to ABC for review. If ABC makes no order adjustment, it sends confirmation to Supplier X. If ABC wants to adjust the order, it sends a revised order to Supplier X. Either way, the process ends by Supplier X uploading the data and confirming the order in the system.
4. If on Monday the inventory is still more than 20 days, an order would not be issued, and thus, Supplier X would wait for the next order day to replenish.

The process is illustrated in the Figure below.

Figure 1: VMI Process Flowchart

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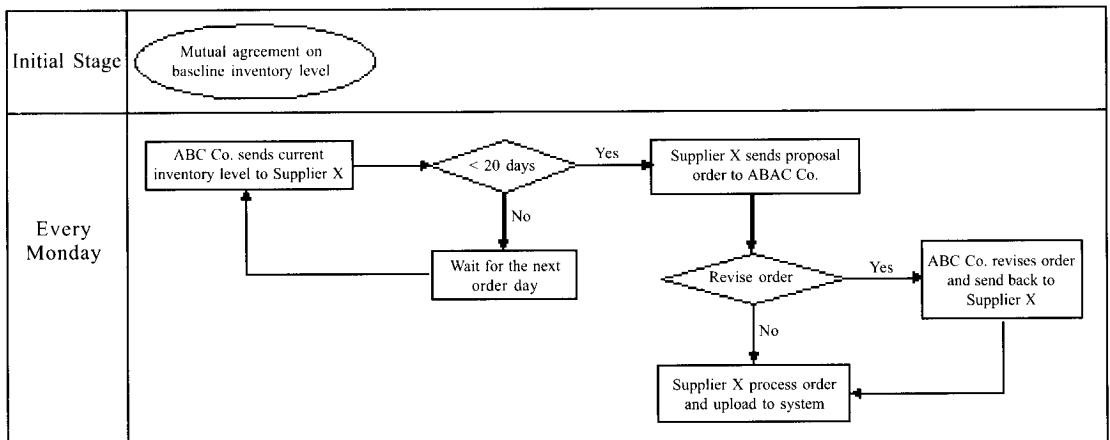
THE INVENTORY PROBLEM

Inventory cost, at 36% is the largest item in ABC's total operating cost, mainly due to the company's safety stock target (20 days of inventory). The second biggest cost, at 23%, is for transportation, but it is quite normal for a distributor to have such a high level because the firm has to support many small local shops (mom and pop shops) which normally have low demand volume per trip. Very often, the ordering pattern is unpredictable as these shops do not have a fixed order date, and place an order at the time they need the goods. Warehousing expenses, at 15% are not as significant as inventory and transportation costs as ABC owns its warehouse. This study will focus on inventory cost, for not only is it the largest operating expense but is getting larger every year because of inventory greater than demand warrants.

The gap between the real demand and average inventory in any given month is quite huge. The preliminary assumption of this gap is the insufficiency of care given to inventory management; which, therefore, leaves room for significant improvement, which would have a positive effect on the company's total inventory turnover and cash flow.

With the existence of competition, the company is now focusing on supply chain efficiency, to reduce the operating cost. The VMI program is one of the company's targets, by conducting this study to bring about cost reduction.

Currently, in the VMI program operated by ABC and Supplier X, ABC can adjust an order in addition to the original amount suggested by Supplier X. This is called 'Co-Managed Inventory' (the customer is allowed to edit the order, either up or down). Usually in VMI, a customer would completely follow the supplier's order supplier as the full responsibility of VMI would be shifted from customer to supplier.

In this case, ABC always increases the order above the original quantity proposed by Supplier X. The reason for this is that ABC lacks confidence in the forecasting ability of Supplier X (even though there is no prior study to prove such incapability). The purpose of the study; therefore, is to investigate the performance of this VMI program to see if an order suggested by Supplier X is good enough for ABC, and to identify whether or not there is a need for ABC to make order adjustments. This will be done through analyzing sales of a product by applying ABC inventory classification and variability coefficient, and by comparing inventory carrying costs between the two scenarios of: Co-Managed Inventory and Vendor-Managed Inventory, using Microsoft Excel and historical company data for 2010.

As product stock-out occurrence is less than 1%, the assumption is made that there is no product stock-out. Also, ordering cost will not be considered because EDI is in place and is a fixed monthly expense. Other ordering cost, such as transportation are not included The focus is only on the measurement of carrying cost, assuming other costs to be constant between the

two scenarios. ABC does not allow full exposure of the data; for example, the actual name of the category or item, and these will be referred to by number.

In the research to find a solution to the problem, the data collection method involves the collation of the company's secondary data, and informal conversations with the company staff to gain knowledge of some general working processes.

Variability Coefficient (VC) is a tool to determine the variability of demand patterns, and can be computed by a formula. After identifying the VC values, the pilot study selected Item A1 and Item A2. The logic for this selection is to allow the author to make a comparative study of products with different sales patterns in order to determine whether or not Vendor-Managed Inventory is applicable to both high and low sales variability products.

REVIEW OF RELATED LITERATURE

Inventory
Tersine (1994) stated that inventory exists in an entire supply chain because of the mismatch in supply and demand and a perfect synchronization between them is almost impossible. Inventory is spread across the chain in the form of raw material, work in process (WIP), finished goods, or maintenance, and repair & operating (MRO) supplies. Inventory is a major cost in the supply chain, and has a massive impact on responsiveness.

The level of inventory is important to customer service by having readily available products. When customer expectation is met, not only could the company maintain its sales, but could also increase them. Inventory cost can be optimized by exploiting economies of scale (Ballou, 2004).

According to Wisner et al. (2008), inventory can be classified broadly into four categories - raw materials; work-in-process; finished goods; and maintenance, repair, and operating (MRO) supplies. Ballou (2004) categorizes inventories into five distinct forms based on the utility or purpose of inventory: pipeline, speculative, working or cycle, safety or buffer, and shrinkage, obsolete or dead stock

There are three classes of inventory cost that have an impact on the company inventory policy as these costs are in conflict or in trade off with each other. These are procurement cost, carrying costs, and out-of-stock cost (Ballou, 2004).

Bullwhip Effect
The bullwhip effect is a phenomenon that can normally be found in forecast-driven distribution channels. Orders to the supplier tend to have bigger fluctuations than actual sales. This is

caused by demand uncertainty and/or interrupted information flows among supply chain partners: the more uncertain and variable the demand, the more amplification there is on the effect of inventory buildup, especially on the upper stream of the chain (Lee et al., 1997a, b). The bullwhip effect generally results in excess inventory, increased costs, and longer lead times for an entire supply chain.

In the traditional supply chain where coordination among supply chain members is low, uncertainty and variability exist and are intensified when moving up the chain (away from the customers). In this relationship, each member is responsible for his/her own inventory control, own production orders, or own delivery orders. Each echelon concentrates only on the information of its immediate customer, and thus, disregards the information of the end customer (Disney & Towill, 2003). This lack of visibility of the real demand leads to a double-guessing culture which leads to a bullwhip effect, as shown below.

Figure 2: Sequential Structure of a 'Traditional' Supply Chain Generating the Bullwhip Effect (demand amplification) in the Clothing Sector
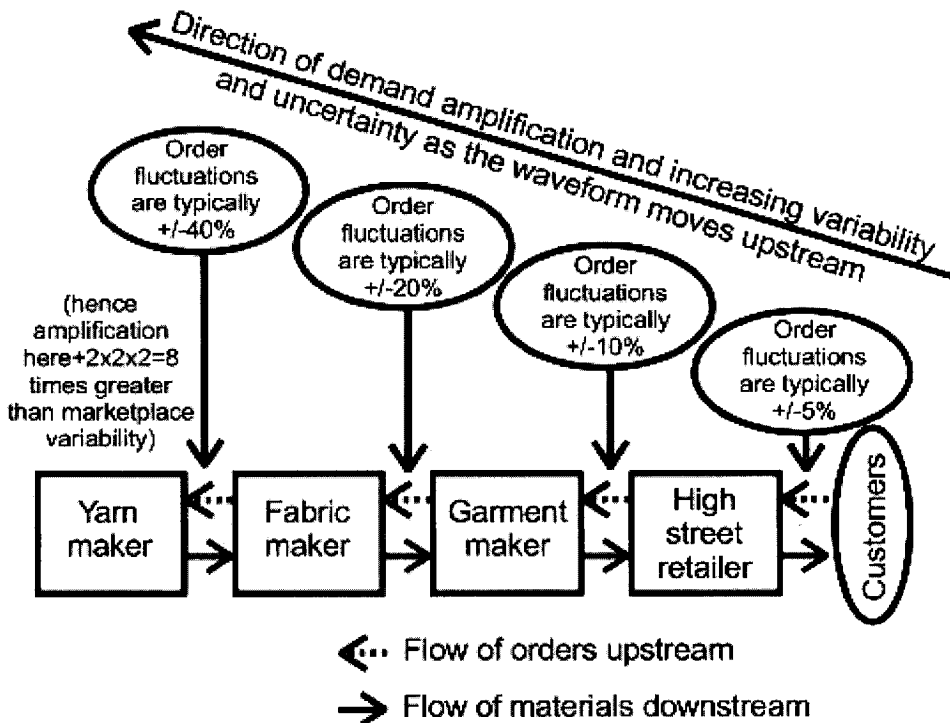
Source: Towill & McCullen (1999)

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Lee et al. (1997a, b) said that there are five fundamental causes of bullwhip: non-zero lead times, demand signal processing, price variations, rationing and gaming, and order batching.

Figure 3: Major Causes of the Bullwhip Effect
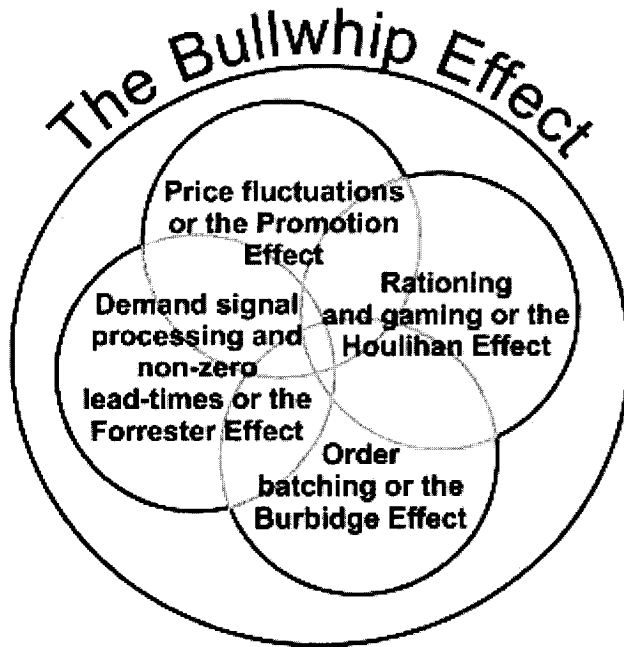
Source: Disney & Towill (2000)

Vendor Managed Inventory (VMI)

Vendor Managed Inventory (VMI), also known as continuous replenishment or supplier managed inventory, encourages collaboration and information sharing among trading partners in the chain (Augulo et al., 2004). The basic principle of VMI is that the vendor (supplier), is acting on behalf of its customer for inventory management (Kuk, 2004). With the shift of responsibility for inventory management from customer to supplier, better forecasting and more efficient product flow could be realized, as suppliers have more specific knowledge and are usually responsible for a more limited range of products. Inventory and logistics costs of an entire supply chain would be reduced when suppliers are responsible for replenishment (Blatherwick, 1998). The essence of VMI falls on the sharing of information, which should be of good quality (accurate and up to date information). The role of the customer changes from inventory management to information provider;

The general benefits of VMI consist of cost reduction, improvement in service offerings, reduced lead time, increased inventory turns, reduced stock out, better control of bullwhip effect, reduction of uncertainty, and greater transparency in the supply chain (Angulo et al., 2004). The complementary advantages are shown below.

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Figure 4: Main Advantages of VMI

Supplier benefits	Customer benefits	Shared benefits
Bullwhip effect reduction	Stock-out reduction	Reduction of data entry errors
Lower reliance to forecast	Financial costs reduction	Improved speed of the process
Reduction of order modifications	Purchasing process simplification	Stock level reduction
Production planning simplification	Increase of sales	Improved service level

Source: Angulo et al. (2004); Dong, Xu, & Dresner (2007)

Information flow is crucial to VMI. Pohlen and Goldsby (2003) stated that information sharing is the core of the VMI process; and hence, the information must be highly accurate and readily available in a timely manner. Fawcett, Osterhaus, Magnan, Brau, and McCarter (2007) mentioned that the two distinct dimensions of information sharing, connectivity and willingness, have a profound impact on supply chain performance. However, most companies emphasize the importance of connectivity alone, often neglecting the willingness dimension.

Figure 5: Connectivity-Willingness Matrix

High	**II -** While closer relationship exists, partner resist open information sharing for fear of opportunistic behavior. - Technology links are in place to enhance coordination, but the information shared is incomplete or insuffcient to support collaboration. - Order and inventory information is shared; however, partners hold closely more sensitive information including new product development plans, technology roadmaps, and market entry objectives. - Opportunities for high levels of unique collaboration are overlooked.	**IV -** Relationship is strategic, built on high level of trust and shared information. - Technology integration has been a high priority in the relationship, enabling high levels of connectivity. - Allrelevant decision making information is shared on a frequent and timely basis. Informaiton is accurate, homest, and open. - Opportunities for high levels of unique collaboration are identified and leveraged via a strong information-sharing capability.
Connectivity		
Low	**I -** Relationship is aim's length, lacks trust, and share's information reactively. - Insufficient resources are available or dedicated to information technology - History of opportunistic behavior limits the willingress to share more information that is necessary. - Minimal information is shared, leading to missed opportunities to imporve efficiencies and collaboration	**III -** Strategic relationship is desired, trust has been established, but information sharing does not yet support relationship goals. - Insufficient resources are available to create adequate technology linkages. - An effort is made to share information; however, information is often processed and communicated slowly and may be inaccurate. Decision makers may have difficulty making sense of the shared information. - Opportunities for high levels of unique collaboration are not readily identifiable and are not fully supported by the needed information.

Low   *High*

Willingress

Source: Fawcett et al. (2007)

Collaborative Planning, Forecasting, and Replenishment (CPFR)

Collaborative Planning, Forecasting, and Replenishment or CPFR, is a Web-based tool to coordinate the various supply chain activities including production and purchase planning, demand forecasting and inventory replenishment between supply chain trading partners (Fliedner, 2003). CPFR can be segmented into three main stages. The first stage involves planning, then follows forecasting, and finally ends with replenishing. The early exchange of information and visibility between trading partners allows for a more reliable and longer term relationship between coordinated parties, and benefits for all.

As CPFR is a new collaborating initiative, this definitely requires changes of the current working process, to deal with resistance and skepticism to the transformation. Some obstacles to the implementation are noted below (Fliedner, 2003):
-   Lack of trust in sharing sensitive information between business partners
-   Lack of internal forecast collaboration, as different working units or departments work to their own figures and often have a distinct forecast unit (i.e. by SKU, product class, vendor, and customer location, etc.)
-   Availability and cost of implementing new technology
-   Lack of technical expertise
-   Fragmented information sharing standards
-   Fear of collusion or conspiring

Among the various problematic issues in CPFR implementation, trust is the biggest fundamental hurdle hindering collaboration among each of the chain members. Sharing sensitive information often creates fear of taking advantage of one another. Willingness, openness and commitment to invest in a long term relationship would then be achieved if and only if trust could be grounded among supply chain partners.

Summary

Co-Managed Inventory, VMI, and CPFR are partnering initiatives and collaboration tools that involve continuous information sharing and many coordinating activities between supply chain members. These could provide many benefits to the participating parties such as stockout reduction, increase of sales, and improved service level.

Collaboration level is at its highest extent in CPFR, and lowest in Co-Managed Inventory. In the latter, duplication of order monitoring and inventory replenishment still exist; therefore, the full benefits of this collaborating initiative could not be greatly achieved. All those problems, such as order modifications, delayed replenishment process, data entry errors, or disrupted production plan, would still exist.

However, in the next level of collaboration, VMI, all these stated problems could be drastically reduced, but the problem of the bullwhip effect could still persist. The reason is that in

VMI, only inventory level and sales data (daily, weekly or monthly) are shared; no forecasting figures are made visible to the supplier. The highest degree of collaboration is the CPFR; in this initiative, both customer and supplier set mutually agreed plans, share the forecast, and fine tune until a consensus agreement is reached, and finally determine the replenishment once the forecast figure is derived. Thus, this level of collaborating initiative would definitely bring the highest benefits of all three, but this, in turn, requires the highest level of trust, commitment, and willingness to invest in a long term relationship by each supply chain member.

PRESENTATION OF RESULTS

Inventory Carrying Cost per Unit

The physical holding cost per one unit case for Items A1 and A2 could be determined, after identifying the total warehouse operating expenses incurred in year 2010 and total unit case of inventory stored in warehouse in the same time period. Opportunity cost per unit case in year 2010 for Items A1 and A2 is 95.84 and 101.84 Baht, respectively. Finally, in this step, inventory carrying cost per one unit case could be computed as it is the summation of physical holding cost and opportunity cost incurred.

Table 4.4 summarizes the holding cost and opportunity cost per case, which in turn, make up the carrying cost per case of the two items in 2010.

Figure 6: Carrying Cost per Case of Items A1 and A2 in 2010

|	Physical Holding Cost (Baht/case/year)	Opportunity Cost (Baht/case/year)	Carrying Cost (Baht/case/year)
Item A1	18.58	95.84	114.42
Item A2	18.58	101.84	120.42

Source: Computed Using Company's Data

Inventory Movement in Microsoft Excel
Inventory movement, in and out balance as well as the on-order amount and stored quantity of inventory, for ABC is simulated in MS Excel. The simulation contains the detail of inventory balance on a daily basis for the 2010 full calendar year.

The graph in figure 4.1 shows the comparison of inventory holding amount (in unit case) of Item A1 and A2 under both condition of Co-Managed Inventory and Vendor-Managed Inventory.

Figure 7: Comparison of Inventory Holding in 2010
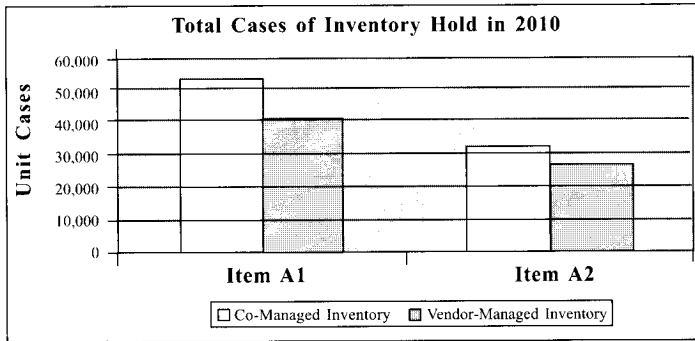
Source: Constructed from Company's Data

Calculation of the Total Inventory Carrying Cost

Inventory carrying cost is the cost the company incurred for inventory on hand, and is directly affected by the amount of inventory stored. The greater the amount of inventory stored, the higher the inventory carrying cost, and vice versa.

Figure 7 shows the total annual inventory carrying cost for ABC incurred in 2010 for Item A1 and A2 under Co-Managed Inventory, and Figure 8 shows the details of cost incurred under Vendor-Managed Inventory.

Figure 8: Total Annual Inventory Carrying Cost in 2010 of Co- Managed Inventory

	Total Unit of Inventory Hold in 2010 (Cases)	Inventory Carrying Cost per Case per Day (Baht)	Total Inventory Carrying Cost in 2010 (Baht)
Item A1	53,055	0.3135	16,632.74
Item A2	32,597	0.3299	10,753.75

**Source:** Computed Using Company's Data

Figure 9: Total Annual Inventory Carrying Cost in 2010 of Vendor-Managed Inventory

	Total Unit of Inventory Hold in 2010 (Cases)	Inventory Carrying Cost per Case per Day (Baht)	Total Inventory Carrying Cost in 2010 (Baht)
Item A1	41,093	0.3135	12,882.66
Item A2	26,051	0.3299	8,594.22

Source: Computed Using Company's Data

Costs for the two methods are displayed in the following Figure 9 bar chart.

Figure 10: Comparison of Total Inventory Carrying Cost between Co-Managed Inventory and Vendor-Managed Inventory in 2010

Total Inventory Carrying Cost in 2010
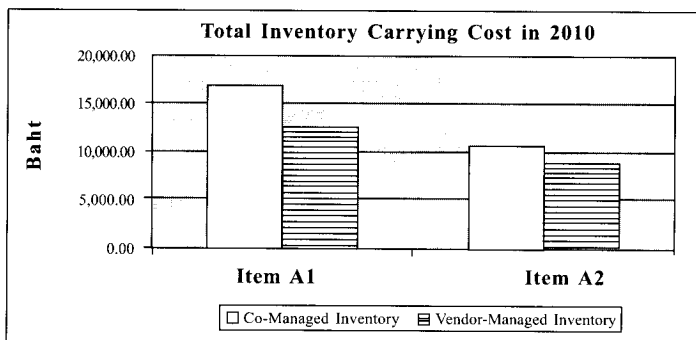
Source: Constructed by Company's Data

Summary

According to the Excel Simulation (which is based on the real historical data in 2010), ABC could realize savings of 3,750.08 Baht for Item A1 and 2,159.53 Baht for Item A2 from the VMI initiative, which is equivalent to reductions of 22.55% and 20.08% respectively from the original cost incurred in Co-Managed Inventory for the two items. Figure 10 summarizes the total inventory carrying cost incurred in each collaborating initiative, the savings earned, in Baht and percentage, realized from VMI implementation for Items A1 and A2.

Figure 11: Savings from VMI Adoption for 2010

	Total Inventory Carrying Cost			
	Co-Managed Inventory (Baht)	Vendor-Managed Inventory (Baht)	Savings (Baht)	Percentage Saving
Item A1	16,632.74	12,882.66	3,750.08	22.55%
Item A2	10,753.75	8,594.22	2,159.53	20.08%
Item A1 & A2	27,386.49	21,476.88	5,909.61	21.58%

Source: Computed Using Company's Data

So totally, for both selected trial SKUs, Item A1 and A2, ABC could realize savings of 5,909.61 Baht annually. This is a 21.6% decrease in total inventory carrying cost for 2010.

Inventory management under the VMI initiative has a better performance than Co-Managed Inventory. Lower inventory level is maintained while the demand of end customers could still met. Therefore, VMI provides a superior performance and bears a lower inventory carrying cost for ABC company.

The inventory movement for Co-Managed Inventory and Vendor-Managed Inventory operated by this distribution company to serve wholesalers and local retailers, accounts for quite a high level of safety stock even under the VMI initiative. This study shows the results of VMI

carried out by a distributor, not for a retailer, which primarily accounts for the high stock level instead of having stock close to zero.

CONCLUSION

From the Excel simulation of inventory movement for Item A1 and A2 product, the order amount originally proposed by Supplier X to ABC was already at an adequate level to serve *the existing demand of end customers.*

However, for Item A1 (high variability product), sales are at peak in May and November, and the sales each day fluctuate, making safety stock decline to as low as 5 cases in May and 8 cases in November, which risk a high chance of ABC facing a stock-out situation and eventually incur lost sales. On the other hand, Supplier X could perform better for Item A2 (low variability product) as the demand of end customers is more stable and does not have a high fluctuation.

From the key findings of this study, the research question, "Will it be better for ABC in terms of inventory carrying cost to apply Vendor-Managed Inventory (no order adjustment)?", could then be answered with a certain degree of confidence that by leaving the full responsibility to the supplier to manage the inventory, ABC would gain a substantial cost saving on the total inventory carrying cost.

However, the supplier's performance in inventory replenishment would be more effective if ABC could share the demand forecast with its Supplier X, as the results from the simulation of Item A1 (which has a high swing in the sales pattern) shows that replenishment is not good enough and there is stillroom for improvement. Through the sharing of forecasting data, more accuracy in inventory replenishment could be achieved as well as the minimization of stock-out and lost sales.

Moreover, certain Key Performance Indicators (KPIs) such as delivery on-time and in full, stock cover days, etc. need to be set up and measured on a continuous (monthly) basis with the supplier, to be sure that the supplier is performing in line with the agreed level, as supplier performance is the key factor of any successful collaborating initiative.

However, implementation will not be easy. For ABC to delegate the full responsibility of inventory management and to implement a VMI initiative with its Supplier X, a high level of trust and confidence must be quickly established: this is a hidden issue that accounts for the order adjustment made by ABC in the current working process. Some hard evidence of high supplier performance should be produced, possibly by means of KPI evaluation, and the metrics that the company strongly emphasizes should be measured, such as delivery performance,

stock-out percentage, and product availability.

The higher the collaborating level, the greater level of trust, confidence, and commitment is strongly required, as the relationship is now becoming strategic (Fawcett et al., 2007). When the issue of trust is resolved, then and only then, ABC could fully engage in a VMI initiative with confidence; and therefore, would allow the supplier to take full responsibility for inventory management. ABC's role would then be only that of vendor management instead of also being responsible for inventory management.

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