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Guatemala: Using Supply Chain Modeling and Simulation to Analyze the Ministry of Health Supply Chain

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USAID | DELIVER PROJECT, Task Order 1
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Abstract
This activity analyzed the characteristics of the integrated logistics system in three departments in Guatemala: Sololá, Totonicapán, and Jutiapa. This paper identifies some of the obstacles to achieving contraceptive availability for the underserved and vulnerable populations; it also offers options for improving equity in access for family planning commodities.

The study identifies elements in the Ministry of Public Health and Social Welfare's (MSPAS) logistics system that could impede the availability and accessibility of contraceptives. By using supply chain simulation and optimization modeling software, with geographic information system tools, the authors propose system-related solutions that could improve the performance of the overall MSPAS.

Cover photo: *Community facilitators, such as these indigenous Kaqchikel women who work in the San Pablo Community Center in Sololá Department, provide health services, including family planning, to the most remote and difficult to access communities in Guatemala.* Photograph by the USAID | DELIVER PROJECT 2009.

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ACRONYMS

APROFAM	*Asociación Pro Bienestar de la Familia de Guatemala*
BCC	behavior change communication
BRES	*Balance, Requisición, y Entrega de Suministros* (Requisitions, Balances, and Delivery of Supplies logistics information form)
CPR	contraceptive prevalence rate
CS	contraceptive security
DAS	*Dirección de Area de Salud* (health area)
ENSMI	*Encuesta National de Salud Materno Infantil* (National Survey of Maternal and Child Health)
ESRI	Environmental System Research Institute
FP	family planning
GIS	geographic information system
IDA	International Dispensary Association
IEC	information, education, and communication
IUD	intrauterine device
LAC	Latin America and the Caribbean
LMIS	logistics management information system
MSPAS	*Ministerio de Salud Pública y Asistencia Social* (Ministry of Public Health and Social Welfare)
NGO	nongovernmental organization
PNSR	*Programa Nacional de Salud Reproductiva* (National Reproductive Health Program)
SDP	service delivery point
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development

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The authors also thank the following staff members from the USAID |DELIVER PROJECT, who provided tremendous support in the conceptualization and implementation of the study and the writing and editing of the report: Juan Agudelo, Linda Allain, Wendy Abramson and Claudia Allers.

EXECUTIVE SUMMARY

The analysis presented in this paper identifies elements in the Guatemala Ministry of Public Health and Social Welfare's (MSPAS) logistics system that could impede the availability and accessibility of contraceptives. The analysis also proposes, through the use of supply chain simulation and optimization modeling software and geographic information system (GIS) tools, system-related solutions that could improve the performance of the overall MSPAS integrated supply chain. The analysis focused on the integrated logistics system in three different departments in Guatemala: Sololá, Totonicapán, and Jutiapa. The departments were identified in a concurrent analysis completed by the Latin America and Caribbean (LAC) Regional Contraceptive Security Initiative, which identified obstacles to achieving contraceptive availability for the underserved and vulnerable populations and provided options for improving equity in access to family planning commodities. The Supply Chain Management and the LAC Regional Contraceptive Security (CS) Initiative teams of the USAID | DELIVER PROJECT conducted this activity.

The study included pre-trip data collection and analysis exercises, in-country interviews with stakeholders, and interviews to service providers from site visits to 43 facilities in the focus departments. In addition, data on product stock levels for Jutiapa and Totonicapán were obtained through the MSPAS logistics unit's logistics module database; data on the Sololá product stock levels were obtained directly from order and requisition forms. We obtained data on unmet need for family planning products through the 2002 Guatemala National Survey of Maternal and Child Health (ENSMI)[1]. Stakeholders consulted prior and during the trip included the MSPAS National Reproductive Health Program (PNSR,) the U.S. Agency for International Development (USAID) Mission, *Calidad en Salud*,[2] and the United Nations Population Fund (UNFPA).

The analysis produced answers to a number of key questions regarding distribution capacity and network design for contraceptives within the framework of an integrated system; it concludes with a number of implications for both policy and operations for the MSPAS to consider.

- ***Product availability at service delivery points (SDPs) does not cause unmet need.*** Data collected during site visits at 43 facilities, as well as data provided by the National Reproductive Health Program suggest low levels of unfulfilled demand (<3 percent), which is defined as being an instance when a product is requested at a SDP but is unavailable.[3] If high levels of unmet need exist, as reported in the 2002 ENSMI study, it does not appear to be due to product availability, but instead is attributed to cultural bias and personal choice. Accordingly, the use of social education campaigns may be a viable strategy to reduce unmet need, and to lead to increased demand for family planning products.
- ***An increase in demand for contraceptives will only have marginal effects on the overall warehousing and transportation capacity needs for the department-level integrated***

[1] Unfortunately, the latest available ENSMI is from 2002. When the new survey becomes available it will be useful to update this analysis with most recent data.
[2] *Calidad en Salud* is a USAID-funded bilateral project that provides technical assistance to the MSPAS in supply chain management for health commodities. University Research Corporation manages the project.
[3] See Table 1 for the difference between this definition and that of unmet need.

distribution systems. Contraceptives take up no more than 3 percent of the volume of the average monthly demand of all products. Even with a 20 percent increase in demand for contraceptives, this would only mean an increase of 4 percent of the total demand volume. At the product level, the leading contraceptive in volume is condoms, which rank 20th on a list of 105 products managed by DAS, and classified by average monthly distribution volume; they take up only 1.3 percent of the volume. Furthermore, in the integrated system, the top two products represent, on average, 20 percent of the volume requirements; *acetaminofen* syrup represents 9.9 percent and *bromhexina* syrup represents 8.8 percent. Efficient and focused management of these two products may help solve warehouse and transportation capacity problems for family planning products.

- ***Data collected on real-demand (sum of real consumption and unfulfilled demand) amounts suggest high levels of month-to-month variability that can be challenging for the supply chain.*** Using supply chain simulation software, the distribution system for Sololá was modeled to illustrate how representative high levels of demand variability can result in either stockouts or an increase in the number of emergency orders. To monitor sites with high levels of variability, MSPAS should perform periodic reviews of their data. If, after a review, the variability is real, they should either be aware of the increased need for emergency orders or increase the maximum stock levels. Conversely, it is possible that sites reporting high levels of variability may be completing their report and order forms incorrectly, which would require more training.
- ***Analysis of the indirect distribution system's configuration through a GIS reveals opportunities to streamline the distribution process.*** In an indirect distribution network, or one with multiple levels, such as the systems in Sololá and Jutiapa, an optimal distribution network configuration would be one in which the facilities at the lowest level of the system receive their commodities from the next higher level located closest to them. A GIS analysis of the MSPAS distribution network in Sololá, with geo-referenced data on roads and health facilities, revealed that five of the 10 district warehouses deliver commodities to SDPs that are located closer to another district.
- ***Changing the distribution system of contraceptives for nongovernmental organizations (NGOs) so that ambulatory physicians pick up products directly at the MOH district warehouse instead of the NGO warehouses can result in a 44 percent increase in order processing resources for the MSPAS.*** For transportation costs, the decision should only be made at the local level after analyzing the road network between the NGO warehouse, the government warehouse, and the jurisdictions. Given the complexities of these localized networks, if the goal is to reduce transportation costs, a generalized policy decision is not recommended.

INTRODUCTION AND OBJECTIVE

The main objective of this activity was to analyze the characteristics of the integrated logistics system in three departments in Guatemala: Sololá, Totonicapán, and Jutiapa. The departments were identified in a concurrent analysis completed by the USAID | DELIVER PROJECT staff with the Latin America and Caribbean (LAC) Regional Contraceptive Security Initiative. The group identified obstacles to achieving contraceptive availability for underserved and vulnerable populations and offered options to improve equity in access for family planning commodities (Sánchez, Abramson, y Lamadrid 2008).[4] Based on the gap analysis to access contraceptives, the study also identified elements in the Guatemalan Ministry of Public Health and Social Welfare's (MSPAS) logistics system that could impede the availability and accessibility to contraceptives; using supply chain simulation and optimization modeling software and geographic information system (GIS) tools, the study proposed system-related solutions that could benefit the performance of the overall MSPAS integrated supply chain. The project's Supply Chain Management and the LAC Regional CS Initiative teams jointly conducted this activity.

[4] Sánchez, Anabella, Wendy Abramson, and Carlos Lamadrid. 2008. *Guatemala: Equity in Access to Family Planning Services and Contraceptives: Identifying Strategies to Improve Access to the Last Mile.* Arlington, Va.: USAID | PROYECTO DELIVER, Task Order 1. (Available in Spanish only).

BACKGROUND AND METHODOLOGY

Prior to arriving in Guatemala, the teams analyzed the available data on health and demographics to identify specific areas of the country where obstacles to family planning services affect the most marginalized segments of the population. A critical piece of this data included the *2002 Guatemala National Survey of Maternal and Child Health (ENSMI)*, which identifies high areas of unmet need for contraceptives. Based on these findings and recommendations from in-country stakeholders (MSPAS, *Calidad en Salud*, and the USAID mission), three departments were selected for site visits: Sololá, Totonicapán, and Jutiapa. The team developed a set of questionnaires and conducted site visits in 43 facilities. In addition, several meetings were held with key stakeholders in Guatemala City, including the MSPAS' National Reproductive Health Program (PNSR), the U.S. Agency for International Development (USAID), *Calidad en Salud*, the United Nations Population Fund (UNFPA), and APROFAM. The team also collected information from the MSPAS logistics unit and their associated logistics module. Using data modeling and simulation software, LLamasoft's Supply Chain Guru, and GIS software, Environmental System Research Institute (ESRI) ArcView and Network Analyst, the team analyzed the logistics system and identified and addressed the following critical questions:

1. Are stockouts causing unmet need at the service delivery point level?
2. If there is an increase in demand for family planning products, what capacity constraints exist and how should they be best addressed?
3. How variable is the demand for contraceptives and what effect does this have on the supply chain?
4. How might the configuration of the MSPAS distribution plan affect the efficiency of the logistics system?
5. What distribution system should nongovernmental organizations (NGOs) use for contraceptives?

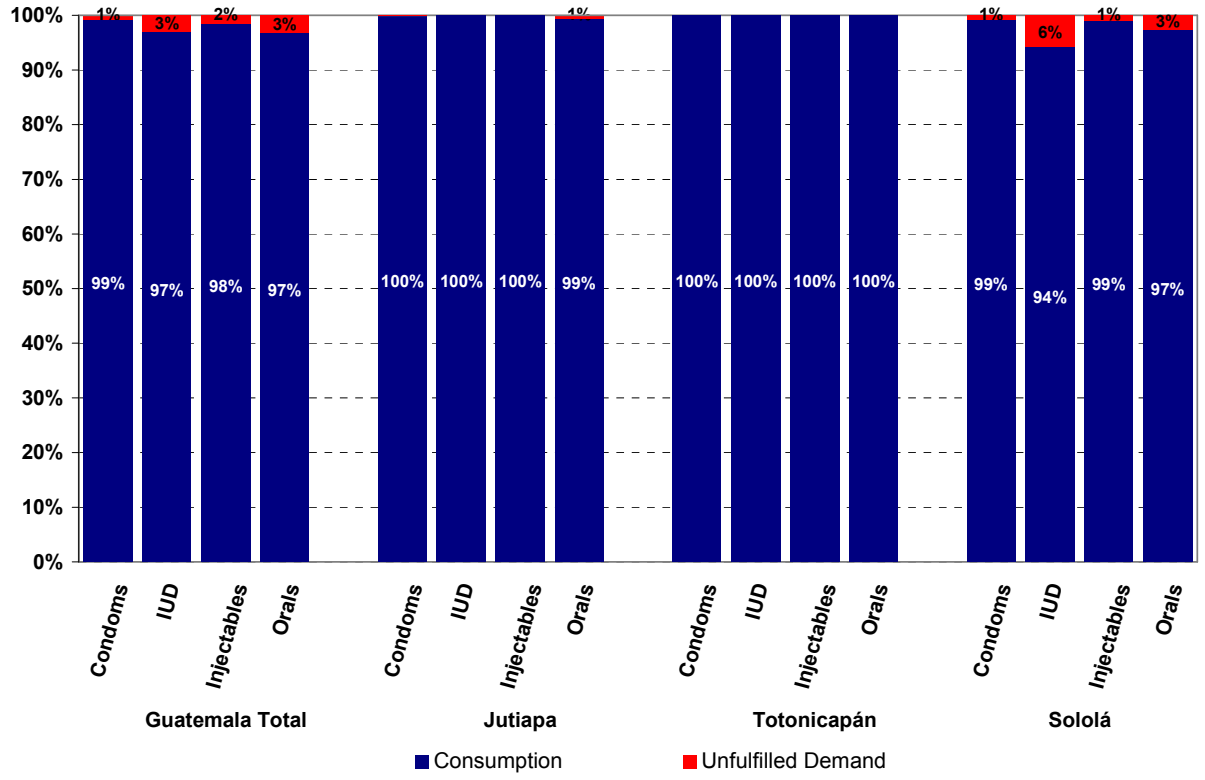
This report addresses these questions and concludes with a number of recommendations on both policy and operations for the MSPAS to consider.

RESULTS

ARE STOCKOUTS CAUSING UNMET NEED AT THE SERVICE DELIVERY POINT LEVEL?

Prior to performing the site visits in Jutiapa, Totonicapán, and Sololá, the teams expected to find significant levels of stocked out family planning products because of the high levels of unmet need in these departments, according to the 2002 ENSMI. Instead, however, during the site visits they found no existing or endemic stockout problems for contraceptives at the health posts, health centers, or district and department warehouses. Data collected during the field visits in May 2008 were consistent with the aggregated 2007 data on consumption and unfulfilled demand collected by the PNSR (see Figure 1).

Figure 1: Unfulfilled Demand for Contraceptives



Source: **MSPAS National RH Program, "Real Demand for Contraceptive Methods (2007)"**

The data suggests that the MSPAS has been successful in ensuring that actual demand for contraceptives is being fulfilled, at a very high rate, at the service delivery point (SDP) level, with a 98 percent average for product availability across the supply chain (health posts, health centers). For the three departments visited, the data is even more impressive—the most popular contraceptive,

Depo-Provera, reached 100 percent availability in Jutiapa and Totonicapán, and 99 availability in Sololá. It is worth noting, however, that *unfulfilled demand*, which is a logistical data item captured in the MSPAS Requisitions, Balances and Delivery of Supplies (BRES) form,[5] is not the same as *unmet need,* which was the basis of the 2002 ENSMI used to identify areas of possible inequity. Following is an explanation of these terms:

Unmet Need: A woman has an *unmet need* if she is married, in a union, or sexually active status; is fecund (able to conceive a pregnancy); does not want to have a child in the next two years; and is not using any contraception, either modern or traditional (ENSMI 2002).

Unfulfilled demand: is a data point captured in the BRES that quantifies the amount of product that was unavailable even though there was actual demand. In practice, this information is collected and added to the actual consumption (called real demand) for the reporting period to ensure that order replenishment amounts reflect real demand versus only consumption.

High levels of unmet need, therefore, can be attributed to factors other than stockouts. In fact, the 2002 ENSMI shows that the main reasons women of reproductive age do not use family planning include (1) the woman is not married or in a union, (2) she is not having sexual relations, (3) her religion forbids contraception, (4) her spouse opposes contraception, (5) the fear of side effects, and others. Of note, the survey results included two reasons related to logistics. The first, *lack of access to services,* rated less than 1 percent for respondents in rural Jutiapa, Sololá, and Totonicapán, which is consistent with a very low level of unfulfilled demand. The second reason, *distance to facilities*, is related to the logistics system itself, and again was negligible in the three departments. See appendix 1 for the full results.

The logistics data, therefore, strongly suggests that unmet need is not being caused by stockouts, as measured in terms of unfulfilled demand. The data implies that women who wish to obtain products can access them when they visit health facilities. The unmet need, as it exists, is due to personal choice and social considerations. The implication of this finding is that social education campaigns may reap huge benefits, leading to increased future use of family planning products. Accordingly, the logistics system should be further analyzed to determine how best to meet an increase in demand.

IF DEMAND FOR FAMILY PLANNING PRODUCTS INCREASES, WHAT ARE THE CAPACITY CONSTRAINTS AND HOW CAN THEY BE BEST ADDRESSED?

The following analysis focuses on identifying warehousing and transport capacity constraints at lower levels of the supply chain health areas (DAS) and SDPs that may arise; it also identifies measures to address them.

Local stakeholders are particularly concerned about whether the current supply chain for contraceptives can handle a potential future increase in demand and if any capital investments are needed to handle increased volumes of stock (e.g., expanding warehouse space or purchasing additional vehicles at the DAS level). To answer this question, the project teams conducted a

[5] The BRES is the reporting and requisition form used throughout the MSPAS commodity supply chain.

volumetric analysis of the logistics system at the department level. This process included creating a data model using the following methodology:

- calculating average monthly demand for all products used in each service delivery point
- matching individual products to corresponding shipping unit volumes, sourced from the United Nations Children's Fund (UNICEF), MissionPharma, and the International Dispensary Association (IDA) (USAID | DELIVER PROJECT 2009)[6]
- segmenting products into three categories: contraceptives, maternal and child health, and other products[7]
- segmenting sites into two categories, health posts and health centers, to determine the percentage of total volume covered by the three types of commodities listed above.

  This data model produced a number of different outputs that provided insights into the capacity needs of the system.

It is important to note that hospitals and NGOs are not included in this analysis because these two types of facilities only receive contraceptives from the DAS; therefore, a volumetric analysis was not required.[8]

Looking at the three groups of products provides an insight into how capacity is split for average monthly demand by these product segments. Figure 2 shows the results for Jutiapa and Totonicapán, for which 2007 and early 2008 data sets for all products were available through the MSPAS computerized logistics module. Key observations from this figure include—

- Contraceptives represent less than 1 percent of volume for Totonicapán and less than 3 percent for Jutiapa[9].
- Maternal and child health products account for approximately one-third of the volume.
- The *other products* category, comprising essential medicines, accounts for approximately two-thirds of the volume.

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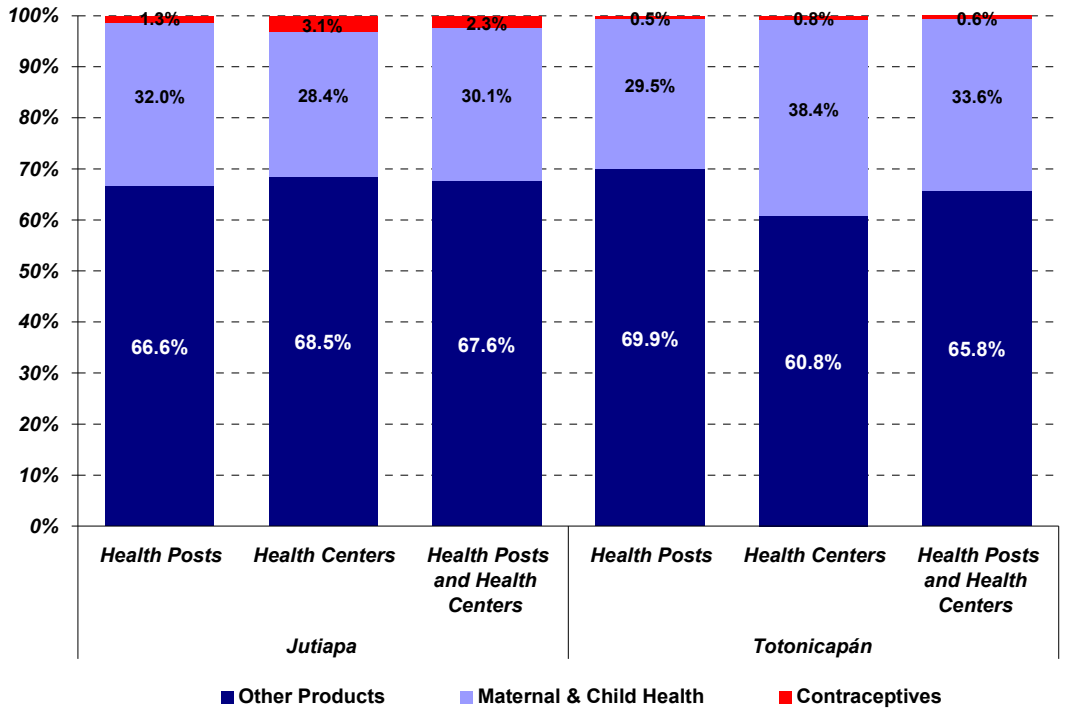
[6] USAID | DELIVER PROJECT. 2009. *Master List of Pharmaceutical and Medical Supplies Volumes, Weights, and Units of Measure.* Arlington, Va.: USAID | DELIVER PROJECT, Task Order 1.

[7] Categories of products were organized based on the essential drugs packages of MSPAS provided by the logistics unit and the PNSR.

[8] To see a comparison of the volumes of contraceptive commodities distributed to health centers, health posts, NGOs, and hospitals, see appendix II.

[9] This difference may be attributed to a higher use of condoms in Jutiapa at health centers, possibly due to demand caused by its proximity to the Pan-American Highway's and related higher incidence of sexually transmitted diseases.

Figure 2: Volume of Average Monthly Demand for All Products by Product Segment



Source: MSPAS Logistics Module (January 2007 to April 2008)

Figure 2 shows that in this integrated system, that family planning products put minimal volumetric load on the distribution system (transport and storage). Table 1 illustrates how an increase in demand for contraceptives would affect the average distribution capacity requirements for health centers in Jutiapa. Note that demand amounts for *maternal and child health* and *other products* are kept constant.

Table 1: Effects of Demand Increases on the Contraceptive Volumes for Health Centers in Jutiapa

	No Change	5% Increase	10% Increase	20% Increase
% of total volume represented by contraceptives	3.1%	3.3%	3.4%	3.7%

Based on the quantities illustrated in Figure 2 and Table 1, a 20 percent increase in demand for family planning services would result in a .6 percent increase in average monthly shipment volumes, e.g., from 3.1 percent to 3.7 percent. The implication is that even a considerable increase in contraceptive demand should have a minimal effect on the warehouse and transport capacity requirements at the DAS and lower levels of the supply chain. It is important to note that the PNSR warehouse is nearing full capacity at the current volume levels; the PNSR will need to consider identifying additional storage space should the demand for contraceptives greatly increase in the

future. Another alternative could be to reduce maximum inventory levels and discuss with suppliers the possibility of modifying the replenishment of shipments.

Carrying out a volumetric analysis by individual products rather than by product segment could also be a useful exercise. As shown in Table 2, products by volume are ranked based on the average monthly actual demand for Totonicapán and Jutiapa.

Table 2: Volumetric Composition of Average Monthly Demand for Jutiapa and Totonicapán

Rank	Product	Volume (cubic meters)	Percentage of Total (%)	Cumulative Percentage of Total (%)
1	ACETAMINOFEN 120/5 mg/ml Frasco Jarabe	2,25	9.9	9.9
2	BROMEXINA 4/5 mg/ml Frasco Jarabe	2,00	8.8	18.8
3	HIDROXIDO DE ALUMINIO Y MAGNESIO 185-200/5 mg/ml Frasco suspensión	1,750	7.7	26.5
4	BENCILO BENZOATO 25% Frasco	1,644	7.3	33.7
5	CLORHEXIDINA GLUCONATO SOLUCION 5% Galón	1,080	4.8	38.5
6	FUMARATO / SULFATO FERROSO 125/1 mg/ml Gotas	1,062	4.7	43.2
7	SALES DE REHIDRATACION ORAL 55.8 g Sobre	.892	3.9	47.1
8	CLORFENIRAMINA MALEATO 2/5 mg/ml Frasco Jarabe	.838	3.7	50.8
9	AMOXICILINA 250/5 mg/ml Frasco suspensión	.814	3.6	54.4
10	ANTIPOLIO 0 Sin Concentración Dosis	.800	3.5	58.0
11	SALBUTAMOL 2/5 mg/ml Frasco Jarabe	.649	2.9	60.8
12	TRIMETROPRIMA SULFAMETOXAZOL 40-200/5 mg/ml Frasco suspensión	.571	2.5	63.4
13	TDA 0.5 ml Dosis	.529	2.3	65.7
14	PENTAVALENTE 0.5 ml Vial	.519	2.3	68.0
15	ERITROMICINA 250/5 mg/ml Frasco suspensión	.387	1.7	69.7
16	ALCOHOL ISOPROPILICO 70 ° Frasco	.319	1.4	71.1
17	ALCOHOL ETILICO DESNATURALIZADO 88 ° Frasco	.302	1.3	72.4
18	FUMARATO / SULFATO FERROSO 300 mg Tableta	.301	1.3	73.8
19	METRONIDAZOL 125/5 mg/ml Frasco suspensión	.294	1.3	75.1
20	**CONDOM**	**.285**	**1.3**	**76.3**
21	DPT 0.5 ml Dosis	.284	1.3%	77.6
22	CLOTRIMAZOL CREMA DERMATOLOGICA. 1 % Tubo	.276	1.2	78.8
23	PEROXIDO DE HIDROGENO 3 % Galón	.264	1.2	**80.0**
41	**LOFEMENAL 75.33 mg Cycle**	**.100**	**0.4**	**94.0**
46	**DEPO PROVERA 150 mg**	**.060**	**0.3**	**95.6**
89	**IUD**	**.004**	**0.0**	**99.8**
105	DIMENHIDRINATO 50 mg Tableta	.0001	0.0	**100.0**

Source: MSPAS logistics module (January 2007 to April 2008)

This type of analysis provides a number of insights. First, it is easy to see, as highlighted in blue, the relative share of total volume that each of the four contraceptive methods represents. Condoms, being the bulkiest, are the 20th most voluminous item, but they only occupy 1.3 percent of the volume of the average monthly demand. Lo-femenal is the 41st item, representing 0.4 percent; Depo-Provera is the 46th item, representing 0.3 percent; and intrauterine devices (IUDs) are 89th, representing less than 0.05 percent of the volume.

It is interesting to note that the volumetric data by product follows, almost exactly, Pareto's law that says 80 percent of the effects come from 20 percent of the causes. As Table 2 shows, 80 percent of the volume is made up by the top 20 percent of total products, with the 23rd ranked product (out of 105 total products), *peroxide de hidrogeno*, reaching the cumulative percentage of the total volume of 80 percent, which is displayed with a bold red line. It should be noted that only one contraceptive, condoms, is in the top 20 percent of product volumes for an average order, ranking 20th out of 105 products.

Looking even closer at these top 23 products, it is easy to see that the first few products take a disproportionate share of the total volume. Notably, the first ranking product, *acetaminofen* syrup takes up 9.9 percent of volume space and *bromhexina* syrup takes up 8.8 percent. These products, pediatric syrups, are bulky and in high demand. This finding has significant implications for inventory management.

Note: For more volumetric breakdowns, including comparisons of average volumes (cubic meters) demanded by different site types, as well as a breakdown of volumes for MCH products, see appendix 2–appendix 5.

HOW VARIABLE IS THE DEMAND FOR CONTRACEPTIVES AND WHAT EFFECT DOES IT HAVE ON THE SUPPLY CHAIN?

One of the challenging aspects of managing any supply chain is being able to meet future demand for products even though the demand is constantly changing. The degree to which monthly demand quantities differ from an average demand quantity, usually referred to as demand variability, plays an important role in determining how a supply chain should be managed. For instance, highly variable demand may necessitate higher safety stocks or more frequent deliveries than the same product with low or no demand variability.

The logistics system in MSPAS follows a rigorous methodology; it uses the past three months of historical demand to determine average monthly consumption, which, in turn, is used to determine order quantities using a maximum-minimum (max/min) system. This process helps adjust inventory quantities according to monthly demand behavior. The team verified how close these three-month historical averages matched the actual consumption. Table 3 shows the percentage for which the projected demand for condoms, IUDs, injectables, and orals was greater or smaller than the actual demand in all three departments, over a ten-month period.

Table 3: Projected Demand as Percentage of Actual Demand for 2007

		MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
		Percentage									
Jutiapa	Condoms	-13	3	5	-12	-23	-5	5	-21	13	46
	IUD	-38	0	33	183	22	-63	44	-64	0	700
	Injectables	-11	5	-7	7	3	-10	2	-8	1	64
	Orals	-40	51	2	13	-8	-22	8	-13	13	104
Totonicapán	Condoms	-17	-12	7	4	35	-18	-26	-47	171	88
	IUD	-47	11	33	22	-70	-41	267	-22	67	67
	Injectables	-24	12	-17	-10	28	-23	19	-13	32	19
	Orals	-50	27	-4	-5	10	-19	-6	-8	29	32
Sololá	Condoms	52	-3	9	18	7	50	-39	-20	8	10
	IUD	-70	33	-33	0	-10		-61	-37	-77	157
	Injectables	-11	31	24	-9	-14	22	-5	27	6	-23
	Orals	-8	44	31	-10	-31	97	-12	-17	4	4

Projected demand under-estimated by more than 20 percent

Projected demand over-estimated by more than 20 percent

Projected demand under- or over-estimated by less than 20 percent

*Projected amounts calculated using an average of previous three months.

Source: (MSPAS National Reproductive Health Program 2007)

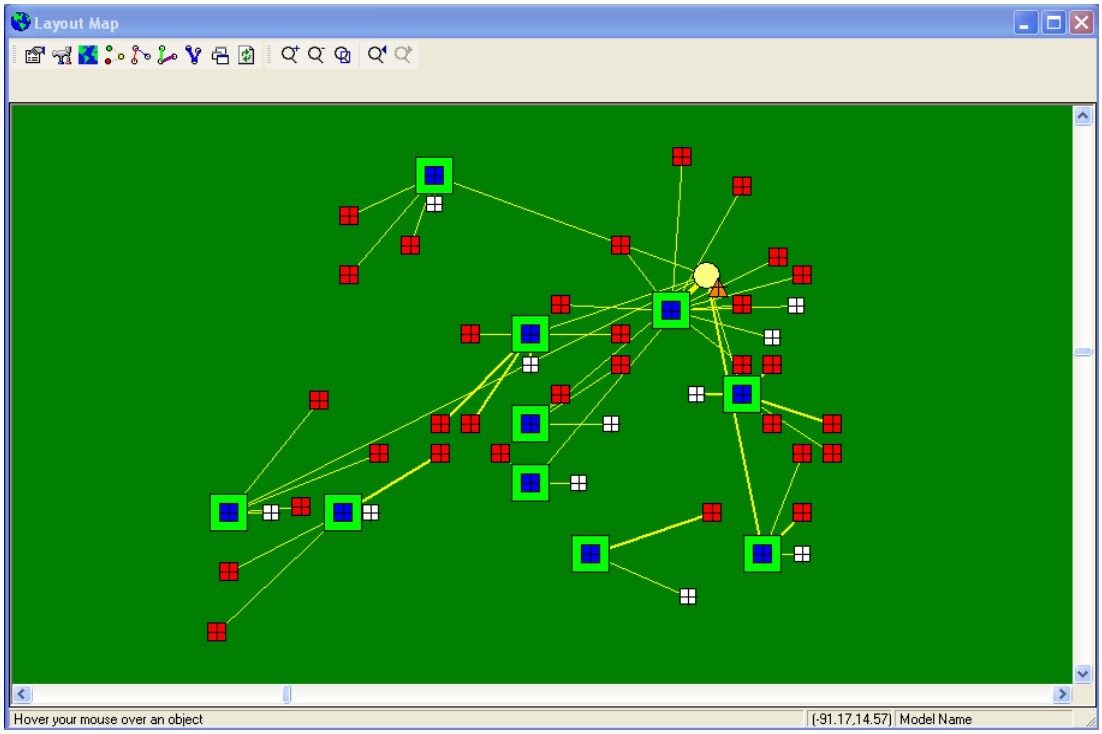
The red highlighted areas represent projected demand that was under-estimated by more than 20 percent; this occurs in 25 of the 120 product-month-department squares in Table 2. The yellow highlighted areas represent projected demand that was over-estimated by more than 20 percent; this occurs in 34 of the 120 product-month-department squares in Table 3. Therefore, for 59 out of a possible 120 times (50 percent), the demand amount estimated, using the three-month historical average, was either over or under the actual demand amount by more than 20 percent. This suggests that even using projections based on the three-month historical data does not completely remove variability. However, variations of average consumption are reduced.

Given the complexity of large logistical networks, such as the MSPAS system, the effect of high variability can be both significant and hard to measure. Accordingly, it is necessary to measure the variability levels using advanced analysis methods, such as supply chain simulation modeling. For this purpose, the project used commercial software, Supply Chain Guru by LLamasoft.

Figure 3 visually represents the model for the Sololá department that was constructed using the software. Constructing the simulation model entailed creating virtual sites that represent the DAS warehouse, 10 district warehouses, 10 health centers, 33 health posts, and one department hospital. A series of sourcing policies and inventory rules were programmed to mimic the simulation for the

actual logistical system for Sololá. The NGOs were not included in the simulation because it was impossible to determine the location of all the NGO warehouses in the system.

Figure 3: MSPAS—Simulation of Sololá DAS



Using this software, the simulation was run three times: (1) a baseline model with no variability in demand, (2) a scenario with 25 percent variability in demand, and (3) a scenario with 50 percent variability in demand. Although the simulation included all contraceptives for the whole department, the resulting values for condoms at Sololá's health center (see in figures 4–6) illustrate the effects of variability on the supply chain. To make the simulation realistic, the value of 106 condoms per month was used as the average demand, using a one-third max-min system and a reorder quantity derived from the previous three-month demand average.

Figure 4: Inventory Levels for Sololá Health Center—No Variability in Monthly Demand for Condoms

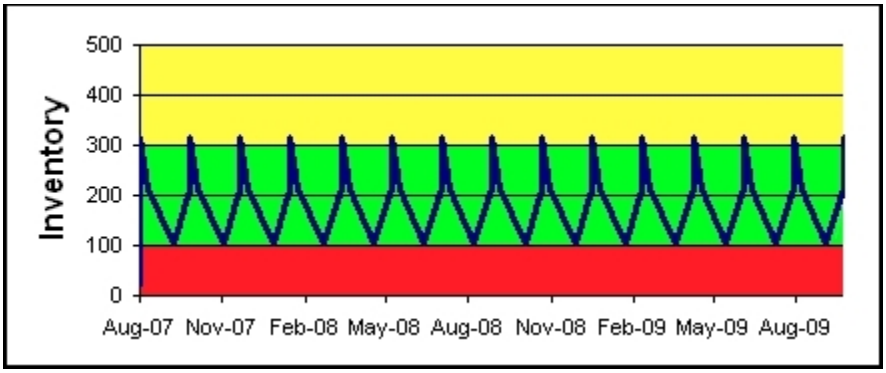


Figure 5: Inventory Levels for Sololá Health Center—25 Percent Variability in Monthly Demand for Condoms

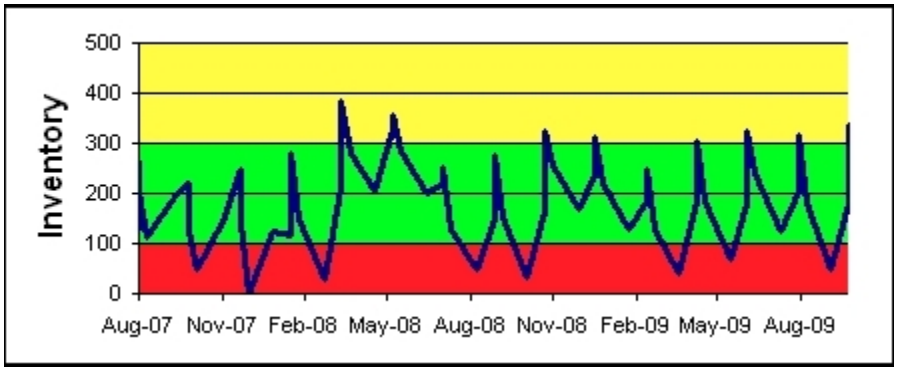
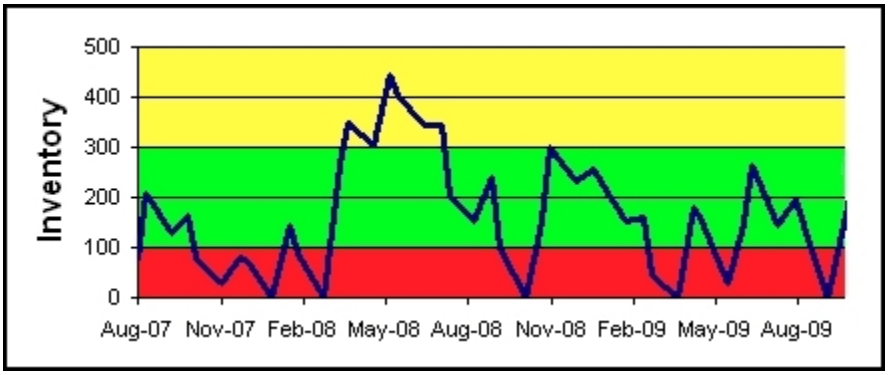


Figure 6: Inventory Levels for Sololá Health Center—50 Percent Variability in Monthly Demand for Condoms



See Table 4 for the results of these simulations.

Table 4: Effect Demand Variability Has on Stockouts at Sololá Health Center

Simulation Run	# Stockout Periods	Instances Crossing above Max (overstocked)	Instances Crossing below Min (potential emergency order)
Zero variability	0	0	0
25% variability	1	5	8
50% variability	5	2	6

As shown in Table 4, the increase in variability to 25 percent resulted in one instance of a stockout and the increase to 50 percent variability resulted in 5 instances of stockout. It should be noted that this occurs even with the three-month historical average calculations for average monthly consumption being used to determine the order amount using the max-min system. Demand variability can impact the supply chain in many ways. One of the most obvious consequences is the supply chain's vulnerability to the bullwhip, or the Forrester Effect—variability at one end of the supply chain can be amplified as it goes through multiple tiers.[10]

Another consequence can be the need for large buffer stock to compensate for the unpredictable demand or increased frequency of emergency shipments. With the high levels of variability in the Sololá supply chain, it might be asked why Sololá's health center is not actually experiencing stockouts, as mentioned in the beginning of this report. While they were in the field, the team noted that, in Sololá, the contraceptives were being delivered monthly to many of the sites, instead of the regular two-month cycle for essential medicines. Therefore, one hypothesis that is consistent with the simulation model is that these monthly deliveries are actually emergency orders.

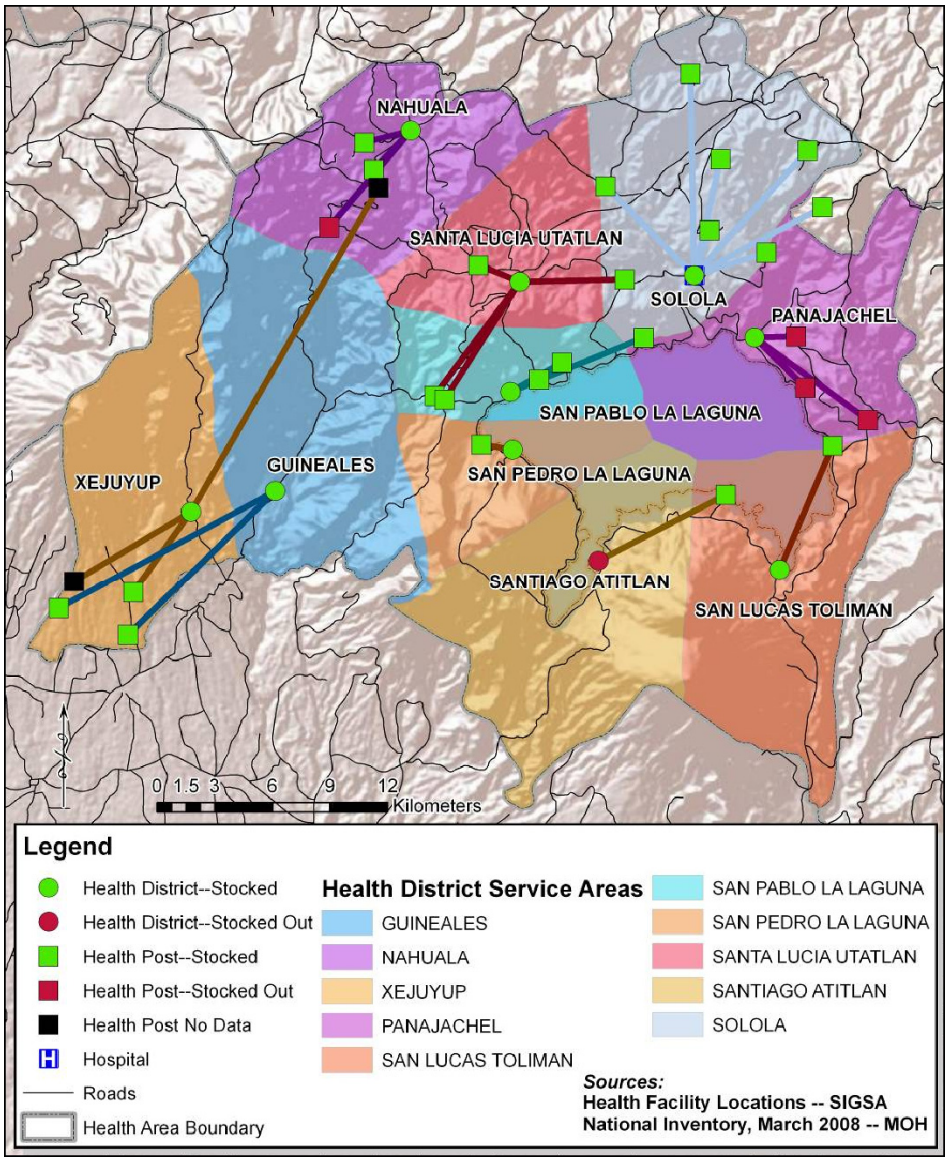
Given the demand variability found in the BRES and the computerized logistics management information system (LMIS), one activity the PNSR should consider is to monitor the quality of data registered in the BRES and analyze if it is reasonable that the demand for contraceptives show this level of variability.

HOW CAN THE CONFIGURATION OF THE MSPAS DISTRIBUTION NETWORK AFFECT THE EFFICIENCY OF THE LOGISTICS SYSTEM?

At this time, it does not seem that the logistics system is contributing significantly to disparities in access to family planning, but the contraceptive prevalence rate (CPR) in the departments identified is quite low and unmet need is high, leading to the conclusion that a number of supply and demand barriers are in play. If these obstacles are overcome, family planning demand should increase and, therefore, the MSPAS will need to maintain and plan for a well-functioning supply chain to manage a larger volume of contraceptives in the system.

[10] The Bullwhip Effect (or Forrester Effect) is an observed phenomenon in forecast-driven distribution channels. The concept is based on the oscillating demand magnification upstream, which resembles a cracking whip.

Figure 7: Sololá MOH Network of Health Facilities and Stock Status (March 2008)



To address this challenge, the study relied on GIS tools to analyze the configuration of the distribution plans for the target departments and to determine whether or not they are organized efficiently. In an indirect distribution network, or one with multiple levels, such as the systems in Sololá and Jutiapa, an optimal configuration would be one in which the facilities at the lowest level of the system receive their commodities from the next higher level that is located closest to them. To best explain this observation, the MSPAS distribution network in Sololá (see Figure 7), with geo-referenced data on roads and health facilities. In Figure 7, the colored areas that correspond to the different districts do not represent district boundaries, but instead all the land that is closest to that district's warehouse and no other. For the system to operate efficiently, the distribution of commodities from each district warehouse to its service delivery points—shown as a bold line connecting health districts to health posts—should occur within the areas located closest to that

district warehouse, as described previously. Note that in Figure 7 some health districts distribute commodities to facilities that are located closer to another district.

WHAT DISTRIBUTION SYSTEM SHOULD NGOS USE FOR CONTRACEPTIVES?

MSPAS contracted NGOs in Guatemala to play an extremely valuable role in meeting the goal of reaching the *last mile*. The NGOs have a basic health team—comprising ambulatory physicians, nurses, institutional facilitators, community facilitators, and traditional birth attendants—who supply the rural areas with family planning commodities. The Ministry of Public Health and Social Welfare is considering whether (a) it is better to replenish ambulatory team stocks at the NGO warehouses (as they do now), or (b) to have ambulatory team personnel pick up contraceptives from either district-level warehouses (indirect distribution model) or department-level warehouses (direct distribution model).

Either option (a) or (b) can be analyzed by the balance of workload between government districts and NGO facilities. As an example, the Sololá department has 10 health centers, 33 health posts—5 NGOs cover 26 jurisdictions. This indicates that district-level warehouse managers now handle 48 orders every cycle. If, on the other hand, NGOs from each of the jurisdictions picked up replenishments from the district-level, they would process an additional 26 orders during the same period or 69 orders. This represents a 44 percent increase in the workload for the districts for processing paperwork, as well as a greater workload on the district-level warehouse managers to process orders—in effect, for a significant amount of their time they would be a dispensary for doctors. The political implication of this arrangement is that most of the logistics management of commodities to NGOs would rely on the district instead of the NGOs, who already receive funding specifically for managing their stocks of essential drugs.

From the logistics data quality perspective, the current system, where ambulatory physicians fill out and manage their BRES forms for contraceptives, would add a layer of quality control because these forms are aggregated at the NGO level before they are submitted to the district or DAS warehouse. The scenario where ambulatory teams go directly to the district to submit their BRES forms and obtain supplies would effectively eliminate this level of quality control in the data from the BRES forms. To compensate, the MSPAS would need to invest more resources to continue building up the capacity of the ambulatory physicians to fulfill these essential recordkeeping tasks.

Moreover, scheduling the additional pickups, especially with relatively informal NGO entities, could create more uncertainties for district's scheduling picking, packing, and manifest capacity. Essentially, the increased complexity and stresses on human resources may mean that leaving things as they are is a better option.

CONCLUSIONS

The data collected and analyzed for this study illustrates that at least 98 percent of women who wish to obtain family planning products can access them when they visit public health facilities. The high level of unmet need, however, based on the most recent surveys, appears to be due to various operational and cultural barriers (Sánchez, Abramson, y Lamadrid 2008). For supply, family planning products are approximately 3 percent of the total volume for the average monthly demand at health facilities; an increase in the use of family planning products will not result in a substantial strain on the integrated warehousing and transportation system at the department level. Even if social campaigns increased demand by 20 percent, the volume requirements for contraceptives would still be only 3.7 percent of the total shipment volume.

Of possible concern, the available data on real demand for contraceptives captured by the logistics system shows a high degree of variability, which can be a leading cause of supply chain difficulties, including stockouts or a lack of stockouts but a large number of emergency orders. This could be the possible reason for why contraceptive products in Sololá are ordered separately from medicines and are delivered to health facilities every month instead of bimonthly for all other products.

An added strain on the logistics system is the organization of the distribution network at the department level. For Sololá, 29 percent of the health posts do not receive their commodities from the nearest district warehouse but from a district located farther away. Without optimizing the distribution network's organization, the DAS pays increased, and potentially, unnecessary transportation costs.

For NGOs, there are many concerns as to whether or not ambulatory physicians should obtain supplies directly from the district warehouse (or the DAS warehouse for a direct system). The main concerns are the potential strain that increased orders will place on district logistics managers and the loss of data quality assurance currently provided by the NGO administration.

Finally, while reviewing the stockout data twice a year, the study also found that using two physical inventories to evaluate stockouts might distort availability during those periods. In particular, because both physical inventory exercises have been done for the last eight years during the same time period, this might lead service providers to secure availability only for those dates (March and September). Monitoring only this indicator does not show if health establishments are adequately stocked all through the year. An alternative to measure availability in a more integral way is to measure the number of days a service was stocked out. The information to build this indicator is found in the Kardex; it could be monitored in the automated LMIS module of MSPAS.

RECOMMENDATIONS

RECOMMENDATION 1: ANALYZE WAREHOUSING AND TRANSPORTATION CAPACITY TO RESPOND TO INCREASES IN DEMAND FOR CONTRACEPTIVES.

The volumetric analysis for all products shows that it is necessary to analyze department-level warehouse and transport capacity to store medicines and contraceptives that respond to 100 percent of consumer demand. If a department reports that capacity constraints for warehousing or transport hinder the distribution of family planning products, the first solution to be considered should focus on managing the bulkier products, namely *acetaminofen* and *bromhexina*, which take up approximately 20 percent of the volume of the average monthly demand to a health facility.

At the national level, the PNSR warehouse is reaching its maximum capacity. Because the PNSR regularly monitors consumption levels at each of the DAS and coordinates national procurement of commodities, it is recommended that the PNSR consider expanding storage capacity, if they see an increase in demand.

Furthermore, concerns were expressed during the study about whether the PNSR would need to invest in vehicles should demand for family planning increase substantially within the departments. If the costs are spread in proportion to the volumes for distribution and warehousing, the PNSR should not need to buy additional vehicles because of the minimal percentage of the total average volume occupied by family planning.

RECOMMENDATION 2: EXPLORE THE CAUSES OF DEMAND VARIABILITY FOR CONTRACEPTIVES AND ADJUST INVENTORY POLICIES.

It is recommended that MSPAS monitor the variability of real monthly demand of products. If product demand is highly variable, as it was in this analysis, the following steps should be considered:

- MSPAS should assess the data to ensure that it is being captured correctly. Sites that report high variability for monthly real demand should be targeted for inspection to ensure they are completing the forms correctly.
- If the data is indicative of real demand values and shows high month-to-month variability, two options could be considered to ensure that stockouts do not occur: (1) increase safety stock levels, or (2) increase deliveries. Both remedies have advantages and disadvantages based on the trade-offs between extra inventory costs and extra transportation costs; therefore, either remedy should only be selected after the source data is confirmed as correct.

RECOMMENDATION 3: ANALYZE THE ORGANIZATION OF THE DISTRIBUTION NETWORK AT THE DAS LEVEL.

To further improve the logistics system, the MSPAS should determine whether the configuration of the distribution networks within each DAS is designed so that health districts supply commodities to the health facilities closest to them. By completing this level of analysis on the system, the different DASs may be able to minimize their transport costs and redirect any savings to other high-priority needs, such as training for personnel or procurement of commodities.

RECOMMENDATION 4: DETERMINE THE BEST METHOD, CASE-BY-CASE, OF SUPPLYING AMBULATORY PHYSICIANS WITH CONTRACEPTIVES.

The decision to have ambulatory physicians pick up products directly at the government district warehouses instead of the NGO warehouses should be considered only after considering a number of different factors. For transportation costs, the decision should only be made at a local level after analyzing the road network between the NGO warehouse, the government warehouse, and the jurisdictions. Given the complexities of these localized networks, it is not recommended that a generalized policy decision be made if the goal is to reduce transportation costs.

In addition to the effects on transportation, MSPAS should consider the effects that this policy change will have on the operational and human resource requirements at the government warehouses. Specifically, this policy change would result in a 44 percent increased workload for processing orders at the district-level warehouses in Sololá. Accordingly, this change should only take place after MSPAS has determined that the human resources are in place to meet these needs. Too much stress on the order processing system at the district warehouse level can result in poor data quality, poor storage practices, poor transport practices, and, ultimately, higher costs and stockouts.

RECOMMENDATION 5: REPOSITION LOGISTICS SYSTEM PERFORMANCE INDICATORS TO REWARD A FULL SUPPLY OF CONTRACEPTIVE COMMODITIES.

One of the most effective means of ensuring contraceptive availability is to reward logistics system personnel according to indicators that measure the achievement of full supply during the entire year. It is recommended that the PNSR revise the indicators that currently define good performance, such as stockout based on the semi-annual inventory of all medicines and contraceptives, and define new indicators that reward personnel based on commodity availability; for example the indicator that measures the duration (in days) of stockouts.

RECOMMENDATION 6: WITHIN THE MSPAS LOGISTICS MODULE, DEVELOP AN ALGORITHM TO MONITOR DEMAND VARIABILITY BY SERVICE DELIVERY POINT.

The demand variability analysis in this report used the Supply Chain Guru to conduct simulations on historical data, yet ongoing analysis of demand variability could be included within the MSPAS logistics module using a specific algorithm. It is also recommended that the logistics unit consider developing such an algorithm to monitor demand variability to the lowest levels of the supply chain (SDPs and NGOs).

RECOMMENDATION 7: COORDINATE BEHAVIOR CHANGE COMMUNICATION AND INFORMATION, EDUCATION, AND COMMUNICATION PROGRAMS WITH PERSONNEL FROM THE SUPPLY CHAIN SYSTEM.

Behavior change communication (BCC) and information, education, and communication (IEC) programs may lead to significant health benefits for populations in the future, along with potential increased future use of family planning products among previously underserved populations. To improve projections of future demand for contraceptives, these programs should include the supply chain managers when developing the strategies.

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APPENDICES

APPENDIX 1: ANALYSIS OF REASONS FOR NOT USING CONTRACEPTIVES AMONG SURVEY RESPONDENTS

REASONS FOR NOT USING CONTRACEPTIVES—URBAN SURVEY RESULTS

Reasons for not using FP	Jutiapa Urban	Sololá Urban	Totonicapán Urban
Not married or in union	***13.04***	***33.46***	***29.18***
Menopausal	0.00	15.21	3.37
Does not have sexual relations	***8.70***	***13.48***	***23.54***
Infrequent sexual relations	0.00	7.21	0.00
Worried about health issues	***8.70***	***6.53***	***7.53***
Pregnant	8.70	6.20	2.38
Infertile	0.00	6.20	1.53
Fear of side effects	13.04	4.13	0.70
Desires more children	8.70	2.06	4.36
For religious reasons	8.70	2.06	2.92
Opposition from spouse	17.39	0.00	6.96
Opposition to FP	8.70	0.00	4.36
Distance to facilities	***0.00***	***1.73***	***0.00***
Total percentage of 7 most frequent responses	**100.00**	**88.29**	**79.30**

First	
Second	
Third	
Fourth	
Fifth	
Sixth	
Seventh	
Other	

ENSMI 2002

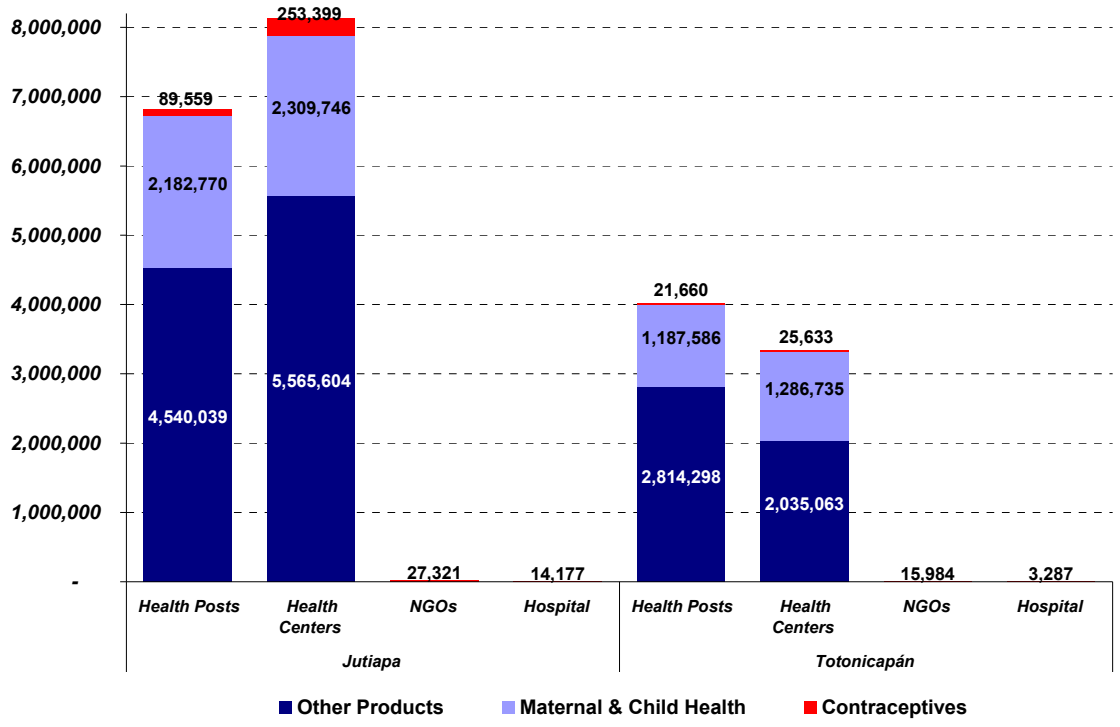
REASONS FOR NOT USING CONTRACEPTIVES—RURAL SURVEY RESULTS

Reasons for not using FP	Jutiapa Rural	Sololá Rural	Totonicapán Rural
Not married or in union	***26.20***	***31.83***	***25.16***
Does not have sexual relations	***16.06***	***11.83***	***13.48***
For religious reasons	***5.88***	***9.44***	***13.89***
Worried about health issues	***6.64***	***8.10***	***11.10***
Pregnant	5.61	7.32	1.42
Menopausal	1.26	4.89	2.07
Infertile	0.00	3.57	1.75
Not familiar with methods	7.52	3.11	6.15
Opposition from spouse	3.67	1.94	5.08
Desires more children	10.00	1.83	6.63
Opposition to FP	6.34	1.18	2.91
Lack of access to services	0.00	0.91	0.91
Distance to facilities	***0.00***	***0.38***	***0.00***
Total percentage of 7 most frequent responses	**78.64**	**76.98**	**81.49**

First	
Second	
Third	
Fourth	
Fifth	
Sixth	
Seventh	
Other	

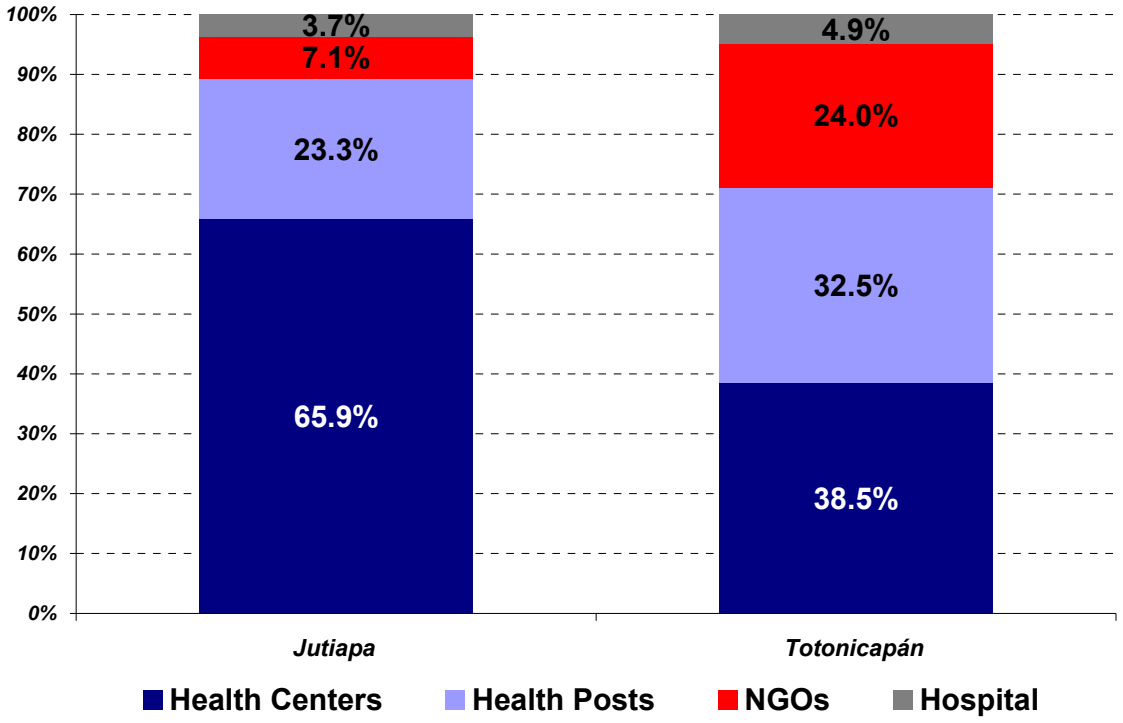
ENSMI 2002

APPENDIX 2: VOLUME OF AVERAGE MONTHLY DEMAND FOR JUTIAPA AND TOTONICAPÁN



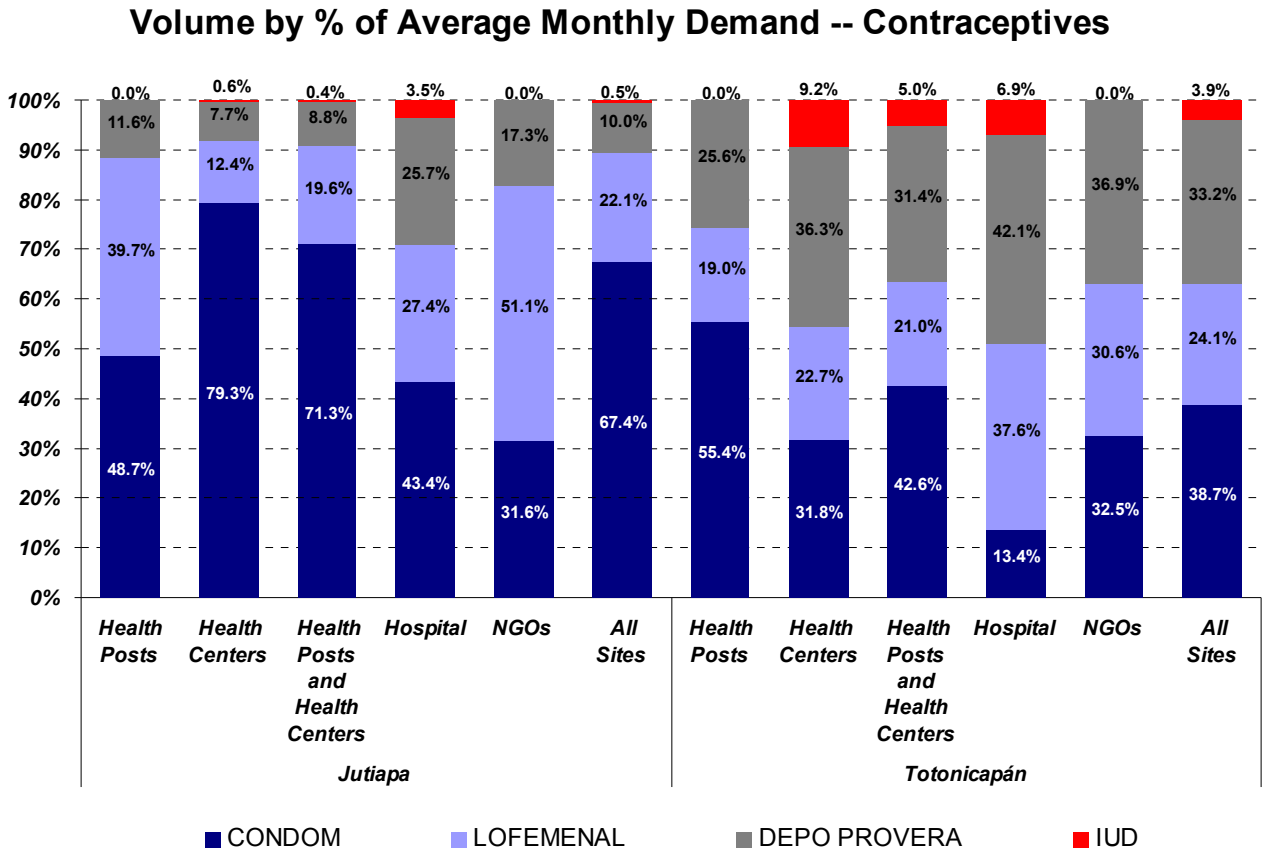
Source: MSPAS Logistics Module (January 2007 to April 2008)

APPENDIX 3: AVERAGE MONTHLY DEMAND VOLUMES BY SITE TYPE



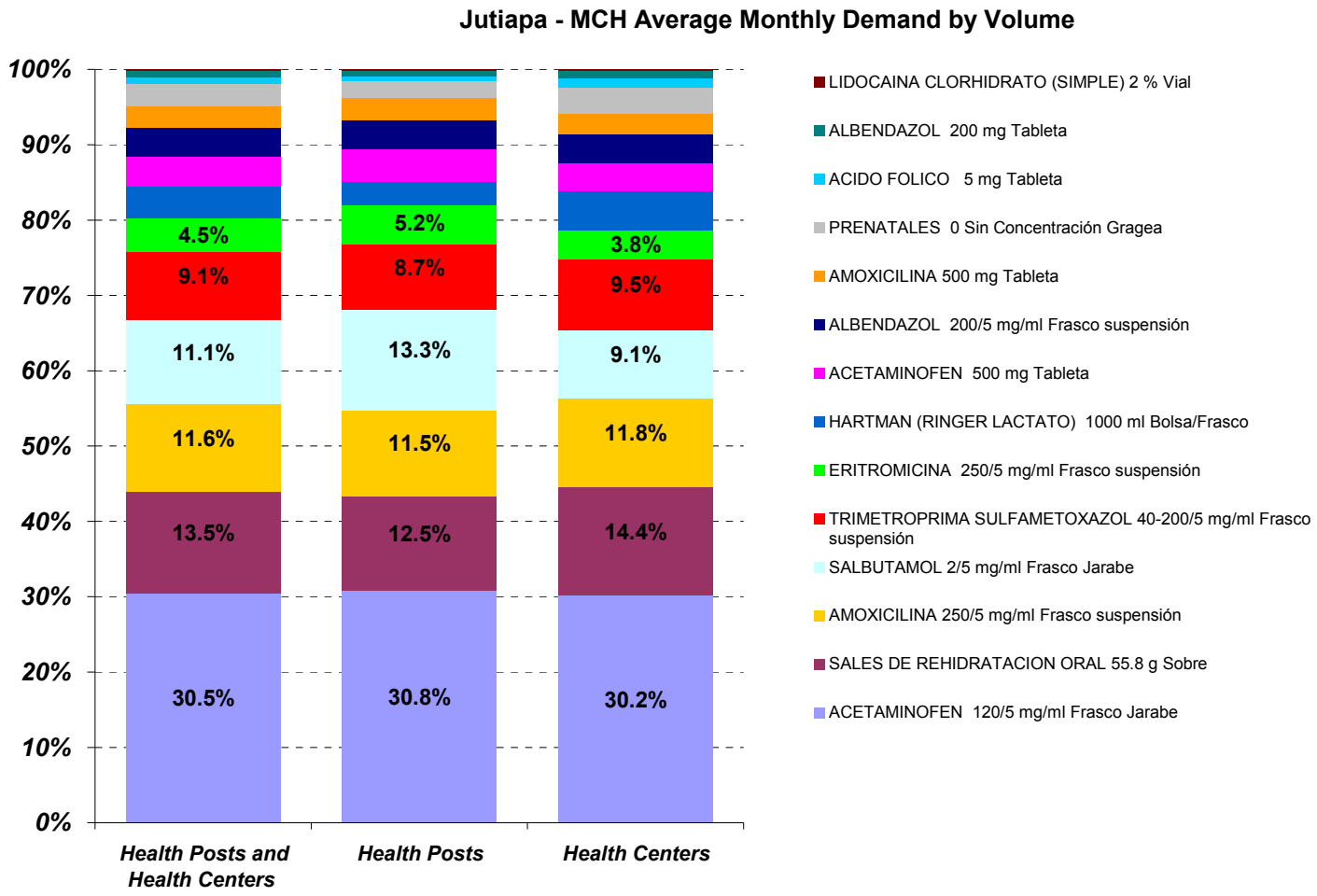
Source: MSPAS Logistics Module (January 2007 to April 2008)

APPENDIX 4: DISTRIBUTION OF MONTHLY DEMAND – PER SITE



Source: **MSPAS Logistics Module (January 2007 to April 2008)**

APPENDIX 5. MCH DRUG DEMAND EXPRESSED IN PERCENTAGE OF VOLUME DISPENSED



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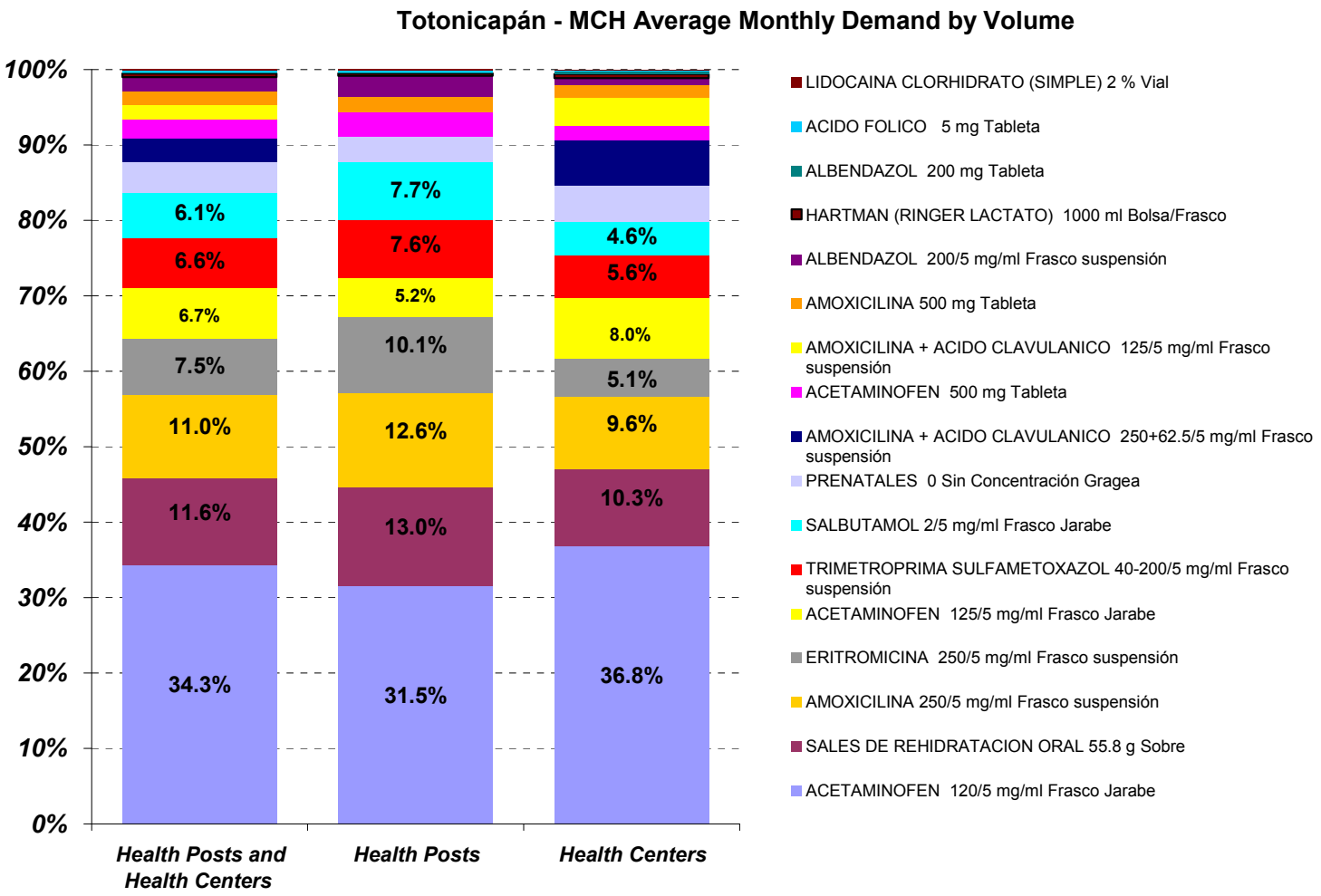

Source: **MSPAS Logistics Module (January 2007 to April 2008)**

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