USAID | DELIVER PROJECT

Nigeria: Segmentation of the Supply Chain for Essential Medicines

Kano and Edo States

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Abstract
From April 2009 until February 2010, the USAID | DELIVER PROJECT worked with Kano and Edo states in Nigeria to apply the segmentation framework to their essential medicines program. Through this exercise, technical advisors were able to use data to identify system design modifications that could render their essential drugs distribution more efficient. The activities focused on catering transportation policies to best fit the products and customers served. This report also reviews some lessons learned in applying this new framework to the global public health setting.

Cover photo: Truck belonging to the Edo state essential drugs program. This truck may be used for supervision visits and delivery of essential drugs throughout Edo state, Nigeria. Benin City, Nigeria February 2010. JSI Staff Photo.

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Acronyms

ACT	artemisinin-based combination therapy
ARV	antiretroviral
CMS	central medical store
DMA	drug management agency
DRF	Drug Revolving Fund
EDP	Essential Drug Program
LGA	local government authority
MOH	Ministry of Health
PHC	primary health care
Q2	second quarter
SKU	stockkeeping unit
TB	tuberculosis
USAID	U.S. Agency for International Development

Acknowledgments

Applying a new conceptual framework is rarely an easy venture, and there are many parties to thank for their contributions and input. The concepts of segmentation were developed as a part of the document *Reengineering Public Health Supply Chains for Improved Performance: Guide for Applying Supply Chain Segmentation Framework*. We are much obliged to the authors who were able to modify this concept currently used in supply chain industry to the international public health setting. In particular, we would like to thank Jarrod Goentzel for his input on that document.

We would also like to thank our colleagues at the U.S. Agency for International Development (USAID) for being willing to support this application outside of the normal work planning cycle. We feel that this shows the value they place in finding innovative ways to improve supply chain management in settings that continue to be challenging.

Of course, this activity could not take place without the cooperation and collaboration with our partners in Nigeria. Thank you to all who participated in engaging workshops and interviews, including the Honorable Commissioners for Health and Permanent Secretaries as well as representatives for most health programs in both Kano and Edo states.

Kind thanks are also in order to the John Snow, Inc. office in Abuja as well for administrative and technical support, specifically to Elizabeth Igharo, Miryam Musa, and Mike Egharevba.

Executive Summary

Segmentation is an approach that can help identify opportunities in supply chains where products or customers can be grouped together or combined in such a way that improves product availability and decreases costs and functional redundancies (Allain et al. 2010). The framework strategically organizes the supply chain into distinct groupings or segments that have common logistics requirements, which best respond to customer needs. Each group is managed according to the characteristics of that group, aligning operating procedures with product and customer requirements.

Technical advisors applied this framework in two states in Nigeria: Kano and Edo. Using requisition data from secondary hospitals, advisors determined the approximate demand of products that should flow through the state central medical stores (CMSs). These product and additional facility (customer) characteristics were used to suggest supply chain system designs modified for the unique situation in each of the states.

Though neither of the states was prepared to make drastic changes to their essential drugs and program-specific systems, the process of thinking through product and customer needs when designing a system was a useful exercise for all involved. Both states have expressed interest in further examining the feasibility of suggested modifications.

Through this exercise, advisors were able to conclude that this framework is applicable in a global health supply chain setting, although to merge multiple program systems, this activity would have to be applied when a system design is already planned. However, use of data to inform system design decisions was a compelling argument for stakeholders to modify some logistics practices. Though facility level data is often challenging to acquire, when it is available similar exercises can inform system design decisions.

Introduction

Public sector health care supply chains continue to grow increasingly complex. Existing programs in primary health care (PHC) and the Expanded Program on Immunization are being scaled up to reach the Millennium Development Goals; new, additional funds are now available for programs in HIV and AIDS, malaria, and tuberculosis (TB); and health sector reform and health system strengthening initiatives are focusing on improving management systems, all contributing to increase the complexity of the environment with service integration and/or decentralization.

As the health system grows and becomes more complex, so does the supply chain that provides commodities to the health system. Programs evolving or scaling up require supply chain systems that are agile, scalable, and robust enough to function well in this environment.

Nigeria is a prime example of such an environment. Recent Global Fund awards have led to a large increase in commodities flowing through the public health system. Also, the country has devolved budgetary and management responsibility to the state and local government authority (LGA) levels, which means that the systems in each state vary greatly.

To achieve product availability under these changing conditions, supply chain managers will have to use new models, new frameworks, and new thinking. One concept currently applied in the supply chain industry to address similar problems is called *segmentation*.

Segmentation is an approach that can help identify opportunities in supply chains where products or customers can be grouped together or combined in such a way that improves product availability and decreases costs and functional redundancies (Allain et al. 2010). The framework strategically organizes the supply chain into distinct groupings or segments that have common logistics requirements, which best respond to customer needs. Each group is managed according to the characteristics of that group, aligning operating procedures with product and customer requirements. It allows a system to:

- Manage complexities
- Increase flexibility and adaptability
- Manage tradeoffs.

In Nigeria, programs are managed separately at the national level. Once at the state level, many of these vertically managed programs (TB and leprosy, reproductive health, immunizations, malaria) begin to merge as the products are often stored in the same warehouse. However, the management of these goods is still generally program-by-program. States also manage the procurement of essential medicines for hospitals and PHC facilities. At the same time, LGAs control the budget and often do the procurement for products at the service delivery point. Each LGA, acting autonomously, handles this process in its own way.

The objective of this technical assistance activity was to introduce concepts of segmentation currently used in the private sector supply chain field to the public health sector to improve product availability in Kano and Edo states, and determine relevance, applicability, and opportunities for developing the concept further to best fit the international public health environment. This paper

documents the experience of applying that segmentation approach in Nigeria over the course of several technical assistance trips.

Preparation

Site Selection and Stakeholder buy-in

In selecting states to apply this segmentation framework, the project considered several criteria:

- A willingness to critically consider the current design of their system
- The ability to identify a particular problem or challenge they would like to address.

Initial meetings with stakeholders in two states, Kano and Edo, revealed that both states met these criteria. An explanation of the concepts to stakeholders in each of the locations revealed genuine interest from both states. The applicability of segmentation to managing donors' expectations about merging essential drugs with vertical programs seemed to be a compelling component.

Information Gathering

A second visit to each of the sites focused on collecting data related to the health products managed at the state level in order to conduct the segmentation analysis. To address the potential issue of merging vertical programs with essential medicines, the technical advisors decided to collect data on all products that could flow through the state CMSs.

In both states, the program managers and the state medical stores kept records related to the various programs: essential medicines, family planning, nutrition, immunizations, malaria, and TB and leprosy. HIV/AIDS products were excluded because they were not managed at the state level. The data of greatest interest included the types and quantities of products managed by the state system, the frequency and mode of resupply at both the state level (from a higher level) and to the hospitals and LGAs within the state, and order fill rates for facilities and types of products. To collect available data, the technical assistance team met with the various program managers and staff at the state medical stores.

Generally, there were no electronic records and only two programs (TB and leprosy, and immunization) prepared summary reports that could be used to accurately document demand. With the exception of immunization, historical requisitions or allocations had to be captured electronically from paper records, where they existed.

Table 1 details the data available in each of the sites.

Table 1. Requisition Data for Health Programs in Kano and Edo States

Location and Program	Comments on Quality and Applicability to Exercise	Decision on What to Collect and Analyze
KANO		
Essential Medicines	Data at the drug management agency (DMA) was managed with mSupply software until 2008. Data was subsequently captured on separate records. The most accessible source was nine months of sales data by customer (value of goods only, not individual products).	Decided that for initial analysis would use monthly sales data as proxy for customer size, volume, and frequency. Consultant engaged for further data entry to enable analysis of product demand factors.
Family Planning	Data for 28 LGAs was available electronically from USAID | DELIVER PROJECT. Data for the other 16 LGAs was limited or incomplete.	Received the electronic data from USAID | DELIVER PROJECT on return to Abuja. Will serve as basis for program analysis, as data for the other 16 LGAs was limited.
Immunization	The immunizations program had very detailed records, indicating population (birth) targets, stock levels, and fill rates at LGA levels. However, program is allocation based and often the state does not receive the full quantities they need for routine vaccination programs.	Have electronic data for full year 2008 for analysis. Determined that immunization program is already segmented by routine, campaign, and outbreak vaccination programs.
Malaria	Free malaria program is only for pediatrics; adult artemisinin-based combination therapy (ACT) information should be available through DMA data.	Very limited data, so nothing to analyze. However, adult malaria drugs are managed through the DMA, so will see demand there once that data is collected.
Nutrition	Receive allocations from zonal store once a year.	None available.
TB and Leprosy	Currently, the TB and leprosy program is not receiving sufficient quantities, so rationing products. Data was given to team, but in different format.	Used number of treatment sites by LGA as customer estimates; will need additional data on distribution of cases to further segment customers.
EDO		
Essential Drug Program (EDP)	Kept records of hospital requisitions (handwritten on lined paper), products backordered, and issued vouchers. Each requisition was several pages long and was associated with multiple issues vouchers. All documents appeared to be stored in different files. The process of matching these was lengthy.	Collected a sample of two hospital requisition forms from July 2009 (127 products total) and matched with back-ordered items and issues vouchers to assess fill rate and product availability. Engaged consultant to collect one year of requisition data, also indicating if products ordered are on the Essential Drug List.
Family Planning	Good paper-based records for 16 of the 18 LGAs and some hospitals of quantities requested and supplied by product.	Took available records and input six quarters worth of records into Excel for analysis.

Immunization	Records were available but disorganized. Requests from LGAs came in on many different types of forms and were kept in multiple files. Had tally cards and eight months (not all consecutive) of summary forms of quantities of vaccines issued to LGAs.	As program is using allocation system (the storekeeper used request amount and stock on hand to allocate quantities of vaccines to LGAs), we input the monthly summary reports of issues data by vaccine into Excel for use in analysis.
Malaria	Had very limited issues data to LGA.	Input the limited data into Excel spreadsheet. Difficult to use as it is allocation-based and supplies are received irregularly (once or twice time per year).
Nutrition	No data available. Allocation once per year to LGAs based on population.	None available.
TB and Leprosy	Used to keep records electronically, but laptop was stolen recently and all records were lost. Had paper information available from second quarter (Q2) 2009 only. Supplies have been insufficient so have been rationing.	Used data available from Q2 2009 and a few recent issues vouchers from zonal store. Also used number of cases and treatment centers by LGA to estimate customer size.

(Source: Durgavich and Heaton 2009)

Missing Data

No distribution records were available in either state for the nutrition program. Nutrition, malaria, and immunization programs distribute based on population-based allocations. Currently, the population figures used to plan distributions to the lower tiers are extrapolated from the 1991 census. Nutrition receives only one annual allocation from the national program, and malaria receives only one or two. It is not possible to tell from the data available how closely these infrequent allocations resemble the actual demand from the field. The team focused on records available at the state level, but as this was not a health facility–based survey, no assumptions regarding availability at the customer level could be made.

With the limited data the technical team was able to collect and enter from the paper-based system, the team used several programs as examples in a workshop format to demonstrate how segmentation would work, as well as the types of characteristics that might be used to create several supply chain segments, rather than programs.

Stakeholders Workshop I

In each of the states, a workshop style meeting was held with Ministry of Health (MOH) stakeholders to review the concepts of the segmentation framework and the information collected during the data-gathering phase. Participants included the honorable commissioner of health, permanent secretary, representatives of many disease-specific programs in the state, as well as representatives of the drug management agency and logistics officers.

Kano State

In Kano state, after an initial review of the concepts, participants completed several exercises to solidify their understanding of dividing products and customers into groups based on logistics characteristics. As a group, they identified product characteristics and customer factors that could have an effect on their supply chain and then placed a few products and customers into groups to

familiarize participants with the idea of classifying products and customers by factors other than programs.

In a following exercise, technical providers facilitated a discussion that examined each of the programs already existing in the public health sector and identified pre-existing segments within those programs. It was determined that the Drug Revolving Fund (DRF), and malaria, nutrition, and immunization programs all incorporate forms of segmented supply chains.

To illustrate the process, the group worked through a scenario where they tried to integrate ACTs into a hypothetical segment of the DRF and considered policies that would be required for this product group.

The workshop concluded by discussing potentially relevant indicators and implications for each of the following logistics functions:

- Service policy
- Inventory policy
- Storage/warehousing policy
- Procurement
- Transportation.

Cross-cutting issues, such as the markup fee for delivering free-to-the-customer product, policy issues surrounding donor engagement, potential human resource constraints, technology implications, and other issues surrounding infrastructure at the CMS were part of the wrap-up discussion.

Edo State

The workshop in Edo state had a slightly different format because the key stakeholders had participated in the kick-off meeting at the beginning of the week. More emphasis was placed on the data collected and the types of analysis that could be done with the data. Guided exercises and a brainstorming session on potential segmentation characteristics produced similar results to those in Kano state.

Additional discussion focused primarily on the quality of the data collected and some of its limitations. There was more program-specific data available in Edo state; however, the essential medicines program had several limitations:

- Information management: Currently, all data is paper-based and related records are often in disparate files and locations.
- Transportation: A very limited use of delivery at the state level, the program relies on hospitals for product pickup. This affects ability to set a transportation policy.
- There is a lack of explicit policies for fill rate and response time for many programs.
- Supply constraints distort the demand picture and irregular schedules limit options for coordination.

Data Entry and Analysis Process

In both states, requisitions from hospitals were only available in hard copy from handwritten forms. However, for the level and detail of data required for further analysis and segmentation, manual collection and data entry would be required. Therefore, the USAID | DELIVER PROJECT office in Abuja, in conjunction with the MOH staff in both states, identified and hired local consultants to collect and analyze data from each state and its respective programs to facilitate the analysis.

As with any manual data entry, and especially with data entry of forms that are not standard, the data entry was time-consuming and required extensive data cleaning. Challenges in the data cleaning and analysis included the following:

- Illegible handwriting.
- Inconsistently labeled products, facilities, and units.
- Volumes assigned to products were estimates based on common international packaging.
- Data collected was limited to secondary facilities.
- Secondary facility reporting rate was as low as 60 percent.

Despite these caveats, there was an opportunity to learn a lot about how the supply chain functions in both Kano and Edo states. Once the data had been cleaned, technical advisors used Microsoft Excel to manipulate and analyze the data.

The analysis focused on requests made to the CMS and considered the secondary hospital facilities to be its customers. System-wide analyses included the total number of products being handled by the CMS, the total volume (physical space) flowing through the CMS, as well as its average volume per month and standard deviation of volume per month. This information revealed the capacity that the CMS should be expected to handle and how that may change from month to month.

The product-specific analysis examined which products were the most and least—

- Frequently ordered
- Voluminous (total physical volume requested from the system during the reporting period)
- Variable (standard deviation of the volume of each product per month).

Initial Analysis Results

Kano State

A DRF activity has operated in Kano state since 2008. For this reason, at the time of the analysis, many of the hospitals had already been capitalized, meaning they had been provided with a seed stock for a set of essential medicines and forms for requesting a resupply. This helped to ensure a certain level of availability and quality of data related to essential medicine requisitions. The analysis overview shows that there are a large number of individual products and a large total physical volume handled by the system (Table 2).

Table 2. Overview of Kano State CMS Throughput

Total Number of Products	1131
Total Volume	447.6 m^3
Average Volume per Month	40.7 m^3
Standard Deviation of Volume per Month	24.6 m^3

The high standard deviation shows that the volume at this CMS is highly variable. On any given month, there may be as little as 16 m^3 requested from the CMS, and the next, it could be as much as 65m^3. This makes it extremely challenging for a CMS to plan appropriate inventory levels.

This information about the system can assist the CMS in making important operational decisions about procurement, warehousing, and distribution practices. Armed with information about the physical volume of products requested from hospitals and how much that could change from month to month, the CMS can make evidence-based decisions about whether they should build a new warehouse and what size it should be. Decisions about human resources and truck sizes can also make use of this practical information.

The data were also sorted by the frequency that an order for a product came to the CMS throughout the study period. The top five and bottom five most frequently ordered items are listed in Figure 1.

Figure 1. Most and Least Frequently Ordered Products in Kano State

High Frequency		Low Frequency	
Paracetamol Syrup 125mg/5ml 60ml	68	Dihydroartemisinin Tablets 60mg 8's	1
Cough Mixture Syrup Mixture 10's	65	Ciprofloxacin Tablets 250mg 14's	1
Multivitamin Syrup Mixture 100ml	58	Arte/Sulfa/Py Tabs 200mg/500mg/25mg 9's	1
Magnesium Trisilicate Susp 200ml	56	Amoxicillin/Clavulanate Tabs 625mg 100's	1
Sulfa/Pyr Tablets 500mg/25mg 3's	47	Gentamycin Injection 280mg 100's	1

Note that the definition of an individual item, or stockkeeping unit (SKU), in these lists is the combination of the product, form, dosage, and packaging size. If any of these four components are different, it should be considered a different SKU. So although erythromycin 250 mg tablets may only be ordered once when packaged in rolls, it is probably more frequently requested from secondary hospitals in bottles of 1000 capsules.

In addition to frequency, the initial analysis sorted each of the products in terms of total physical volume requested from the CMS for each product and the variance of that volume of each product. The results for Kano state are shown in Figures 2 and 3.

Figure 2. Most and Least Frequently Ordered Products by Volume in Kano State

High Volume		Low Volume	
Dextrose Saline Infusion 0.05 500ml	14.65	Chlorpromazine Injection 50mg 10's	0.02
Chloroquine Phosph Inj 250mg 100's	12.26	Erythromycin Tablets 250mg 100's	0.01
Magnesium Trisilicate Susp 200ml	10.55	Arte/Amod Tabs 50mg/200mg 12's	0.01
Cough Mixture Syrup Mixture 10's	9.77	Prednisolone Tablets 5mg 100's	0.01
Syringe & Needle Med Cons 5ml 100's	9.27	Clotrimazole Cream 0.01 10's	0.00

Volume, as noted in Figure 2, is a composite of two qualities: the bulkiness of an individual item and the quantity that was ordered in total from all of the secondary facilities. An extremely large product that was only ordered once by one hospital would likely not make this list, nor would a frequently ordered, yet relatively small item.

Figure 3. Products with the Most and Least Variance in Demand in Kano State

High Variance		Low Variance	
Normal Saline Infusion 0.009 500ml	0.93	Acetylsalicylic Acid Tablets 75mg 100's	0.01
Exluton/microlut Tablets Cycle 24's	0.81	Dexamethasone Gutt 0.001 10's	0.01
Disp Gloves Med Consumable Pkt 100's	0.78	Ciprofloxacin Tablets 500mg 10's	0.01
Ampicillin/Cloxacillin Injection 500mg 10's	0.68	Hydralazine Injection 20mg 5's	0.01
Syringe & Needle Med Cons 5ml 100's	0.65	Hydrocortisone Injection 100mg 10's	0.01

Figure 3 shows products that had a large overall volume, but were ordered inconsistently. Ordering patterns can easily be affected by the bulk of a product. For example, items such as syringe and needle packs and disposable gloves, although used quite regularly in all hospitals, are very bulky. Because each package is large, can last a long time, and has minimal risk of expiry, facilities may only order one per quarter, or even less frequently. This makes the demand infrequent and difficult for the CMS to predict.

Edo State

A similar process was used to review the data from Edo state, although gaps in the requisition data made the analysis more challenging. Table 3, below, provides an overview of Edo state's EDP in terms of the number of products and total physical volume handled. While the total volume is smaller than Kano state's, the relatively high standard deviation still makes it difficult for EDP personnel to plan for storage and distribution requirements.

Table 3: Overview of Edo State EDP Throughput

Total Number of Products	1050
Total Volume	258.7 m^3
Average Volume per Month	25.9 m^3
Standard Deviation of Volume per Month	15.75 m^3

While Kano state's recently established DRF includes a standardized list of products in terms of package sizes, Edo state does not operate its EDP in this fashion. For this reason, product names listed in the following tables, and in the analysis generally, often do not include product package sizes. In some instances, a product may have appeared in the requisition data both with an associated pack size and without, which the analysis team would treat as two distinct products. While in reality these two products may have used the same pack size, it would be impossible to tell from the data exactly which products are the same. Because of this, the total number of products cited in the analysis (1,050) is likely to be higher than the total number of SKUs actually handled by the Edo state EDP.

As with Kano state, the technical assistance team analyzed Edo state's data in terms of order frequency, physical volume requested, and month-to-month variance of that volume (Figures 4–6).

Figure 4. Most and Least Frequently Ordered Products in Edo State

High Frequency		Low Frequency	
Ampiclox 500mg capsules packs	48	Chymoral tablets packs	1
5ml syringe and needle packs	38	Dexamethasone 0.5mg tablets packs	1
Ciprofloxacin 500mg tablets packs	38	Ibuprofen 200mg capsules packs	1
Paracetamol 500mg tablets 1000/cup	36	Rotex 10units/ml injection ampoules	1
Astyfer 200ml suspension bottles	35	Plastic Shopping bag pieces	1

Figure 5. Most and Least Frequently Ordered Products by Volume in Edo State

High Volume		Low Volume	
Blood giving set 50/pack	9.09	Artequin (adult) 200mg+250mg tabs 6/pk	0.21
Pentazocine 30mg/ml inj amps	8.50	Zinnat 250mg tablets 10/pkt	0.21
Dexamethasone 4mg inj amp	5.90	Secnidazole 500mg tablets 6/pkt	0.23
Dextrose saline .05 ivf 500ml	5.44	Paluther 40mg injection ampoules	0.24
Cotton wool packs	5.16	Augmentin 625mg tablets 14/pkt	0.25

Figure 6. Products with the Most and Least Variance in Demand in Edo State

High Variance		Low Variance	
Frusemide 20mg injection ampoules	2.22	Primolut N 5mg tablets 30/pkt	0.01
Cotton wool packs	2.09	Calamine lotion 0.15 solution bottles	0.01
Chloroquine 300mg tablets 1000/pkt	1.65	Chloramphenicol 0.01 gutt bottles	0.01
Disposable gloves packs	1.64	Eleron 200ml syrup bottles	0.01
Flagyl 400mg tablets packs	1.48	Emtrisil 200ml syrup bottles	0.01

Similar to Kano state's requisition data, bulky medical consumables such as cotton wool packs and blood giving sets represented a relatively large proportion of the total physical volume, and also exhibited relatively high month-to-month variance. Cotton wool packs for example, represented an estimated 5.16 m^3 over the 10-month analysis period, but had a variance of 2.09 m^3 per month. These figures show that the total amount of cotton wool ordered was driven by a few large, infrequent requests by hospitals.

Presentation of Results and Segmentation Workshop

In both states, technical assistants followed the data analysis with a stakeholder workshop to review the concepts of segmentation, present the results of the analysis, and conduct segmentation exercises to apply the theory of segmentation to the real-world data. In both instances, local counterparts brought together the high commissioner for health, permanent secretary, representatives of commodity programs, CMS employees, LGA representatives, and in Kano state, personnel from the Partnership for Transforming Health Systems Phase II for this segmentation workshop.

The workshops began with a review of supply chain and segmentation concepts to frame the discussion of how these theoretical concepts could be used to improve MOH operations in each state's specific context. Following this, the technical assistants presented a summary of the data analysis by going through the product and customer results tables discussed previously. Participants gained an understanding of how the EDP operated, the number of different products handled, their total volume, and how much this volume could be expected to vary on a month-to-month basis. Participants concluded that this kind of information could be helpful for warehouse and transportation planning.

To apply the segmentation framework using this analysis, the technical assistants conducted an interactive exercise in which the entire list of products and customers was broken into segments according to shared logistics characteristics. Based on these segments, workshop participants identified potential transportation strategies that would cater specifically to the logistics requirements of the products and customers contained in those segments. For each customer and product grouping, participants discussed how the particular logistics specifications involved would impact handling and distribution requirements. In this way, participants could see how, backed by real-world data, segmentation could be used to identify specific strategies and operating practices that respond to particular requirements. By the end of the exercise, the participants had filled a matrix diagram with potential transportation strategies for each customer/product group combination, such as in the example from Kano state, shown in Figure 7.

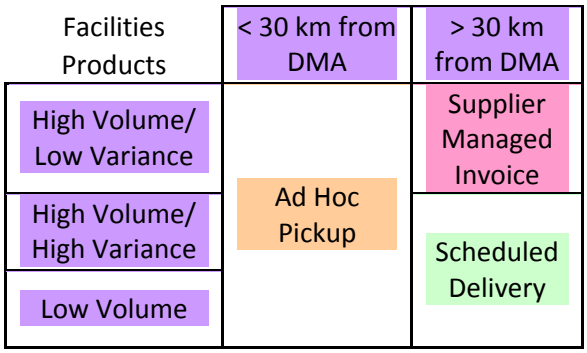
Figure 7. Transportation Strategies for Customer/Product Group Combinations in Kano State

Results of Workshop Discussion

Facilities / Products	< 30 km from DMA	> 30 km from DMA
High Vol/ Low Variance	Direct from Manufacturer,Scheduled Delivery, Sched. Forced-Order Pickup, Ad Hoc Pickup	Supplier Managed Inventory, Scheduled Delivery, Direct from Manufacturer
High Vol/ High Variance	Ad Hoc Pickup, Direct from Manufacturer	Direct from Manufacturer, Scheduled Delivery
Low Volume	Ad Hoc Pickup	Sheduled Delivery

In this example, workshop participants decided that for low-volume products, ad hoc deliveries would make sense for customers within 30 km of the DMA, while limited transportation resources could be best allocated toward scheduled deliveries to sites further than 30 km. The participants made similarly rational selections for the other product groups, although for most customer/product combinations they identified more than one strategy that could respond to the relevant logistics characteristics. The different combinations of possible strategies could be broken up to develop numerous potential arrangements, as shown in the example from Kano state in Figure 8.

Figure 8. Potential Transportation Strategy Configuration for Kano State



In this example, all product groups make use of an ad hoc pickup system for customers close to the DMA, while customers further away use supplier managed inventory for the high volume/low variance products and scheduled delivery for the high volume/high variance products. While this

arrangement is one possible combination of the strategies identified by workshop participants, there are numerous other potential arrangements. The possible combinations should be narrowed down based on feasibility and the need for a manageable number of segments (two or three, ideally). These finalists should then be compared and analyzed via costing studies, network modeling, and/or pilot studies to determine the ideal solution.

After review and discussion of the results of this activity, the technical assistants led another group activity to extend and apply the concepts of segmentation used in the first activity. In this exercise, participants applied these concepts to determine potential groupings for essential medicines destined for PHC customers. The technical assistants began the exercise by presenting this hypothetical scope before going through a comprehensive list of logistics characteristics for both customers and products, which the participants chose from based on their relevance to the scope and objectives of the exercise (Figure 9). In Edo state, the participants selected "Public Health Priority" and "Shelf Life" as product characteristics that would impact the success of potential transportation strategies, and "Access to Transportation" as a customer characteristic. Participants then used these characteristics to create groups within the list of essential drugs used by PHC facilities. After creating these groups, participants identified transportation strategies that would support successful product delivery, using the same potential strategies as in the first exercise (Figure 10).

Figure 9. Categorized Edo State PHC Products

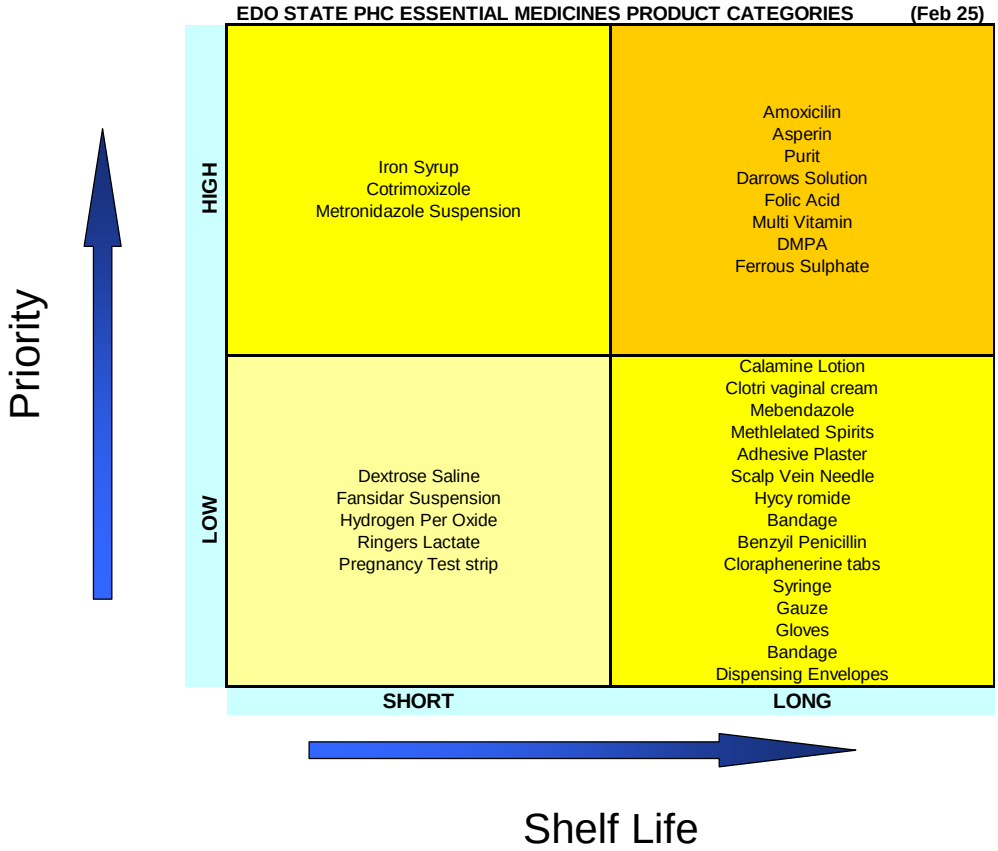
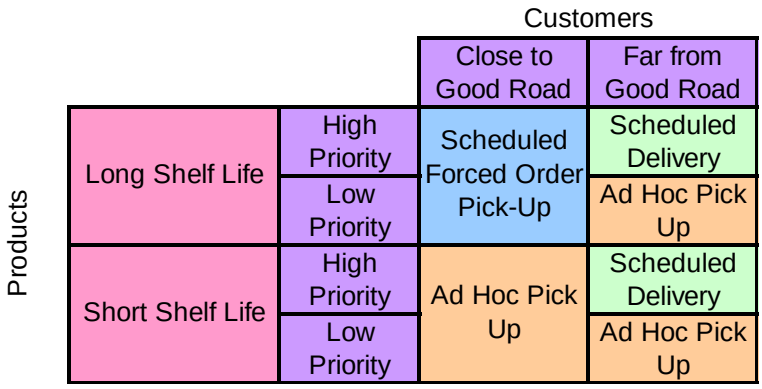


Figure 10. Potential Segments for Transportation Integrating Product and Customer Characteristics



As these examples from Edo state show, the participants first grouped essential medicine products around the selected logistics characteristics to understand what kinds of products would be contained in each group. Once they populated these groups, they selected transportation strategies for each customer/product combination. Participants quickly understood and applied the various transportation strategies in this second phase of the activity, recognizing the tradeoffs discussed in the earlier exercise that focused on secondary facilities.

At the end of the workshops, participants reflected on the theory and application of supply chain segmentation and how it could play a role in future improvements. In each state, the discussion focused on issues particular to its current objectives. In Edo state, discussion highlighted that segmentation could be used to improve service to current customers in order to encourage new customers to use the EDP as a supplier. In Kano state, with the intention of expanding its customer base to include a greater number of PHCs participating in the DRF, workshop participants determined that the program will have to make its operational processes more efficient to handle a large increase in the number of customers it serves.

Follow-Up in Edo State: Network Simulation for Transportation Assessment

Based on the results of the segmentation workshop in Edo state, a key next step identified was costing and performance modeling of the potential transportation arrangements. During the segmentation workshop, participants had concurred that a more responsive strategy might be well suited to transporting high volume and high priority products to facilities outside of Benin City. At the same time, an ad hoc pickup strategy could still work for lower volume, lower priority products. To be able to implement these strategies, Edo state required further refinement and costing of the arrangements identified during the segmentation process.

As a follow-up visit to Edo state, the USAID | DELIVER PROJECT proposed the use of network analysis to compare various distribution approaches in terms of the resources required to implement and sustain them. The aim of this technical assistance was to provide a clear and well-researched way forward for the Edo state MOH to improve distribution of essential medicines, and ultimately contribute to the health and well-being of patients across the state.

Prior to data analysis, the technical team conducted site visits and personnel interviews to help develop a picture of the current essential drug distribution system and identify specific problems.

For this research, the team applied the commercially available network analysis tool Supply Chain Guru™ (LLamasoft, Inc., Ann Arbor, MI, USA) to perform strategy simulation using data inputs collected during this and previous activities in Edo state. The team created 14 different scenarios (see Appendix A) to model potential versions of direct delivery strategies for the Edo state EDP. These 14 scenarios included differing arrangements of the following variables:

- Potential customer segmenting
- Total number and types of customers served by the EDP
- Total number and type of vehicles available for transport
- Delivery frequency and routing arrangement.

During these site visits, the technical assistants concluded that because the average secondary facility did not handle a large number of products, segmentation between product groups for distribution made little sense and that it would be difficult for requisition officers at these hospitals to manage a small group of products in two different ways. However, for procurement at the CMS, segmentation between product groups would be more feasible. During the segmentation workshop, the technical assistance team recommended that the CMS procure high volume, fast moving products under long-term contracts, effectively making them "shelf items," and improving their availability for hospital customers.

Based on the results of the scenario modeling, the technical team proposed the following recommendations:

- Segmentation of the two large secondary facilities in Benin City (requiring these sites to pickup products while all others received deliveries) would greatly reduce the transportation burden on the EDP.
- Two dedicated vans, each with load capacity of 2 m^3, should be enough to satisfy all demand within a given year.
- Use of planned routing or geographic customer grouping (according to the arrangements researched in this study) can help balance the workload across vehicle assets.
- The EDP should also consider the possibility of outsourcing direct delivery to a third party.

While the network modeling activity could potentially have recommended against a segmented approach, the segmentation workshops still would have played a valuable role in refining the objectives and identifying areas for improvement. Additionally, much of the data used in the network modeling phase had been gathered and cleaned during the earlier data collection and workshop phases.

Based on the results of this analysis in Edo state, a similar activity was planned for Kano state, using the previously analyzed consumption data to inform network modeling of the distribution system. In this activity, Kano state Ministry of Health stakeholders agreed to segment the DRF transportation function by delivering requisitions to facilities with a consistently high order value, while requiring facilities with lower value and less frequent requisitions to pickup their orders.

Conclusion

Lessons Learned

Applicability in Other Contexts

The concepts of segmentation can be applied in many other country contexts and can answer a variety of questions. From infrastructure considerations, such as adding a warehouse, to setting inventory levels and transportation options, most supply chains have a question that could be addressed using a segmentation exercise. And, although this is a fairly data-heavy exercise and may require extensive resources to gather that data, in most instances the information is available and accessible in some form. The biggest challenge is collecting and processing it so that it is useful in a segmentation analysis.

Analyzing the Supply Chain and Determining Bottlenecks

The segmentation framework is a useful way for supply chain managers to better understand their product and customer groups. Information such as monthly throughput volume, frequency of product requests, and specific ordering patterns of individual facilities can influence inventory control procedures, delivery routes, and system designs.

The ultimate goal of a segmentation exercise is to use data and assumptions about a system design, either for the entire system or for a subset of products and customers in the system. For best results, understanding both how the products and customers behave, as well as any operational bottlenecks, is essential. Even if a complete system re-design is not the intention, the exercise uses data to highlight operational bottlenecks, which could eventually inform future interventions to address those bottlenecks.

Using Data for Decisionmaking

One of the more significant results of these segmentation exercises in both Kano and Edo states is the use of data to support decisions about designing a supply chain system. Many well-designed systems have simply come from the instinct of the supply chain managers who work in the system. This process works on many occasions, but not always. There is an art to designing a supply chain, but it should be supported by data. And, the data in an exercise such as segmentation can assist decisionmakers to advocate for improvements to a supply chain.

In Kano state, the decision had already been made to build a new warehouse at the CMS prior to the segmentation exercise. However, the size of that warehouse had not yet been determined. Although determining warehousing constraints was not a primary question to be addressed with the segmentation exercise, information from the results informed how much additional storage space was needed.

Donors are increasingly requesting that MOH employ evidence-based decisionmaking, particularly when making decisions about health system strengthening. The segmentation exercise is a good example of how data can garner support from stakeholders and assist in management decisions.

Addressing Integration

Like the drive for use of data for decisionmaking, many donors have been advocating for integrated health services, which can make the health system more efficient. However, it would be incorrect to assume that integration would pertain to supply chains in the same way.

The types of products that could flow through an entirely integrated supply chain vary greatly—from expensive antiretrovirals (ARVs) with short shelf lives to extremely cheap and bulky cotton wool procurable in the open market, and everything in between. A fully integrated, one-size-fits-all supply chain would treat cotton wool the same as ARVs. However, the resources used to ensure near 100 percent stock availability for ARVs and the extra security provided for these expensive products in high demand would be wasted on very cheap cotton. Likewise, should ARVs be managed in the same way as cotton wool, there would likely be extensive expiries and stockouts. Managing for the average product means none of the products are served well.

Segmentation is a systematic response to requests for fully integrated supply chains. Rather than seek efficiencies by managing discordant products with the same policies, which could actually result in a more inefficient system, segmentation merges the supply chain functions of products or customers where it is beneficial, using data and critical thinking to group segments together. Segmentation is the supply chain managers' answer to the call for integration of vertical program products.

Data Challenges

The first step in collecting data is to determine what data should be collected and how that data will represent the supply chain. There were pros and cons for a variety of different data points: issues from CMS, shipping data, invoice data, and requisition data. Technical advisors felt that health facility requisitions sent to the state CMS would best represent the demand of each of the hospitals. However, this data had never been collected and compiled before. Acquiring requisition data from each of the hospitals required sending a representative to each of the facilities to request the data. It was difficult to determine if the requisition forms acquired during the data collection were all of the requisitions. They also did not account for any procurements made in the open market, outside of the state CMS. Despite these caveats, requisition data was the preferred data point.

Additionally, in one of the states, hospitals were not using a standard requisition form, making the data entry from handwritten forms even more challenging. Consultants hired to enter the paper requisition forms into an Excel spreadsheet took more than two months to complete the work.

Not only was this process time- and resource-intensive, but as with any manual data entry, it was also not extremely robust. Some of the handwriting was difficult to read and there were many missing fields. Although this is inherent to any form of manual data entry, it does highlight its weaknesses. In addition to the time to enter the data, technical advisors put much effort into cleaning the data to ensure the segmentation results were as accurate as they could be.

The segmentation analysis would be more accurate and much faster if conducted in a system where at least part of their data is collected and analyzed electronically. This should not exclude programs without automated data from considering applying a segmentation analysis, but they should plan appropriately for the time that it may be necessary to gather, enter, and clean the data used to segment the products and customers.

Stakeholder Participant Selection

In both Kano and Edo states, workshops were held to introduce the concepts of segmentation to relevant stakeholders. This introduction is necessary to ensure appropriate commitment from decisionmakers about re-designing a program or multiple programs' supply chain(s) assumptions and decisions on how each segment can and should be managed. This process is better with a smaller number of stakeholders who are familiar with how these products move through the supply chain.

The smaller groups led to more thoughtful, productive discussions about how products and customers act and what specific supply chain interventions would be best suited to their needs. These specific discussions were difficult to have in plenary. Thus, the workshop portion of this analysis should be done in two phases. The first phase should occur with a wide variety of participants to gain perspective and commitment. The second phase, as recommended in the USAID | DELIVER PROJECT publication, *Planning and Designing a Logistics System Design Workshop* (USAID | DELIVER PROJECT 2009), works better with a smaller, more technically-focused participant list.

Being Prepared for Change

For a segmentation exercise, supply chain decisionmakers should ideally be open to the possibility of major changes in the design of their system. Reengineering a supply chain based on a segmentation exercise could save the system a large amount of resources, but would often require a substantial initial investment. Thus, this exercise would ideally occur when a system design or other major transition is already planned.

Additionally, to segment across multiple vertical supply chains and multiple partners requires support from all those involved. In both Kano and Edo states, technical advisors were primarily limited to data on the essential medicines package. And, as none of the other vertical programs were looking to re-design their supply chains, merging vertical programs would have been challenging. Timing and coordination are important pieces to consider when applying this segmentation framework.

Although neither Edo nor Kano states were prepared to make such sweeping changes to their systems, each was able to apply smaller, more manageable changes based on some of the results of the segmentation data analysis. Additionally, further feasibility and costing analyses were able to reveal just how much they could change with the resources available.

As an approach to supply chain improvement, segmentation offers a high degree of flexibility. It can be used to identify strategies in one or many functional areas, and across one or numerous operating tiers. What is definite is the ability of segmentation to apply real world data in a compelling fashion to stakeholders of various backgrounds. Public health practitioners can easily comprehend concepts such as fast and slow moving, high or low value, and bulky or small products. With segmentation, they can apply this knowledge of logistics characteristics in areas where delivery systems are already segmented across lines of product programs. With increasing pressure to combine these product programs, developing country public health systems can make use of segmentation to rationally identify operating strategies that could potentially accommodate product integration. Segmentation has the ability to look at problems both large and small, all with a focus toward increased supply chain performance and product availability.

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Appendix A: Scenario Results

Scenario	KM	Work days/Asset	Shipments	Vans	Trucks	Trans Cost	Labor Cost	Maint/Ins/Dep	Asset Fixed Cost	Total Annual Cost
Baseline	128,664	244	821	3	0	$ 13,117	$ 7,200	$ 22,500	$ 90,000	$ 42,817
Hospital_MedZones	45,896	88	300	3	0	$ 4,679	$ 7,200	$ 22,500	$ 90,000	$ 34,379
Hospital_Private	-	0	-	3	0	$ 77,500	$ -	$ -	$ -	$ 77,500
Hospital_Prop1	45,370	88	301	3	0	$ 4,625	$ 7,200	$ 22,500	$ 90,000	$ 34,325
Hospital_Prop2	42,600	67	189	3	0	$ 4,343	$ 7,200	$ 22,500	$ 90,000	$ 34,043
Hospital_Prop3	51,929	94	307	3	0	$ 5,294	$ 7,200	$ 22,500	$ 90,000	$ 34,994
Hospital_Prop4	50,661	85	255	2	1	$ 5,165	$ 7,200	$ 40,000	$ 160,000	$ 52,365
Hospital_Prop5	85,557	141	416	3	0	$ 8,722	$ 7,200	$ 22,500	$ 90,000	$ 38,422
Hospital_Prop6	45,663	129	288	2	0	$ 4,655	$ 4,800	$ 15,000	$ 60,000	$ 24,455
Hospitals_Base	84,822	160	535	3	0	$ 8,648	$ 7,200	$ 22,500	$ 90,000	$ 38,348
LGA_Base	43,842	84	286	3	0	$ 4,470	$ 7,200	$ 22,500	$ 90,000	$ 34,170
LGA_MedZones	36,648	66	213	3	0	$ 3,736	$ 7,200	$ 22,500	$ 90,000	$ 33,436
LGA_Prop1	36,397	68	224	3	0	$ 3,711	$ 7,200	$ 22,500	$ 90,000	$ 33,411

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