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Peru logistics chain analysis

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Introduction

The inventory module of Situation Analysis, developed by the Population Council, has been adapted to help generate indicators of logistics system functioning suggested by The Evaluation Project and to provide an analytical framework that permits more accurate estimations of the frequency, location, and patterns of logistics problems. During the first quarter of 1996, the Situation Analysis inventory module was implemented in the health region of Los Liberatdores Wari in southern Peru. In 1997, the same module was implemented in the coastal province of Santa (Ancash department), and in two provinces of the highlands department of Huancavelica. In total, comparable information was obtained from 149 service delivery points (SDPs) in four departments (Ica, Ancash, Ayacucho, and Huancavelica). The data collected from these facilities include inventories of contraceptive supplies and other consumable materials required for the safe delivery of all types of contraception; the frequency of contraceptive stockouts in the three months prior to the survey; service and distribution statistics required for calculating the number of months of stock on hand; and potential or evident problems with storage practices or conditions.

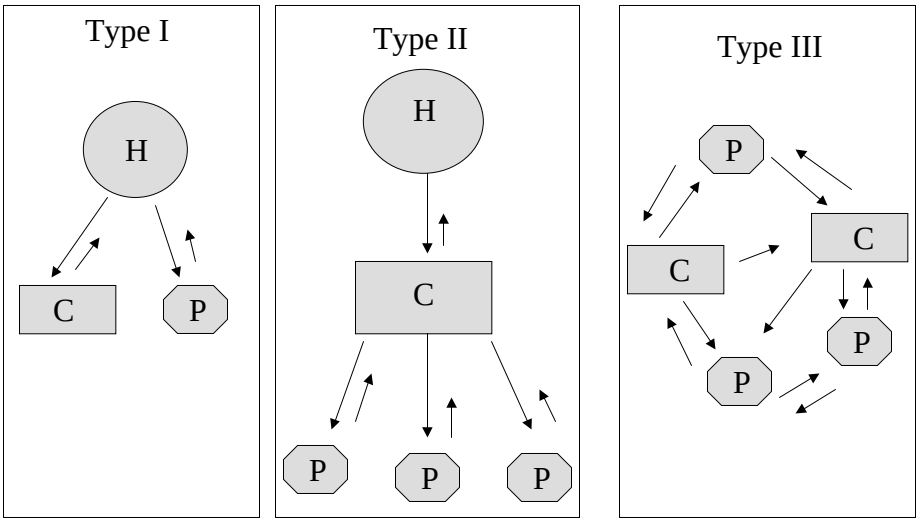
Descriptive information regarding the local logistics systems was collected after the inventory module had been implemented. In this paper, data on material stockouts is cross-tabulated with the logistical framework within which each SDP is operating, based on the hypothesis that understanding problems in logistics systems functioning requires knowledge of the context in which service delivery points are re-supplied. An analysis of logistics systems that incorporates the supply chain (rather than taking each facility in isolation) may help program managers' better tackle logistical problems in the future.

Logistics Frameworks: Inventory Data from Peru

In Peru, three principal types of logistical chains are present in the four departments surveyed (see Figure 1). The most common chain is the dyad, where a central hospital is responsible for supplying both health centers and health posts within its jurisdiction. The traditional three tiered chain also exists in which a hospital is responsible for supplying specified health centers, and the centers in turn are responsible

for supplying their designated health posts. The third type of logistics chain, present only in one of the four departments, is referred to as a "micro-network" formed of health centers and posts with fluid re-supply mechanisms. This functional organization has developed from access considerations, budgetary concerns, and/ or public health goals.

Figure 1 *Types of Logistics Chains*



H=Hospital C=Center P=Post

For all three types of chains, local hospitals receive supplies directly from the Ministry of Health. The two-way arrows in Figure 1 indicate that the existence of a chain does not detail how an individual SDP physically receives its supplies. That is, some hospitals or centers may deliver supplies directly to their dependent health units while others may require that these facilities collect their own supplies. The following table presents the distribution of SDPs by department and type of logistics chain.

Table 1 *Distribution of SDPs by Geographical Department and Logistics Hierarchy*

Department	Type I: Hospital Dyad	Type II: Hospital to Center to Post	Type III: Micro-network (Fluid re-supply between Centers & Posts)	Total (N)
Ayacucho	36	0	26	62
Ancash*	16	22	0	38
Huancavelica	9	9	0	18
Ica	31	0	0	31
% of Total	**62%**	**21%**	**17%**	**149**

*Santa only

Grouping SDPs into their respective logistic chains permits identification of entire systems that are performing poorly relative to other arrangements. Table 2 displays the percentage of SDPs with one or more months of supply on hand (based on past distribution averaged over a three month period) by chain type. SDPs with less than a month's worth of supply are considered to be effectively "stocked out" as they would be unlikely to be able to accommodate even small increases in demand.

Table 2 *Percentage of SDPs with 1+ Months of Contraceptives in Stock by Chain Type*

	Type I	Type II	Type III	All SDPs
Condoms	73	73	54	68
Pills	73	89	22	66
Injectables	50	83	58	58
IUDs (excluding posts)	85	100	25	80

However, as was shown in Table 1, chain types are not evenly distributed throughout the four regions. In particular, the micro-network configuration is found only in Ayacucho, a poor, mountainous department facing particularly difficult access issues. Types 1 and 2 are found in both mountainous (Ayacucho and Huancavelica) and coastal (Ica and Ancash) areas, although Type 1 is the dominant configuration in the coastal regions, where access is easiest. Given such a distribution, the comparison of logistics system performance by chain type is heavily influenced by the particular characteristics of the regions in which they are found. While a global comparison of the performance of

the three chains is made in Table 2, the main focus of analysis will therefore be intra-chain dynamics.[1]

Dynamics of Supply Flow within Chains

Characterizing the functioning of a logistics system requires knowledge of where bottlenecks are occurring once stocks leave the central storage facility usually located in the capital city. For the dyad (Type 1), stockouts can result from insufficient supply at the central hospital (typically resulting in stockouts at both the hospital and peripheral facilities), or may be confined to centers and posts, while sufficient supplies are maintained by the distributing hospital. In the latter case, stockouts may be due to insufficient requisition orders by the peripheral facility (due to poor record keeping), or episodic conditions such as unfavorable weather or other transportation difficulties. Within the three tiered system (Type 2), supply problems begin at either the first or second tier, but follow the same dynamic presented for the dyad chain. The fluid structure of the micro-network makes the physical identification of bottlenecks less useful, although it may be possible to identify the characteristics of the facilities (or local networks) most likely to have supply problems.

A. Analysis of Logistics Functioning for Dyad Relationships

Locating the breakdown within the logistical chain is the first step toward reducing the frequency of stockouts. Table 3 displays the distribution of contraceptive stockouts by type of facility within the Type 1 (dyad) chain. Facilities that reported no monthly distribution of a given method (e.g., less than one pill user served per month) have been excluded from analysis, since their lack of 'stockouts' is not a direct reflection of logistics management.

[1] Given the geographical distribution of chains discussed above, it is somewhat surprising that Type 2 performed significantly better in terms of pill and IUD stocks than the other chain types (*Chi Square Test*, $p<.001$ and $p<.01$, respectively).

Table 3 *Percent Distribution of Stockouts by Type of Facility, Dyad Chains (Type 1)*

	Pills	Condoms	Injectables	IUDs
Hospitals (N=10)	0	0	40	0
Centers (N=29)	30	24	62	23
Posts (N=46)	33	37	46	NA
All Facilities (N=85)	28	29	51	17

From the distributor's perspective (i.e., the hospital), 10 independent chains are represented in Table 3, and insufficient stocks at the level of the hospital do not appear to be a generalized problem, while between one quarter to over half of centers and posts had inadequate stocks of at least one contraceptive method. Supply flows also appear to depend on the method in question. IUDs, with a lower monthly distribution rate, are least affected by supply problems, while injectable contraceptives are subject to the highest level of stockouts.

In the dyad system, the difference in stock levels between health centers and health posts is expected to be less pronounced than in a three tiered system, given that both types of peripheral facilities are only one tier away from the principal local distributor. This seems to be the case, on average, for the SDPs presented in Table 3.

In some cases, it may be more meaningful to separate SDPs into their dyadic pairs, presenting the four possible combinations of stock levels in a two-by-two table. Table 4 presents the distribution of facilities with adequate stocks of oral contraceptives by dyad.

Table 4 *Relationship between Hospital and Peripheral Unit in Logistic Dyads: Stocks of Oral Contraceptives*

	Center/Post with Adequate Stocks	Center/Post Stocked-out	Row Total
Hospital with Adequate Stocks	63%	37%	100 %
	(26 pairs)	(15 pairs)	(41 pairs)
Hospital Stocked-out	0%	0%	0%

Analyzing stock levels by the supplier-recipient relationship confirms that, in the case of oral contraceptives, the bottleneck is between the local supplier (hospital) and the peripheral facility, while local hospitals themselves appear to be adequately stocked.

Similar findings for condom stocks are presented in Table 5, with no evidence of supply problems at the hospital level, accompanied by supply problems in half of all dyads, resulting exclusively in stockouts among peripheral facilities.

Table 5 *Relationship between Hospital and Peripheral Unit in Logistic Dyads: Condom Stocks*

	Center/Post with Adequate Stocks	**Center/Post Stocked-out**	**Row Total**
Hospital with Adequate Stocks	54%	46%	100 %
	(22 pairs)	(19 pairs)	(41 pairs)
Hospital Stocked-out	0%	0%	0%

Greater variation in dyad performance was seen with respect to injectables (Table 6). All four possible logistics situations are present: just under a quarter of all dyads were in the ideal logistics situation of distributor and peripheral facility both adequately stocked; 27 percent of peripheral units were stocked out while the hospital had adequate stocks; 29 percent of centers or posts were *stocked* while the hospital was stocked out; and 20 percent of all dyads were in the least desirable logistics situation where both the hospital and the peripheral unit were stocked out.

Table 6 *Relationship between Hospital and Peripheral Unit in Logistics Dyads: Injectables*

	Center/Post with Adequate Stocks	**Center/Post Stocked-out**	**Row Total**
Hospital with Adequate Stocks	24%	27%	60%
	(10 pairs)	(11 pairs)	(21 pairs)
Hospital Stocked-out	29%	20%	40%
	(12 pairs)	(8 pairs)	(20 pairs)

These results indicate that supply problems related to injectables are generalized (approximating a random distribution), rather than localized within specific dyads (as was seen with respect to oral contraceptives and condoms). Where greater heterogeneity in the local system is present, analysis by dyad offers more precise information as to the magnitude of logistics problems.

B. Analysis of the Three Tiered Logistics System

The distribution of stockouts among the 25 facilities functioning under the 3 tiered (Type 2) system is presented in Table 7.

Table 7 *Percent Distribution of Stockouts by Type of Facility, Three Tiered Chains*

	Pills	**Condoms**	**Injectables**	**IUDs**
Hospitals (N=2)	0	0	0	0
Centers (N=5)	33	80	40	0
Posts (N=24)	13	21	17	NA
All Facilities (N=31)	14	29	19	0

As viewed from the top-down, only two independent chains are presented in Table 7 (22 SDPs belong to one three tiered system in Ancash and nine belong to another in Huancavelica). Neither hospital suffered from supply problems, indicating a breakdown in the movement of supplies within each area. Results in Table 7 also suggest that health centers face greater supply problems than health posts. This is a somewhat surprising finding for a three-tiered framework, where the centers themselves are responsible for supplying posts within their jurisdiction.

The three tiered system can also be analyzed by supply pairs. While results in Table 7 indicate that hospitals are adequately stock (and that the hospital –center dyads would be distributed between the two cells in the top row of the two-by-two tables presented above), the distribution of center-post dyads needs further analysis.

Table 8 *Relationship between Center and Post Dyad in Three Tiered System: Oral Contraceptives*

	Post with Adequate Stocks	**Post Stocked-out**	**Row Total**
Center with Adequate Stocks	65% (13 pairs)	10% (2 pairs)	75% (15 pairs)
Center Stocked-out	25% (5 pairs)	0%	25% (5 pairs)

The distribution in Table 8 indicates that adequately stocked centers are most likely to have adequately stocked posts and confirms that stocked out centers do not necessarily lead to stocked out posts. This may be a reflection of health centers' higher contraceptive

distribution, rendering stockouts more likely if record keeping is inadequate. In contrast, posts attending fewer family planning clients may hold enough supplies to get through several months of demand, providing supply coverage during periods when the distributing center is stocked out.

A similar pattern is seen with respect to condom stocks (Table 9) and injectables (Table 10), with posts reporting considerable higher stock levels than centers, almost irrespective of the supply status of the corresponding center.

Table 9 *Relationship between Center and Post Dyad in Three Tiered System: Condoms*

	Post with Adequate Stocks	**Post Stocked-out**	**Row Total**
Center with Adequate Stocks	35%	10%	45%
	(7 pairs)	(2 pairs)	(9 pairs)
Center Stocked-out	40%	15%	55%
	(8 pairs)	(3 pairs)	(11 pairs)

Table 10 *Relationship between Center and Post Dyad in Three Tiered System: Injectables*

	Post with Adequate Stocks	**Post Stocked-out**	**Row Total**
Center with Adequate Stocks	25%	5%	30%
	(5 pairs)	(1 pair)	(6 pairs)
Center Stocked-out	60%	10%	70%
	(12 pairs)	(2 pairs)	(17 pairs)

The analysis of dyads strongly suggests that efforts to improve the flow of supplies within the three tiered logistics system should focus on the movement of supplies between the local hospital and corresponding health centers. The center-to-post distribution chain appears less problematic, since most of the stockouts seen among posts resulted from inadequately supplied centers, and not necessarily due to a breakdown in the logistics relationship. However, 10 percent of posts were stocked out of oral contraceptives and condoms, while their supplying health center was adequately stocked, indicating that attention is warranted to those relationships.

Discussion

The ultimate goal of a logistics system is to ensure that the relevant supplies are available for every client that arrives at the door of a health facility or family planning clinic. Effective logistics management is undoubtedly a difficult task, and inadequate supplies are often the primary obstacle to improving the quality of family planning and reproductive health services. Even when program managers are aware of stockouts among health units in their jurisdiction, it is not always evident where the bottlenecks are actually occurring. An analysis of inventory data within the context of logistics relationships provides additional information on the nature of the detected problems that should help refine corrective action.

A logistics supply chain analysis with data from Peru suggests that the most significant bottlenecks occurred between the local hospital and health centers. This was found with the Type 1 (dyad) system, where both centers and posts receive their supplies directly from the hospital, and in the Type 2 (three tiered) system where hospitals supply centers, which in turn supply the posts in their area. This finding is somewhat contrary to a general perception that posts are the most difficult units to re-supply, given their relative geographical isolation.

While the distribution of stockouts by type of health unit provides basic information about the distribution of logistics problems, it provides no information as to the source of the detected problems. When SDPs are divided into dyads (or distributor-recipient pairs), it is possible to pinpoint where breakdowns are occurring and what their effects are on facilities further down the logistics supply chain. Analysis of data from Peru found that health centers generally did a better job of stocking their dependent health posts, when compared with hospital-center dyad, and that the stock level at the distributing center had a less pronounced affect on the supply status of the recipient health post than would be expected. This type of additional information provided by the contextual analysis of logistics data should lead to more relevant strategies for improving the flow of supplies between health facilities.