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Supply Chain Design and Postponement Opportunities

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Supply Chain Design and Postponement Opportunities

By Shishir Gupta
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Summary: This thesis analyzes the current scenario in terms of transportation lead times, demand and shipment patterns, and proposes kitting postponement opportunities, including cost benefit analysis for blood glucose monitoring meters as produced by a leading healthcare organization. This included creating a robust inventory model for the postponement center and for the central warehouse, development of transport mode shift analysis and cost impact tool, and creating postponement implementation tools.

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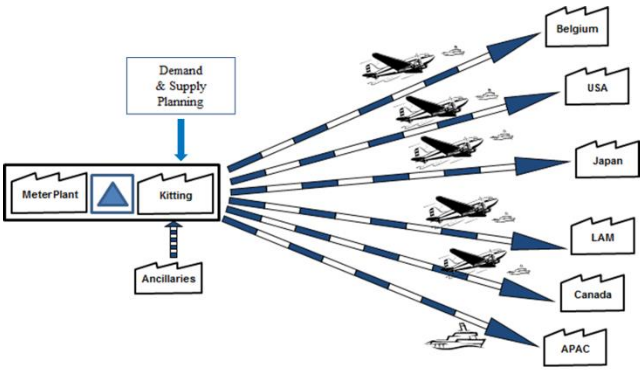
KEY INSIGHTS

1. Postponed kitting operations, if implemented correctly, can significantly reduce transportation costs for critical health diagnostics tools.
2. Increased inventory holding costs are the cost of agility achieved by implementing postponement strategies, when the organizations aim for higher service levels.
3. The importance of up-stream processes should be considered and taken into account, although the focus may only be on down-stream process.

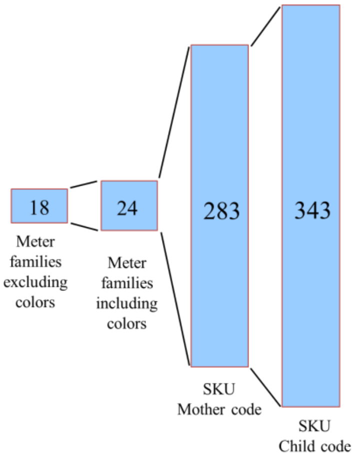
Introduction

A leading multinational pharmaceutical, medical devices and consumer packaged goods company produces glucose meters (intermediates) at an external supplier in China. In a second stage, these meters are configured (programming language) and combined with other components in a bigger variety of kits (finished goods) at the same location. After customization, the kits are shipped by a combination of ocean and airfreight to a regional warehouse from which they are delivered to the market. The product is made-to-stock. The figure below shows current state supply chain.



Current State Supply Chain.

Long lead-time, high Mean Absolute Percentage Error (MAPE) on finished goods, low responsiveness and the need to optimize transport cost inventory, led the organization to the decision to design a more agile supply chain. The meters (intermediates) would still be produced in China, but customized to kits (finished goods) in a regional postponement center close to the Regional Distribution Center.



Adjacent figure shows how the SKUs expand through the supply chain, from base meter to final product (meter kit) delivered to the customer, further strengthening the case for a postponement strategy

Expansion of SKUs from Base Meters to Final Kits.

The main research question we addressed in this thesis was whether postponement would impact the inventory and transportation costs. While maintaining a very high service level of 96%, we increased the utilization of boat transport mode at 80% and above, and reduced the use of air shipments. Overall framework consists of offsetting the increased inventory costs and the set-up cost of postponement center with the savings in the transportation costs. We undertook following activities to get to the answer of our question:

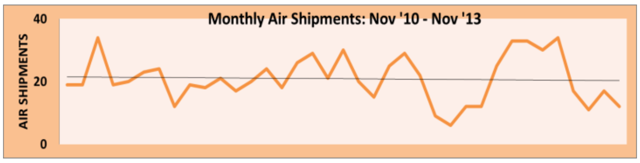
- Transportation analysis to understand air and boat shipment patterns and lead times.
- Demand and shipment analysis for Europe, Middle East and Africa (EMEA) region.
- Inventory model development for postponement center and for the main European warehouse.
- Transportation scenario development for cost-benefit analysis basis shifts in transportation mode (China to Postponement Center).
- Implementation of work schedules at the postponement center to convert base meters into finished kits.
- Understanding the pitfalls for implementing postponement strategy here, and how to avoid them for a successful outcome.

Air transportation analysis

768 shipments during the duration from Nov ‘10 to Nov ’13 were analyzed. These pertain to shipments of final products from China to the central warehouse in Europe. The lead-time value stream is shown in the figure below.

Air Shipment Lead Times.

The following figure illustrates the frequency of air shipments from China to the central warehouse in Europe. We can see that, on average, there is an air shipment on each working day over that last three years. This entails a very high transportation cost. A postponement strategy may enable to move shipments by boat, thus reducing the overall transportation costs.



Trend of Air Shipments by Month.

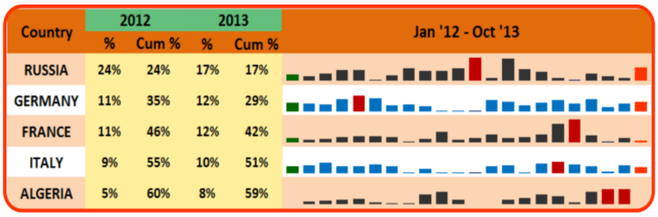
Boat transportation analysis

Recently, the company has started boat shipments from China to the central warehouse in Europe. 14 boat shipments were analyzed. Boat shipments are cheaper as compared to air shipments, though the total transit time is more at approximately 53 days, as compared to 5 days for air. A postponement strategy will enable more utilization of boat to ship base meters. This would be made possible as base meters will be kept at the postponement center, and will be converted to finalized kits basis demand from the central warehouse. Hence, assemble-to-order will enable more utilization of boat/ocean transportation.

Meter kits demand and shipment analysis

Demand and shipment data for 2012-13 across Europe, Middle East and Africa (EMEA) was extracted from the warehouse management system data-warehouse. Data consisted of figures on a daily basis. The data was rolled-up to identify major contributors of demand and shipments. 80/20 rule was applied for further drill-down on countries, SKUs and meter families.

The figure below shows that 5 countries contributed to more than 60% of total demand of kits.



Country	2012		2013		Jan '12 - Oct '13
	%	Cum %	%	Cum %	
RUSSIA	24%	24%	17%	17%	
GERMANY	11%	35%	12%	29%	
FRANCE	11%	46%	12%	42%	
ITALY	9%	55%	10%	51%	
ALGERIA	5%	60%	8%	59%	

Demand Analysis for SKUs by Country.

The products shipped by the company are classified into two categories:

1. Revenue Meters – Where the end customer pays for the meter (end product)
2. Free of Cost (FOC) Meters – Where the meter is given free to the customer

Following are some significant observations from the detailed demand and shipment analysis:

- 10 countries out of 59 contribute to 81% of total demand in 2013. Demand came from 62 countries in 2012. Russia alone has a demand of 17% of all the kits.

- 10 SKUs out of 177 contribute more than 50% of total demand in 2013. 8 SKUs have been identified to be common between 2012 and 2013, constituting top 10 in terms of demand.
- In 2013, revenue meters were shipped to 50 countries, while FOC meters were shipped to 32 countries. In 2012, these figures were 55 and 32 respectively. More than 80% of revenue meters were shipped to 9 countries in 2013, whereas in the same year, more than 85% FOC meters were shipped to 7 countries.
- In 2013, number of SKUs for revenue meters were 173, versus 176 for FOC SKUs. Both saw an increase of approx. 20% from the number of SKUs in 2012. Five revenue meter SKUs made up for 50% of all revenue meters shipped in 2013. For FOC meters, 12 SKUs constituted 50% of all FOC meters shipped in 2013.

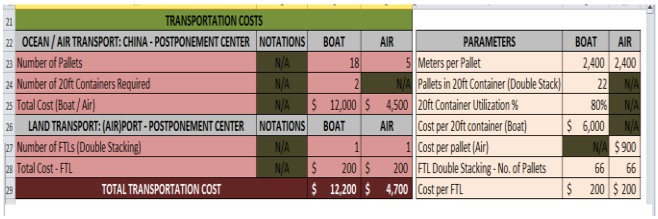
Inventory model selection and development

The nature of operations is multi-period and hence a multi-period inventory system model was developed both for the postponement center and for the central warehouse. Multi-period inventory systems was designed to ensure that an item will be available on an ongoing basis throughout the year. Usually the item would be ordered multiple times throughout the year where the logic in the system dictates the actual quantity ordered and the timing of the order. Since the inventory count was being done on a periodic basis, periodic review model was created. As there were lead times associated with transportation, safety stock was factored into the model.

Proposed transportation model and mode shift scenario analysis

Given the complexities of EMEA region in terms of multiple country specific languages, government rules, and so on, the number of SKUs in the supply chain just explodes, putting more pressure on the current transportation scenarios. Hence, we linked the transportation model with the inventory model, and provided the flexibility of scenario analysis for shifting percentage of demand movements between ocean and air modes for shipments from China to the postponement center.

Following is a snapshot of the transport cost calculator and mode shift scenario enabler created for the postponement center.



TRANSPORTATION COSTS			
OCEAN / AIR TRANSPORT: CHINA - POSTPONEMENT CENTER	NOTATIONS	BOAT	AIR
Number of Pallets	N/A	18	5
Number of 20ft Containers Required	N/A	2	N/A
Total Cost (Boat / Air)	N/A	$ 12,000	$ 4,500
LAND TRANSPORT: (AIR)PORT - POSTPONEMENT CENTER	NOTATIONS	BOAT	AIR
Number of FTLs (Double Stacking)	N/A	1	1
Total Cost - FTL	N/A	$ 200	$ 200
TOTAL TRANSPORTATION COST		$ 12,200	$ 4,700

PARAMETERS	BOAT	AIR
Meters per Pallet	2,400	2,400
Pallets in 20ft Container (Double Stack)	22	N/A
20ft Container Utilization %	80%	N/A
Cost per 20ft container (Boat)	$ 6,000	N/A
Cost per pallet (Air)	N/A	$ 900
FTL Double Stacking - No. of Pallets	66	66
Cost per FTL	$ 200	$ 200

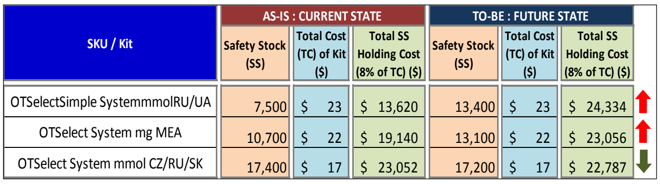
Snapshot of Excel Based Tool for Transportation Scenario Analysis.

Results

Post developing the inventory and transport models, we quantified the costs by creating baseline for current operations (AS-IS), and compare that with various scenarios (TO-BE). For the inventory cost comparisons, we analyzed the safety stock holding cost of top three SKUs / kits. We made an attempt to understand the shifts in the costs between the existing set-up, and in a postponement scenario. For the transportation costs, we created four scenarios.

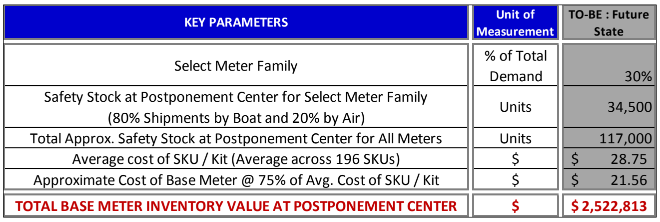
- **Inventory cost shifts**

The two tables below shows how inventory related costs would shift post postponement. While the holding costs may increase for some high demand SKUs, it may decrease for other similar high demand SKUs. Inventory values of the base meters are expected to go up to meet the higher service level requirements of 96%.



SKU / Kit	AS-IS : CURRENT STATE			TO-BE : FUTURE STATE			
	Safety Stock (SS)	Total Cost (TC) of Kit ($)	Total SS Holding Cost (8% of TC) ($)	Safety Stock (SS)	Total Cost (TC) of Kit ($)	Total SS Holding Cost (8% of TC) ($)	
OTSelectSimple SystemmmolRU/UA	7,500	$ 23	$ 13,620	13,400	$ 23	$ 24,334	⬆
OTSelect System mg MEA	10,700	$ 22	$ 19,140	13,100	$ 22	$ 23,056	⬆
OTSelect System mmol CZ/RU/SK	17,400	$ 17	$ 23,052	17,200	$ 17	$ 22,787	⬇

Safety Stock Holding Cost Comparison for Top SKUs / Kits.

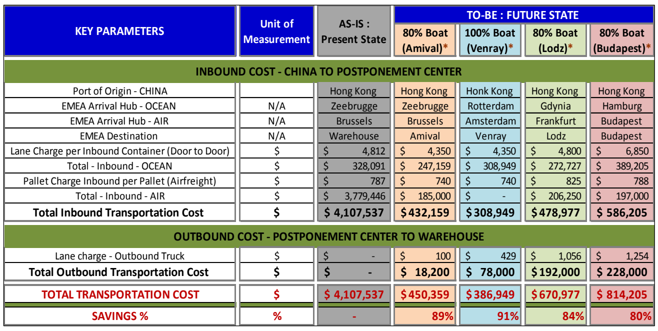


KEY PARAMETERS	Unit of Measurement	TO-BE : Future State
Select Meter Family	% of Total Demand	30%
Safety Stock at Postponement Center for Select Meter Family (80% Shipments by Boat and 20% by Air)	Units	34,500
Total Approx. Safety Stock at Postponement Center for All Meters	Units	117,000
Average cost of SKU / Kit (Average across 196 SKUs)	$	$ 28.75
Approximate Cost of Base Meter @ 75% of Avg. Cost of SKU / Kit	$	$ 21.56
TOTAL BASE METER INVENTORY VALUE AT POSTPONEMENT CENTER	$	$ 2,522,813

Inventory Valuation of Base Meters at Postponement Center.

- **Transportation cost shifts**

The following table summarizes the “AS-IS” costs versus four scenarios of “TO-BE” costs, and corresponding cost savings per annum for transportation. We can infer that implementing postponement would enable to shift majority of shipments to transport through boat mode. This in turn would entail significant transport related savings when compared to current high usage of air mode of transportation.



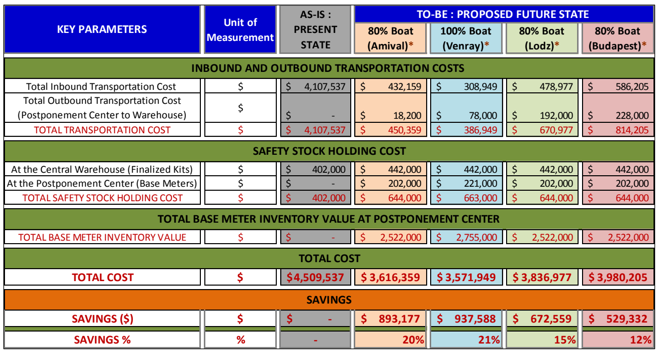
KEY PARAMETERS	Unit of Measurement	AS-IS : Present State	TO-BE : FUTURE STATE 80% Boat (Amival)*	100% Boat (Venray)*	80% Boat (Lodz)*	80% Boat (Budapest)*
INBOUND COST - CHINA TO POSTPONEMENT CENTER						
Port of Origin - CHINA		Hong Kong	Hong Kong	Honk Kong	Hong Kong	Hong Kong
EMEA Arrival Hub - OCEAN	N/A	Zeebrugge	Zeebrugge	Rotterdam	Gdynia	Hamburg
EMEA Arrival Hub - AIR	N/A	Brussels	Brussels	Amsterdam	Frankfurt	Budapest
EMEA Destination	N/A	Warehouse	Amival	Venray	Lodz	Budapest
Lane Charge per Inbound Container (Door to Door)	$	$ 4,812	$ 4,350	$ 4,350	$ 4,800	$ 6,850
Total - Inbound - OCEAN	$	$ 328,091	$ 247,159	$ 308,949	$ 272,727	$ 389,205
Pallet Charge Inbound per Pallet (Airfreight)	$	$ 787	$ 740	$ 740	$ 825	$ 788
Total - Inbound - AIR	$	$ 3,779,446	$ 185,000	$ -	$ 206,250	$ 197,000
Total Inbound Transportation Cost	**$**	**$ 4,107,537**	**$ 432,159**	**$ 308,949**	**$ 478,977**	**$ 586,205**
OUTBOUND COST - POSTPONEMENT CENTER TO WAREHOUSE						
Lane charge - Outbound Truck	$	$ -	$ 100	$ 429	$ 1,056	$ 1,254
Total Outbound Transportation Cost	**$**	**$ -**	**$ 18,200**	**$ 78,000**	**$ 192,000**	**$ 228,000**
TOTAL TRANSPORTATION COST	**$**	**$ 4,107,537**	**$ 450,359**	**$ 386,949**	**$ 670,977**	**$ 814,205**
SAVINGS %	**%**	**-**	**89%**	**91%**	**84%**	**80%**

* Postponement Center Location

Transportation Savings Scenarios from Postponement.

- **Total as-is versus proposed cost comparison**

The following table shows the comparison between total As-Is cost (transportation and safety stock holding costs) and costs from a proposed postponement scenario (transportation, safety stock holding costs at the postponement center and the central warehouse, and cost of base meters). We can see that postponement is a financially viable strategy here.

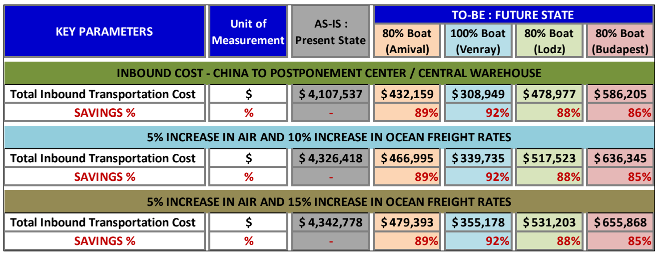


KEY PARAMETERS	Unit of Measurement	AS-IS : PRESENT STATE	TO-BE : PROPOSED FUTURE STATE 80% Boat (Amival)*	100% Boat (Venray)*	80% Boat (Lodz)*	80% Boat (Budapest)*
INBOUND AND OUTBOUND TRANSPORTATION COSTS						
Total Inbound Transportation Cost	$	$ 4,107,537	$ 432,159	$ 308,949	$ 478,977	$ 586,205
Total Outbound Transportation Cost (Postponement Center to Warehouse)	$	$ -	$ 18,200	$ 78,000	$ 192,000	$ 228,000
TOTAL TRANSPORTATION COST	$	$ 4,107,537	$ 450,359	$ 386,949	$ 670,977	$ 814,205
SAFETY STOCK HOLDING COST						
At the Central Warehouse (Finalized Kits)	$	$ 402,000	$ 442,000	$ 442,000	$ 442,000	$ 442,000
At the Postponement Center (Base Meters)	$	$ -	$ 202,000	$ 221,000	$ 202,000	$ 202,000
TOTAL SAFETY STOCK HOLDING COST	$	$ 402,000	$ 644,000	$ 663,000	$ 644,000	$ 644,000
TOTAL BASE METER INVENTORY VALUE AT POSTPONEMENT CENTER						
TOTAL BASE METER INVENTORY VALUE	$	$ -	$ 2,522,000	$ 2,755,000	$ 2,522,000	$ 2,522,000
TOTAL COST						
TOTAL COST	**$**	**$4,509,537**	**$ 3,616,359**	**$ 3,571,949**	**$ 3,836,977**	**$ 3,980,205**
SAVINGS						
SAVINGS ($)	**$**	**$ -**	**$ 893,177**	**$ 937,588**	**$ 672,559**	**$ 529,332**
SAVINGS %	**%**	**-**	**20%**	**21%**	**15%**	**12%**

Total As Is Versus Proposed Cost Comparison.

- **Transportation costs sensitivity analysis**

We did sensitivity analysis to understand the impact on overall transportation costs if the airfreight rates were to increase by 5%, and ocean rates were to increase by 10% and 15% at the same time. The following table summarizes the results. We can see that despite a 15% increase in ocean freight rates, postponement remains a viable option.



KEY PARAMETERS	Unit of Measurement	AS-IS : Present State	TO-BE : FUTURE STATE 80% Boat (Amival)	100% Boat (Venray)	80% Boat (Lodz)	80% Boat (Budapest)
INBOUND COST - CHINA TO POSTPONEMENT CENTER / CENTRAL WAREHOUSE						
Total Inbound Transportation Cost	**$**	**$ 4,107,537**	**$ 432,159**	**$ 308,949**	**$ 478,977**	**$ 586,205**
SAVINGS %	**%**	**-**	**89%**	**92%**	**88%**	**86%**
5% INCREASE IN AIR AND 10% INCREASE IN OCEAN FREIGHT RATES						
Total Inbound Transportation Cost	**$**	**$ 4,326,418**	**$ 466,995**	**$ 339,735**	**$ 517,523**	**$ 636,345**
SAVINGS %	**%**	**-**	**89%**	**92%**	**88%**	**85%**
5% INCREASE IN AIR AND 15% INCREASE IN OCEAN FREIGHT RATES						
Total Inbound Transportation Cost	**$**	**$ 4,342,778**	**$ 479,393**	**$ 355,178**	**$ 531,203**	**$ 655,868**
SAVINGS %	**%**	**-**	**89%**	**92%**	**88%**	**85%**

Results of Transportation Costs Sensitivity Analysis.

Conclusions

We started this journey to address whether postponement of the final kitting of blood glucose monitoring meters would impact their inventory and transportation costs. While maintaining a very high service level of 96%, we wanted to increase the utilization of boat transport mode at 80% and above, and reduce the use of air shipments. We wanted to move away from made-to-stock to assemble-to-order for the meter kits.

We established that postponement could be a worthwhile strategy as the total savings from reduction in transportation costs outweigh the increase in inventory related costs. Most importantly, the goal of establishing an agile supply chain, a supply chain that can proactively act to customer's requirements and ensure product availability on the shelves with a very high degree of certainty, looks financially feasible.

The research work presented in this thesis report can be enhanced further by involving the forecasting department responsible for doing the need analysis of the blood glucose monitoring meters. While this paper address the downstream processes of making the supply chain agile, it does not touch upon the up-stream processes of forecasting of meter demand. We think if that element can be brought into fray, and clubbed with what we developed, would help develop a robust end-to-end process for addressing customers' needs.