Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management
Bali, Indonesia, January 7 – 9, 2014

Centralizing Slow-Moving Items in a Retail Network – A Case Study

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Abstract

The subject of the study is a Singapore-based third-party logistics provider (3PL) that manages a network of retail stores on behalf of a public sector client. The network currently stocks a large number of slow-moving items (SMI) at store-level, which leads to significant working capital tied-down on inventory. This paper studies into and quantifies the effectiveness of a proposed approach to centralize the retail network's inventory of slow-moving items to a pooling point. Results from the analysis show that under the base scenario with just 5% of items (by unit sales volume) stocked centrally, the aggregation of demand across retail outlets can contribute to a net 27.3% reduction in fulfillment costs. Furthermore, a selective centralization strategy can also be designed to be quite robust (i.e. costs would be close to optimum) within a broad range of SMI definitions.

Keywords
Slow-moving inventory, centralization, retail logistics

1. Introduction

This paper is based on a study conducted on behalf of one of Singapore's largest logistics service providers. Besides the provision of warehousing and forwarding services, this 3PL also undertakes a contract to manage a network of 21 small retail outlets for a client in the public sector.

The business operating model of the retail outlets is unique when compared to regular commercial outlets. Under the terms of the contract, each individual retail outlet is required to stock and maintain hundreds of stock keeping units (SKUs) that are prescribed by the client. Unlike in a normal retail environment, retail outlets do not have the option of reducing the range of available merchandize, which mainly comprises apparel, footwear and accessories. Thus, items on sale consist of both fast-moving items (FMI) and slow-moving items (SMI), and the capital outlay on the items is funded solely by the operator (i.e. in this case the 3PL).

The 3PL does not impose any profit margins on the items carried by outlets, but only receives a monthly management fee for managing the outlets. The 3PL is contractually obligated to purchase goods on a non-consignment basis (45 days credit term) from the client's approved list of distributors. The 3PL is also in-charge of processing payments from end-customers and is then reimbursed by the client for the cost of the goods. The cost and selling prices of the items are predetermined by the client and its suppliers. Under the terms of sale established by the client and its suppliers, there is no volume discount or any other form of discount on the ordering quantity placed by the 3PL. Transportation costs are also built into the unit rate of goods, and therefore the 3PL currently incurs zero inbound transportation costs. Under such an operating model, Economic Order Quantity (EOQ) effects are minimal since ordering costs are negligible. Items that are unsold or obsolete cannot be returned or resold to any party. Instead, the 3PL has to dispose of the items and absorb the losses, which greatly depresses operating margins in a highly competitive industry.

To meet the client's performance targets, the 3PL is pressured to meet or exceed service levels on the availability of items, but this incurs inventory holding costs to the 3PL. Hence, when balancing the two trade-offs, store managers have a tendency to misallocate resources by either overstocking or under-stocking in their outlets. Overstocking will result in excessive inventories while under-stocking will result in stock-outs, both of which are undesirable.

This paper describes the proposed adoption of a selective retail inventory centralization policy and how it is different from the traditional concepts of centralization. Finally, a set of results from the analysis of the historical demand patterns is presented.

2. Literature Review

2.1. Selective Inventory Control Techniques

Not all inventories are likely to be of equal importance and an inventory manager should place different emphasis on different categories of items through the use of classification schemes.

Wintel & Patch (2003) observe that companies conventionally focus only on the management of FMI, due to their revenue generating ability, and ignore the potential savings from managing SMI effectively. Generally, most companies with SMI accounting for up to 15 to 20% of the total inventory level are holding well in excess of what is really needed. According to Wintel & Patch (2003), companies that address SMI can yield one-time returns of more than 200% and ongoing returns from reduced carrying charges of more than 25% per year.

Classification can be done via various selective inventory control techniques (Shah, 2009). These include ABC classification (in which items are classified based on the value of consumption) and FSN classification (in which items are classified based on volume of usage, i.e. fast, slow or non-moving).

An example of an application of FSN classification is that of Cummins India (as cited by Shah, 2009), which had classified their spares parts into 4 categories (FMI, moderate-moving items, SMI and non-moving items). By designing separate policies for each category of spare parts, Cummins was able to improve their service levels from 35% to 98% during the period from 1990 to 2000.

2.2. Risk Pooling via Inventory Centralization

The concept of inventory centralization is perhaps best stated by Liu et al (2012) as the consolidation of inventory held at various locations into one single location which permits the quick deployment (transshipment) of inventory to the site where it is required.

Bhatnagar & Teo (2009) described the benefits of risk pooling, which culminates in lower total inventory on-hand and ensures adequate supply to retailers, including for those with sudden surges in orders. Likewise, Frankel et al (2002) suggested that when slow-moving SKUs cannot be eradicated, retailers should pool these items into segmented SKUs so as to manage them separately from the less complex items to achieve cost minimization.

However, the benefits of inventory consolidation are not always evident. As pointed out by Chopra & Sodhi (2004), the benefit of pooling inventory is especially great if the product risk is high. They also suggested that when capacity is expensive, it should be pooled. Similarly, Shah (2009) adds that centralization is most effective when transportation cost is negligible and demand variability is high.

The results of pooling slow-moving inventory can be tremendous. For example, Reliance (a manufacturing company) used to maintain spares inventory worth Rs 3.48 billion (4% of the value of annual sales) in 1997. With a centralization initiative in place over the last decade, Reliance's spare inventory level is now much lower and moreover. Sales have increased 10-fold while spares inventory has increased only 3-fold. As such, Reliance's spares inventory has decreased to a mere 1% of annual sales value (Shah 2009).

The review of literature thus suggests that establishing an intermediate pooling point for SMI (as shown in Figure 1) could be an effective strategy to overcome the 3PL's current challenges with SMI. This pooling point would be in addition to (and not replace) the existing direct channel for FMI between distributors and retail outlets. End-customers' demand for SMI would be met via a dedicated delivery van that conducts multiple daily milk-runs to the individual retail outlets.

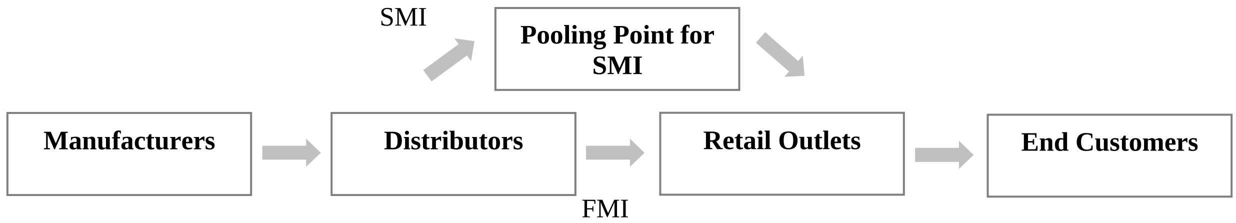


Figure 1: Proposed SMI pooling model

3. Identifying Slow-Moving Inventory and the Associated Costs

There are numerous operating parameters unique to each retail network, in particular the demand pattern and variability, which will determine the viability of centralizing SMI. In this study, a Pareto analysis is first conducted to identify the slowing-moving SKUs that will be the best candidates to be centralized. The cost of holding inventory and the inventory policy are also discussed briefly.

3.1. Pareto Analysis

The primary source data is the Point-of-Sales (POS) system used by the retail chain. The relevant information extracted from the POS system are:

- Individual retail outlet’s monthly Stock Balance Report for the Year 2012; and
- Individual retail outlet’s weekly Sales Volume Report for the Year 2012.

The initial set of data consists of over 2,000 SKUs, which are filtered down to 403 SKUs after critical and obsolete items are eliminated from consideration.

The average monthly unit sales volumes differ greatly among these 403 line items, though total demand is generally stable over time. Unit sales can be as high as 4,594 per month for the most popular item and as low as 1.5 per month for the least popular item. 84% of unit sales volume in 2012 was accounted for by 20% of the 403 SKUs.

Using sales history data from 2012, the Pareto chart is plotted in Figure 2.

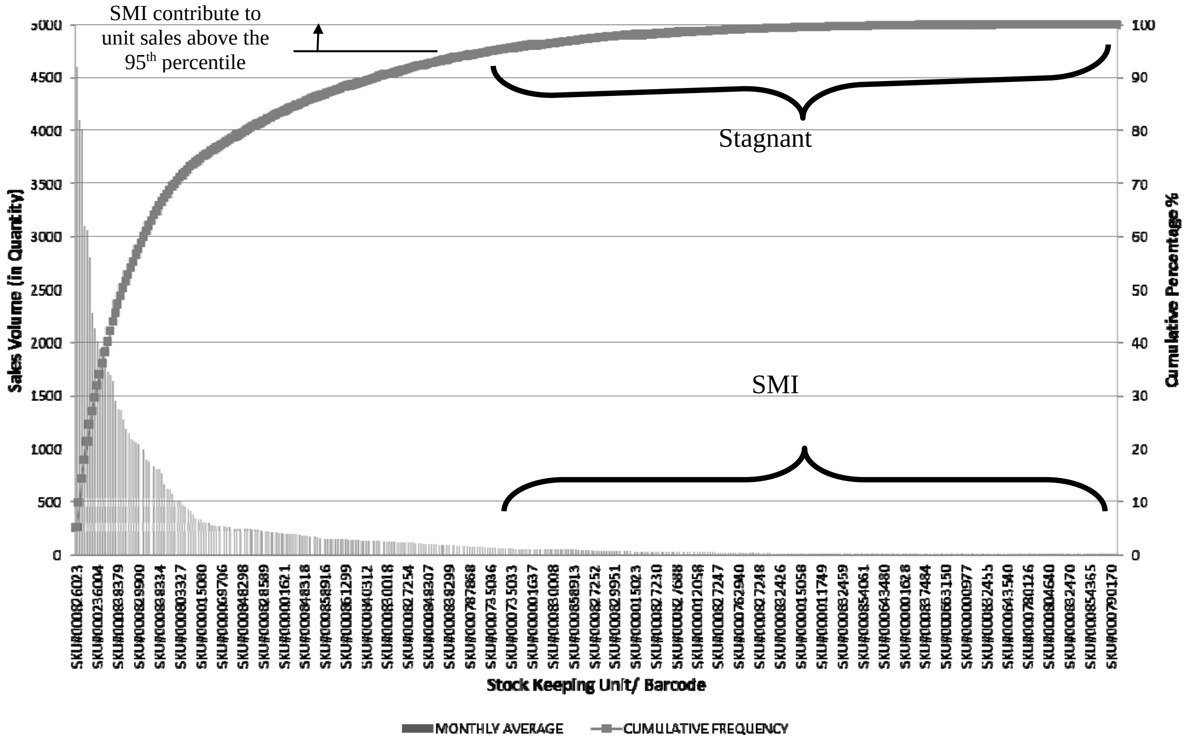


Figure 2: Classifying SMI using Pareto chart

In this stratification analysis, the top 20 SKUs account for 52% for total unit sales, while the bottom 241 SKUs contribute only 5%. Within these slowest-moving 241 SKUs, the highest and lowest sales volume per month are 68.7 units and 1.5 units respectively.

When viewed in perspective against the rest of the SKUs, these slowest-moving SKUs appear to be almost stagnant (or hardly moving). They thus form the focus for this study, as candidates which can be stocked centrally. The SKUs that account for the remaining 95% of sales volume would remain decentralized at the individual retail outlets.

Figure 3 shows the distribution of the SKUs according to the speed that they move. It should be noted that the definition of SMI is subjective and need not be always fixed at the slowest-moving 5% of items.

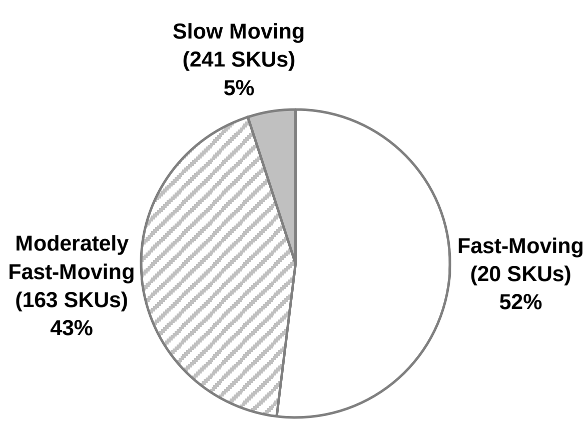


Figure 3: Stratification of SKUs by unit sales volume

3.2. Inventory Holding Cost

The cost of holding inventory is a juxtaposition of several cost components and can vary widely across companies and industries.

In the context of this study, inventory holding cost (IHC) comprises 6 main components:

- Retail outlets' rental fees: For areas of outlets used for on-site inventory storage
- Overhead costs: Incurred for administration and planning-related work
- Losses: Based on historical records on the amounts written-off for obsolescence, pilferage and damage
- Opportunity costs: The 3PL's Weighted Average Cost of Capital (WACC) which is 8% per annum
- Transportation costs: Incurred during transshipment (transfer of stock) between retail outlets
- Insurance costs: To insure the goods at retail outlets against theft, fire and other risks

Average inventory value (AIV) is derived from the monthly inventory reports generated over the course of the year in 2012.

Table 1 summarizes the components of inventory holding cost as a percentage of inventory value.

Table 1: Inventory holding cost as % of inventory value

Component	Amount/ Value
Rental Fees (a)	\$50,400
Overhead Costs (b)	\$125,760
Losses (c)	\$40,000
Opportunity Cost of Capital (d)	\$149,956
Transportation Costs (e)	\$22,800
Insurance Costs (f)	\$93,723
IHC (g) = (a+b+c+d+e+f)	\$482,639
Average Inventory Value (AIV) (h)	\$1,874,455
IHC as % of Inventory Value (g/h*100%)	**25.75%**

3.3. Inventory Policy

The current retail network generally adopts a Periodic Review Policy (PRP), even though store managers have some leeway in tweaking the policy to adapt to demand trends and to meet their stores' performance metrics.

Under the PRP, the appropriate levels of safety stock and average inventory level for each SKU at every retail outlet are calculated (via a demand planning system) using equations (1) and (2) respectively.

$$\textit{Safety Stock} = Z \times STD \times \sqrt{r + L} \quad (1)$$

$$\textit{Average Inventory Level} = \frac{r \times AVG}{2} + Z \times STD \times \sqrt{r + L} \quad (2)$$

Where:

- Z is the safety factor (1.645 for a service level of 95%, such that probability of stock-out is 5%)
- STD is the standard deviation of weekly demand
- r is the length of the review period (2 weeks)
- L is the replenishment lead time from the supplier to any of the retail outlet or the pooling point (1 week)
- AVG is the average weekly demand

For this study, it is assumed that:

- The demand pattern (especially coefficient of variation) in subsequent years would deviate negligibly compared to that in the year 2012, even as sales volumes increase. For example, this would mean that the range of apparel that would be considered as uncommon-sized (and therefore slowing-moving) remains reasonably consistent over time.
- Back-orders would not be lost if they can be fulfilled within the same day. This is partly due to the captive nature of the customers who will face similar (if not greater) difficulties in getting the required slow-moving items from the open market outside of the retail chain.

4. Results and Analysis

4.1. Required Inventory Levels under Decentralized versus Selectively-Centralized Systems

To assess the viability of selectively maintaining SMI at a pooling point, versus the existing decentralized system, a detailed cost comparison is conducted.

Variability in customer demand, as measured by standard deviation (STD) or coefficient of variation (COV), is expected to be lower when demand is aggregated across multiple retail outlets. This in turn reduces the amount of safety stock required, average inventory level and inventory holding costs.

A random SKU is selected from the total of 241 SKUs for the purpose of discussion. Table 2 shows the average weekly demand at individual retail outlets for the sample SKU (SKU#000848304) with a unit cost of $38. This SKU is a slow-moving pair of footwear (of an uncommon size) that is carried by all retail outlets.

The summed weekly STD, safety stock, average inventory level, AIV and IHC from all 21 retail outlets are shown in the second last row of Table 2. The corresponding aggregated figures (under a centralization strategy) are shown in the last row of the table.

Table 2: Cost comparison between decentralization and centralization for SKU#000848304

Retail Outlet	Average Weekly Demand	STD	COV	Safety Stock	Average Inventory Level	Average Inventory Value	Inventory Holding Cost
A	0.15	0.41	2.70	1.18	1.34	$50.76	$13.07
B	0.29	0.70	2.41	1.98	2.27	$86.30	$22.22
C	0.96	1.80	1.88	5.14	6.10	$231.92	$59.72
D	0.15	0.46	2.99	1.31	1.46	$55.62	$14.32
E	1.19	1.40	1.17	3.99	5.18	$197.06	$50.74
F	1.35	2.31	1.71	6.58	7.92	$301.21	$77.56
G	1.00	1.30	1.30	3.70	4.70	$178.67	$46.00
H	0.17	0.43	2.49	1.23	1.40	$53.19	$13.69
I	0.13	0.40	2.95	1.13	1.27	$48.17	$12.40
J	0.40	0.75	1.85	2.13	2.53	$96.35	$24.81
K	0.81	1.03	1.27	2.93	3.74	$142.24	$36.62
L	0.04	0.19	5.05	0.55	0.59	$22.49	$5.79
M	0.92	1.23	1.34	3.52	4.44	$168.78	$43.46
N	0.44	0.75	1.70	2.14	2.58	$98.25	$25.30
O	0.25	0.52	2.08	1.48	1.73	$65.74	$16.93
P	1.08	1.28	1.19	3.65	4.73	$179.69	$46.27

Q	0.15	0.41	2.70	1.18	1.34	$50.76	$13.07
R	0.62	1.05	1.71	2.99	3.61	$137.21	$35.33
S	0.13	0.44	3.30	1.27	1.40	$53.22	$13.70
T	0.25	0.52	2.08	1.48	1.73	$65.74	$16.93
U	1.79	2.21	1.23	6.29	8.08	$307.17	$79.09
Sum	**12.29**	**19.60**	**-**	**55.85**	**68.14**	**$2,590.54**	**$667.02**
Aggregated	**12.29**	**7.78**	**0.63**	**22.16**	**34.45**	**$1,309.82**	**$337.26**

From Table 2, it can be seen that the standard deviation of aggregated weekly demand (7.78) is 60% lower than the standard deviation of 19.60 summed across all the 21 retail outlets.

This illustrates the rationale behind centralization, which is that the decrease in standard deviation when demand is aggregated will ultimately lead to a decrease in safety stock levels, average inventory levels and thus the cost of holding inventory.

This same analysis is performed on all 241 slow-moving SKUs.

4.2. Net Cost Savings from Selective Centralization

Notwithstanding the significant benefits in inventory reduction, selective centralization of inventory incurs significant implementation costs that have to be deducted in order to derive the net cost savings. These implementation costs include the cost of rental for additional space at the pooling point, cost of additional transportation from pooling point to retail outlets and the cost of stock-picking. Such *additional* costs are currently calculated to be $0.10 per item, since many of the SMI are small low-weight items.

In this case, transportation costs (from pooling point to outlets) are low due to the availability of spare capacity in the existing ad-hoc transshipment arrangement between outlets. Such costs can increase very quickly if the centralization program is scaled up beyond the existing available capacity or if the cost of fuel rises.

In the base scenario with centralization of the slowest-moving 5% of items (i.e. 95% remain decentralized), the net cost saving from fulfillment amounts to $11,728 or a decrease of 27.3%, as shown in Table 3.

Table 3: Net cost savings from centralization

	Average Inventory Value	Inventory Holding Cost
Decentralized SMI	$166,875	$42,967
Centralized SMI	$92,752	$23,882
Savings from Inventory Holding	$74,123	$19,085
Implementation Costs for Centralization	---	$7,358
Net Cost Savings	**---**	**$11,728**

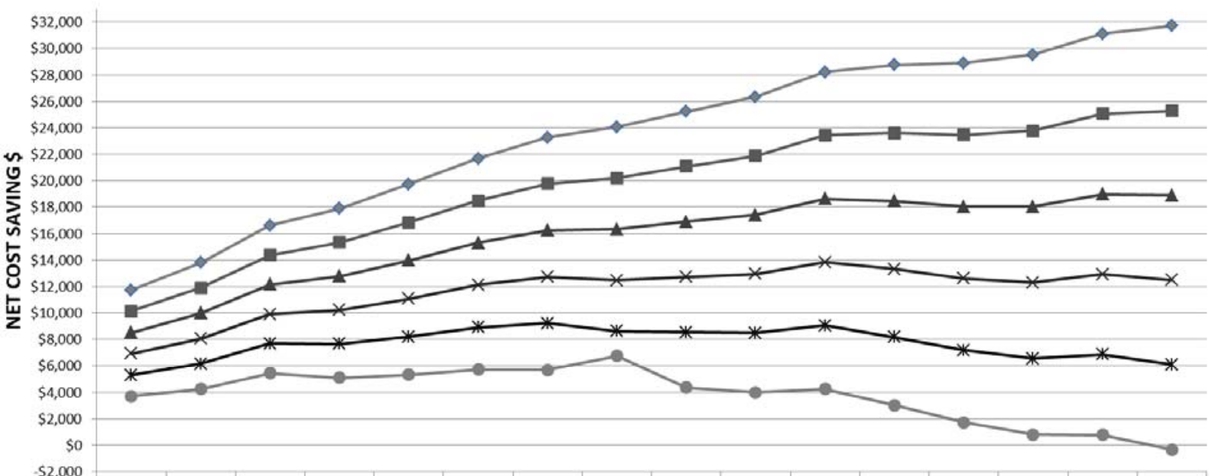
4.3. Sensitivity Analysis

For any degree of centralization of SMI, when the costs of picking, rental of pooling point and delivery increase, the benefits of centralization will be diminished.

Intuitively, as the range of SMIs in the centralization program is expanded, net savings should also increase, but at a decreasing rate. However, at some point, net savings may even become negative, as the cost of scaling up the dispatch service (from the pooling point) rises.

Therefore, to support the above hypothesis and test the sensitivity of the net cost savings to these two variables (degree of centralization and cost of implementation), an analysis is carried out on multiple combinations of selective centralization (5% to 20% of unit sales volume) and unit costs of implementing centralization ($0.10 to $0.25 per item). The results are plotted in Figure 4.

In Figure 4, the labels in the x-axis represent the SKUs that are classified as SMI based on cumulative frequency on the Pareto chart. For instance, the label "SMI START @95%" means that SKUs contributing to 95% of sales volume (consisting of 162 SKUs) are classified as non-SMI and should remain decentralized. The remaining 5% of slowest-moving SKUs by sales volume (above the 95th percentile, consisting of 241 SKUs) are classified as SMI and will be pooled at a central location.



	SMI START @95%:	SMI START @94%:	SMI START @93%:	SMI START @92%:	SMI START @91%:	SMI START @90%:	SMI START @89%:	SMI START @88%:	SMI START @87%:	SMI START @86%:	SMI START @85%:	SMI START @84%:	SMI START @83%:	SMI START @82%:	SMI START @81%:	SMI START @80%:
$0.10	$11,728	$13,794	$16,614	$17,906	$19,730	$21,677	$23,274	$24,057	$25,241	$26,347	$28,220	$28,757	$28,909	$29,524	$31,112	$31,701
$0.13	$10,120	$11,885	$14,381	$15,345	$16,847	$18,486	$19,758	$20,196	$21,066	$21,877	$23,425	$23,610	$23,472	$23,781	$25,047	$25,296
$0.16	$8,513	$9,975	$12,147	$12,785	$13,963	$15,296	$16,242	$16,336	$16,891	$17,408	$18,630	$18,462	$18,035	$18,037	$18,981	$18,890
$0.19	$6,906	$8,065	$9,914	$10,224	$11,080	$12,106	$12,726	$12,475	$12,717	$12,938	$13,834	$13,314	$12,598	$12,294	$12,915	$12,485
$0.22	$5,298	$6,155	$7,680	$7,664	$8,197	$8,916	$9,210	$8,614	$8,542	$8,469	$9,039	$8,167	$7,161	$6,550	$6,850	$6,080
$0.25	$3,691	$4,246	$5,446	$5,103	$5,313	$5,725	$5,694	$6,753	$4,367	$4,000	$4,243	$3,019	$1,724	$807	$784	-$325

Figure 4: Sensitivity analysis on implementation costs and degree of centralization

When the implementation cost per item is $0.10 (top-most line) and when SMI is defined as 20% of slowest-moving SKUs by unit sales volume, the net cost saving achievable is $31,701. This amount is about $20,000 more than when the SMI to be centralized is taken to be the slowest-moving 5% of SKUs by unit sales volume.

An important insight from the sensitivity analysis is that the net costs savings tend to taper off as more SKUs are added to the mix of SMIs to be centralized. For instance, at an implementation unit cost of $0.16 and 15% level of centralization (i.e. items above the 85th percentile of unit sales), the increase in savings from centralizing an additional 4% of items is just $351 ($18,630 minus $18,981). In other words, there are minimal savings to be gained from centralizing more than 15% of items by sales volume (consisting of 316 SKUs) in this case.

Furthermore, when the unit cost of implementation is $0.25 and 20% of all unit sales volumes are stocked centrally, net cost savings become negative and the centralization strategy is non-viable.

5. Conclusion

A review of literature suggests that centralization of inventory is routinely done for spare parts and for finished goods prior to distribution to retailers. However, centralization of inventory from retail outlets is much less common (except in transshipment strategies which are more ad-hoc in nature). This paper fills some of the gaps in the literature when slow-moving inventory is systematically centralized from individual small retail outlets and dispatched on demand.

Results from the analysis of historical demand data over the past year show that under the base scenario with just the slowest-moving 5% of items stocked centrally, the aggregation of demand across retail outlets can contribute to a net 27.3% reduction in fulfillment costs. If products are of higher values, even greater savings can be expected and more working capital can be released from holding inventory. The selective centralization strategy can thus be very effective for retail networks which are located in compact cities with low transportation costs and/or are already conducting transshipment between outlets on an ad-hoc basis.

Furthermore, a sensitivity analysis conducted also suggests that generally up to 15% of items by unit sales volume can be centralized, beyond which incremental net benefits are minimal. The implication for supply chain managers is that a selective centralization strategy can be designed to be quite robust (i.e. costs would be close to optimum) within a broad range of SMI definitions, and hence a reclassification of FMI/SMI need only be performed infrequently.

The approach proposed in this paper serves as a benchmark for future research on optimizing slow-moving inventory in retail networks, but the results are based on the analysis of only one particular retail network. When the model is applied to more retail networks, a framework can theoretically be developed to establish guidelines on the extent that centralization can be feasible in achieving global optimization of fulfillment costs in retail chains.

Finally, the findings from the analysis provide retailers and their 3PLs with a view of the potential quantitative benefits that can be achieved when an inventory centralization policy is selectively introduced, therefore improving operating margins in a highly competitive industry.

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Biography

Shao Hung Goh is an Associate Lecturer in Logistics and Supply Chain Management at the Singapore Institute of Management (SIM) University. He holds an MS in Industrial Engineering from the Georgia Institute of Technology and MS & BE degrees from the National University of Singapore (NUS). Mr Goh’s research interests include supply chain integration and the continuous reinvention of the third-party logistics (3PL) business model. He has authored conference papers, given talks and conducted courses in various areas of supply chain management. He also recently contributed to a book chapter on how 3PLs can differentiate themselves from the competition by extending the range of value-added services offered to customers. Mr Goh has several years' industry experience at a leading 3PL and a major Singapore-based shipping line.

Boon Lian Lim is a graduate from the Singapore Institute of Management (SIM) University. He holds a Bachelor of Science degree in Logistics and Supply Chain Management and has several years of working experience in the logistic industry. He is currently an assistant manager with one of the largest 3PL organization in South East Asia. His scope of work includes managing a network of retail outlets and overseeing international inbound shipments. His areas of interest consist of warehousing, demand and supply planning of inventory and project management in the logistic field.