Gauging the Demand and Supply of Generic Medicine Distribution System in India

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P. Baba Gnana Kumar
KristuJayanthi College
(gnanakumar12000@yahoo.com)

Health care delivery system needs re-engineering as the essential medicines stock-outs are increasing. This research aims to identify the reasons for essential medicines stock-outs and methods to overcome this problem for the policy makers. After conducting research among 217 pharmacy stores, we identified three peculiar problems such as delinquent forecasting, improper sourcing methods and arbitrated drug pricing. We concluded that these problems can be reduced by introducing integrated customer data base, centralized sourcing system and direct sourcing system.

Keywords: Demand Sensing; Price Affordability; Spill Over Demand

1. Motivation

In developing countries, 30% of the deaths in primary medical centers are attributable to non-availability of medicines in the public health delivery system (WHO, 2014). According to the World Health Organization (WHO), an estimated 649 million people in India do not have consistent access to essential medicines. Even though, per-capita expenses on essential drugs increased from 29.77% to 46.6%, the supply of medicines decreased by 9% in India during the period 2008-13 (Anurag, 2013). The proportion of drug stock-outs stand at 17% in Tamil Nadu while it is 42% in Bihar (Planning Commission Report, 2014). Public spending on health care is rising in India. Urban patients in India spent 17.6 % of their mean per capita expenditure on the essential medicines; whereas it is 23.4% in case of rural places (Roy, 2012). An enormous sum of money is being spent on healthcare and medication services by the poor people in India. It suppresses them again to poverty. 2.2 per cent of families goes below the poverty line every year if the spending on essential medicines increases at the present rate of 19%. (Rao, 2012). Even though India is one among the countries in the world to have low-priced medicines (WHO, 2014), the stock-out problem persists and it is having repercussion effects in the health of the public. In this context, the research is motivated to find out the causes of drug stock- outs of the public health delivery system and suggest a policy to overcome it**.**

2. Knowledge GAP

WHO and Health Action International (HAI) established a systematized method for measuring medicine prices, availability, affordability and price components in low-income and middle-income countries (Cameron, 2009). Greene's research examines the role of pharmaceuticals in global health practices by creating 'essential medicines' and suggested the measures to revise the list prepared by World Health Organization (Greene, 2011). Hao's research estimated the relationship between prices and availability of essential medicines using the World Health Organization methodology in China. (Hao 2009). Michael's research measured the effect of essential medicine stock-out and found out the adverse outcomes in medication adherence (Michael, 2015). Catherine's research on the availability of essential medicines in low-income countries concluded that inadequate public health care infrastructure, budgetary constraints, and lack of human resource capacity are the reasons for stock outs (Catherine, 2014). The present research endeavour is to explore the reasons of stock-outs of essential medicines and empirically advocate the methods that reduce the stock-outs followed in existing system in India.

3. AIM

The value agenda of the research is to discover how the stock-outs for essential medicines are happening in the public health delivery system. The strategic agenda is to find the mechanism used in the public health delivery system to reduce the stock-outs in the supply of essential medicines. The research enables the policy makers to switch over to successful health delivery model.

4. Methodology

This research has been undertaken in two phases and the results are analyzed in six stages. In the first phase, primary data are collected from 217 proprietors of registered medical, retail outlets in Tamil Nadu. Cameron's research (2008) indicate that the median availability of essential drugs in the public health system was about 3.3% in Maharashtra, 12.5% in Karnataka, 10% in Haryana, and 30% in Tamil Nadu. As the stock-out situation is better managed in Tamil Nadu as compared to other states in India, we considered the Tamil Nadu for conducting the research. There are 29,342 registered medical stores in Tamil Nadu. Out of that, there are 528 chain medical retails shops are in Tamil Nadu (Source: Tamil Nadu Government web portal) the chain retail, medical units are linked with networking system to maintain the database of the customers. We send the online questionnaire to all of the chain retailing units through the mail. After having a follow-up, we received responses from 272 medical store proprietors. Out of 272 responses, 217 are validated. In the second phase, secondary data regarding demand from January 2005 are collected from one of the largest retail medical stores in Tamil Nadu. Table -1 shows the stages used in analyzing the data.

Table 1 *Input – Process- Output Table*

Stages	Purpose	Input	Process	Output
I	To find out the causes for essential medicines stock outs	Primary data collected from 217 medical stores	Factor analysis	Unpredictable drug supply systems; Unresponsive sourcing and Unreasonable drug pricing
II	To find out the impact of medical coverage schemes on demand estimation	Secondary data from a Chain medical store	Correlation and Growth factor	Correlation is 0.96 and demand is growing in exponential manner.
III	To measure the spillover effects among the demand pattern	Demand among the customer covered by medical schemes	Vector Error correction Model	1% increase in the customer base (coming under medical coverage) leads to 2.2% increase in demand
IV	To find out the suitable method of demand sensing	Past history of demand	Exponential smoothing	Estimation with customers having medical coverage stands good.
V	To find out the methods to reduce the Supply problem	TNMSC secondary data	Case Study	TNMSC method decreased the cost and price.
VI	To find out the methods to reduce pricing problem	Government Medical Co-operative Stores	Case Study	The prices were under control in the health care distribution system.

The reasons for stock-outs are found out by collecting the primary data from the medical stores in Tamil Nadu. Three reasons are found out using factor component analysis in the first phase. To solve the first problem of demand sensing, we identified a hands-on approach used by retail medical chain unit and tested it empirically. To solve the second problem, we identified the strategy used by the Tamil Nadu Medical Services Corporation (TNMSC). To solve the third problem on price issues, we identified the strategy used by the Government owned co-operative medical store in Tamil Nadu.

5. Phenomenon – How Stock-Outs are Happening?

Access to essential medicines is a crucial factor and it is essential that maximum quality and mostly safe medicines should remain available, accessible and affordable to all the needy of any economy. According to WHO, the factors acting as barriers to a smooth important drug delivery system may include:- dishonest medicine supply systems; cheap and substandard quality of medicines; absurd prescription, iniquitous health financing mechanisms exorbitant drug pricing; ; insufficient funding for research in neglected diseases and finally and a stern product patent regime. Accessibility to new medicines has become more cumbersome. It is also having a high impact on the price structure of the medicines.

The factor component test was applied to find out the reasons for drug stock outs in Tamil Nadu. Through interview schedule, 217 proprietors of medical stores spread out through Tamil Nadu were surveyed, and they were asked to provide their opinion about the twelve variables on a five-point scale (Completely disagree to agree completely). The data collected were coded to perform factor analysis. The null hypothesis, which the population correlation matrix is the identity matrix, was rejected by Bartlett's test of sphericity. The value of Kaiser-Meyer-Olkin statistics (0.653) is also higher than 0.5. The chi-square statistics value is 885.47, and it is significant at 95% level of confidence with degrees of freedom 66. Hence, principal component analysis is appropriate for analyzing the correlation matrix of the nineteen variables. The number of factors was selected based on the eigenvalue. We select three factors having eigenvalue greater than one. The variables are having factor loading less than 0.5 are filtered out. The cumulative variance of the three factors is 63.4%. The results are displayed in Table 2

Table 2 *Rotated Component Matrix*

Variables	Factor loading		
	1	2	3
Distribution protocols among the suppliers	0.804		
Changes in Contractual relationships	0.801		
Discontinuance of specific drugs	0.771		
Changes in brand names	0.560		
Government procurement and regulation changes	0.528		
Price variations in the channel of distribution		0.893	
Competitive pricing		0.872	
Affordability of the clients		0.802	
Irrefutable customer prescription			0.815
Uneven demand			0.734
Absence of demand forecasting tools			0.655
Pharmacists' non-availability	Filtered out		

The variables such as distribution protocols, changes in contractual relationships, discontinuance of specific drugs, changes in brand names and Government procurement are highly correlated. We name these variables as 'delinquent forecasting'. The variables such as - price variations, competitive pricing and clients' affordability are highly correlated and contribute to a single factor that we label as 'arbitrary drug pricing'. The variables such as irrefutable customer prescription, uneven demand and non-availability of forecasting tools are highly correlated and contribute to a single factor that we label as 'risk in sourcing'. Hence, we conclude that unpredictable drug demand systems, risk in sourcing and unreasonable drug pricing are the causes of stock-outs. The stock-outs happen due to flaws in supply chain management and usage of improper demand sensing mechanism.

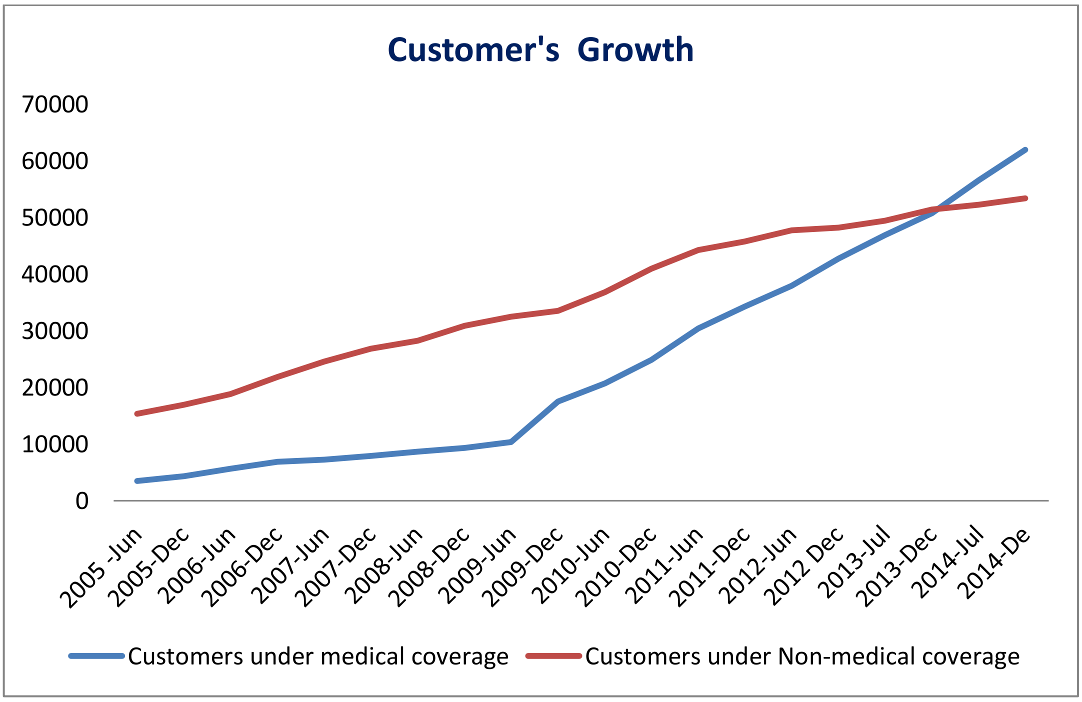
6. Strategic Proposition I– How to Forecast the Demand?

As the previous stage apparently quotes that there is a need for demand sensing system. To forecast the demand, we have to identify the factors that create demand. While analyzing the history in Tamil nadu, we observed that the drug stock-outs decreased by 27% within five years in Tamil Nadu due to the introduction of public health insurance schemes (TNMSC,2014). Government, as well as corporates, give insurance as well as medical benefits to their employees. The scheme has been widening to the public also. Government of Karnataka, Andhra Pradesh and Tamil Nadu introduced the Yeshasvini Health insurance scheme -2003, Aarogyasri Health insurance scheme -2007 and Kalaignar Health insurance scheme - 2009 respectively. Past researches on government insurance schemes (Samuel, 2013) (Pugazhenthi, 2014) appraised the projects and concluded that these schemes have more value additions to the health care sector. After the introduction of medical coverage schemes by the state government, the demand for the essential medicines increased. Hence, we decided to find out the relationship between medical coverage schemes and demand for essential medicines.

6.1 Relationship between Customer Base and Demand

To find out the effects of medical coverage benefits in forecasting the demand for essential medicines, we collected the data from a chain pharmacy store located in 24 places in Tamil Nadu. The customers' database from January 2005 to December 2014 in the pharmacy store is used. The demand for the six medicines (Paracetamol tablets, Co. Trimoxazole Tablet Ciprofloxacin tablets, Ranitidine Tablets, Pyrazinamide Tablet and Norfloxacin Tablet of 10 X 10) is considered as a whole unit. Exhibit-1 shows the trend of the customers segmented on the basis of medical coverage.

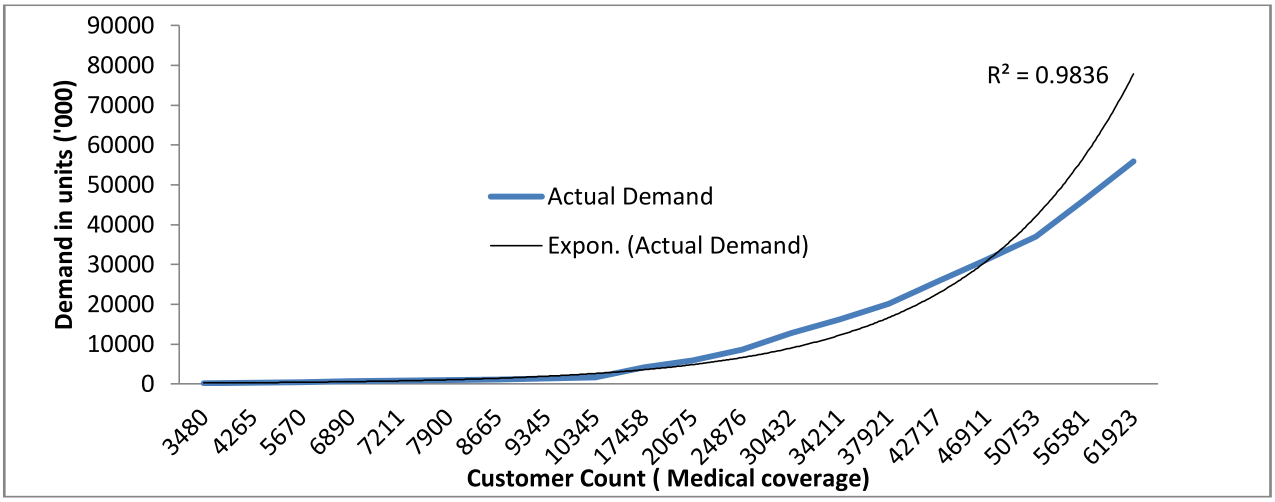
Exhibit 1 *Customers' Growth*



The government health insurance scheme was introduced in June 2009. Prior to that employee of the corporate sector were benefited under different health schemes. Within four years of introduction, the total number of customers coming under the medical coverage crossed the customers coming under the non-medical coverage schemes. Exhibit-2 reflects the penetration level of health insurance schemes. The growth of demand is exhibited in the

The demand for essential medicines has exponential growth as compared with the customer count. The correlation coefficient between customer growth having medical coverage and demand is 0.967, where it is 0.82 in case of customer growth having non-medical coverage. Hence, we conclude that customers' database can be considered as the base for determining demand and the demand trend is in an exponential manner.

Exhibit 2 *Growth Rate of Demand based on Customer Base*



6.2 Spillover Effect of Demand

To find out the spillover effects between the increase in the customers and the demand of the essential drugs, we used 'Threshold Vector Error Correction Model' (TVECM). We study the collinearity variation between customers count and demand.. We derive the following VECM equations.

$$\Delta Y_t = a_y z_{t-1} + \sum_{i=1}^{p} b_{yi}\,\Delta Y_{t-i} + \sum_{i=1}^{p} c_{yi}\,\Delta X_{t-i} + \varepsilon_{y,t} \qquad \ldots (1)$$

$$\Delta X_t = a_x z_{t-1} + \sum_{i=1}^{p} b_{xi}\,\Delta Y_{t-i} + \sum_{i=1}^{p} c_{xi}\,\Delta X_{t-i} + \varepsilon_{x,t} \qquad \ldots (2)$$

Whereas ΔX_t, is the output series from customers coming under the medical coverage and ΔY_t , is the output series from the customers coming under the non-medical coverage. b_{yi} ,c_{yi}, b_{xi} and c_{xi} represents the short-run coefficients. $\varepsilon_{y,t}$ and $\varepsilon_{x,t}$ are residuals. The speed of adjustment in interest rate due to market information is determined by the coefficients a_x and a_y . When these coefficients are high, adjustment is rapid. The goodness of fit is measured in terms of R^2 value. Table-3 displays the estimates of the adjustments coefficients obtained by TVECM using equation (1) and (2).

Table 3 *TVEECM Co-Efficient*

Independent: Customers under Medical coverage		Independent: Customers under non-medical coverage	
VCM Co-efficient	R^2 Value	VCM co-efficient	R^2 Value
0.46	0.72	0.049	0.44

The error correction is significant in both equations, suggesting a bidirectional error correction. However, the error correction in the first equation (Dependent – customers under medical coverage) is greater in absolute term than that of the second equation. The co-efficient of the first equation makes greater adjustment in order to re-establish the equilibrium. Hence, it may conclude that the customers under medical coverage determine the demand. Using the multivariate GARCH model, the pattern of information flow between the credit scores and interest rate are examined. We derive the multivariate GARCH equation which is as follows:

$$\begin{pmatrix} H_{11,t} & H_{12,t} \\ H_{21,t} & H_{22,t} \end{pmatrix} = C'C + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}' \begin{pmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon^2_{2,t-1} \end{pmatrix} \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix}' \begin{pmatrix} H_{11,t-1} & H_{12,t-1} \\ H_{21,t-1} & H_{22,t-1} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \qquad \ldots (3)$$

Whereas $H_{11,\,t}$ and $H_{22,\,t}$, are the conditional variances of the first and second serial orders. $H_{12,t}$ and $H_{21,t}$ are the conditional covariance between the two series. The C_{ij} are elements of a 2x2 symmetric matrix of constants *C*. The

elements a_{ij} of the symmetric 2x2 matrix a_i measure the degree of innovation from demand *i* to demand *j*. The elements of b_{ij} of the symmetric 2x2 matrix b_i indicate the persistence of conditional volatility between customers base and demand.
The elements b_{ij} of the symmetric matrix b_i in the equation (3) states that all of the estimated coefficients are significant. The spillover from customers covered under the medical coverage to demand is 0.433 (b_{12}). The spillover from customer base to demand is 0.9524 (b_{21}). The output of the analysis suggests that an 1% increase in the customer base (availing medical benefits) leads to 2.2% increase in demand.

6.3 Technical Variables for Forecasting the Demand

In the next stage, we estimated the demand for the six essential drugs by using the modified exponential smoothing model. Adaptive exponential smoothing method has been used as the smoothing constant is defined (Ekern, 1981,Spyros Makridakis, 2008). The forecast values are based on the multiplicative trend and multiplicative seasonality of essential medicines.

While considering the demand trend, the customer database is segmented into two categories. The customers having medical coverage by either Government or by private agencies are segmented in one group. The second segment includes the clients buying medicines without having any medical coverage by the third party. As pharmacists are selling to both segments, we used 'reference – dependent model' approach to estimating the demand under the exponential smoothing model. Three alternatives for determining the linearity and exponential of 'reference-dependent products' are established as under-

A1: Input Shipment history of all clients as a past indicator (to measure linearity) and open customer orders (to measure exponential growth) as a present indicator.
A2: Input Shipment history of clients having medical coverage as a past indicator and open customer orders as a present indicator.
A3: Input Shipment history of clients having no medical coverage as a past indicator and open customer orders as a present indicator.

Historical data of the six product have been inputted under the above three alternatives. Demand for the six product have been estimated with the modified exponential smoothing method.
In this model, we assume that the time series as follows

$$y_t = (b_1 + b_2 t) S_t + \epsilon_t \quad \text{.........} \quad (1)$$

$\mathbf{b_1}$ is the base signal also called the permanent component (medicines purchased by customers in past)
$\mathbf{b_2}$ is a linear trend component
$\mathbf{S_t}$ is a multiplicative seasonal factor (Based on open customer orders seven days prior to estimation)
$^{a}{}_{t}$ is the random error component
Let the length of the season be L periods.
The seasonal factors are defined so that they sum to the length of the season, i.e.

$$\sum_{1 \le t \le L} S_t = L \quad \text{.........} \quad (2)$$

The multiplicative seasonal model is appropriate for this time series in which the amplitude of the medicines' demand is proportional to the average level of the series, i.e. a time series displaying multiplicative seasonality. The current deseasonalized level of the process at the end of period *T* be denoted by *RT*.
At the end of a time period *t*, let
$\bar{R}_t$ be the estimate of the deseasonalized level.
$\bar{G}_t$ be the estimate of the trend
$\bar{S}_t$ be the estimate of seasonal component (seasonal index)
The overall smoothing equation is determined as follows

$$\bar{R}_t = \alpha \frac{y_t}{\bar{S}_{t-L}} + (1-\alpha) * (\bar{R}_{t-1} + \bar{G}_{t-1}) \quad \text{.........} \quad (3)$$

Where 0 < ∞< 1 is a smoothing constant.

Dividing *yt* by $\bar{S}_t$−L, which is the seasonal factor for period *T* computed one season (L periods) ago, deseasonalizes the data so that only the trend component and the prior value of the permanent component enter into the updating process for $\bar{R}_T$.

Smoothing of the trend factor-

$$\bar{G}_t = \beta * (\bar{S}_t - \bar{S}_{t-1}) + (1-\beta) * \bar{G}_{t-1} \qquad \text{……………………………. (4)}$$

Where $0 < \beta < 1$ is a second smoothing constant.

The estimate of the trend component is simply the smoothed difference between two successive estimates of the deseasonalized level.

$$\bar{S}_t = \gamma * (y_t/\bar{S}_t) + (1-\gamma) * \bar{S}_{t-L} \qquad \text{…………………… (5)}$$

Where $0 < \gamma < 1$ is the third smoothing constant.

The estimate of the seasonal component is a combination of the most recently observed seasonal factor given by the demand *Yt* divided by the deseasonalized series level estimate *Rt*
and the previous best seasonal factor estimate for this time period. Since seasonal factors
represent deviations above and below the average, the average of any *L* consecutive seasonal
Factors should always be 1. Thus, after estimating *St*, it is good practice to re normalize the
L most recent seasonal factors such that

$$\sum_{i=t-q+1}^{t} S_i = q \qquad \text{………….……………… (6)}$$

The forecast for the next period is given by

$$y_t = (\bar{R}_{t-1} + \bar{G}_{t-1})\bar{S}_{t-L} \qquad \text{………………….. (7)}$$

Multiple-step-ahead forecasts (for T < q)

The value of forecast *T* periods hence is given by

$$y_{t+T} = (\bar{R}_{t-1} + T * \bar{G}_{t-1})\bar{S}_{t+T-L} \qquad \text{……………. 8)}$$

Minimum of two full seasons (or 2*L* periods) of historical data is needed. The historical data is either the past history of medicines used by the customers. To initialize a set of seasonal factors we use, *j* =1, 2, · · ·, m. *L* denote the average of the observations during the *j* th season.

The estimation of the trend component is decided by the following equation.

$$\bar{G}_0 = \frac{\bar{y}_m - \bar{y}_1}{(m-1)L} \qquad \text{……………………………. (9)}$$

The estimation of the deseasonalized level is decided by the following equation.

$$\bar{R}_0 = \bar{x}_1 - \frac{L}{2}\bar{G}_0 \qquad \text{………………………………. (10)}$$

Seasonal factors are computed for each time period *t* = 1, 2, · · · ,*mL* as the ratio of actual observation to the average seasonally adjusted value for that season, further adjusted by the trend; that is

$$\bar{S}_t = \frac{\bar{x}_t}{\bar{x}_i - [(L+1)/2 - j]\bar{G}_0} \qquad \text{………………………… (11)}$$

Where $\bar{x}$i is the average for the season corresponding to the *t* index, and *j* is the position of the the period *t* within the season. The above equation will produce m estimates of the seasonal factor for each period.

$$\bar{S}_t = \frac{1}{m}\sum_{k=0}^{m-1} \bar{S}_{t+kL} \qquad t = 1, 2, \cdots, L \qquad \text{…………………….. (12)}$$

$$\bar{S}_t(0) = \bar{S}_t \frac{L}{\sum_{t=1}^{L} \bar{S}_t} \qquad t = 1, 2, \cdots, L \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

The demand forecasting is based upon the shipment history of the given medicines for six months and the open customer orders of the last month. The estimated demand and actual demand after 60 days are tabulated as follows.

Table 4 *Demand Deviations*

Sl.No	Product (10 x 10)	A1	A2	A3	Change in
		Change in Demand	Change in Demand	Change in Demand	Actual Demand
1	Paracetamol tablet	6.54%	4.70%	6.80%	4.90%
2	Co. Trimoxazole Tablet	0.94%	0.78%	3.90%	0.98%
3	Ciprofloxacin Tablets	2.26%	2.10%	5.20%	1.80%
4	Ranitidine Tablets	5.33%	4.42%	4.20%	4.72%
5	Pyrazinamide Tablet	0.32%	1.97%	4.76%	2.10%
6	Norfloxacin Tablet	3.89%	2.86%	4.74%	2.62%

By comparing the estimated demand with the actual demand, there is a significant difference between the first and third alternative. However, the results of the second alternative coincide with the actual one (proved with‘t’ test). Hence, it may be concluded that the shipment history of clients having medical coverage can be used as the past indicator and open customer orders can be used as a present indicator to estimate the demand for essential medicines.

7. Strategic Proposition II – How to Reduce Sourcing Problem?

We propose the model of Tamil Nadu Medical Services Corporation Limited (TNMSC) to reduce the sourcing problem. The introduction of TNMSC not only decreases the stock-out problem but also reduced the prices of essential medicines (Poornalingam, 2003). The Tamil Nadu government provides health care for about 30 % of its population through government hospitals. Prior to 1994, district health officers control the drug procurement, storage and supplies. Danish International Development helped the Tamil Nadu government to establish Tamil Nadu Medical Services Corporation Limited (TNMSC) to have centralized procurement system. TNMSC commenced its operation in January 1995 to conduct logistics and supply chain for medical supplies. Medicines were purchased at competitive prices in a transparent manner. Scientifically simplified procedure for procurement, storage and distribution of medicines are followed. It helped to ensure availability of medicines in hospitals throughout the year. Drugs are purchased directly from manufacturers and not through agents. The manufacturers were required to have good manufacturing practice (GMP) certificate and market standing for at least three years. The TNMSC bring to an end the practice of giving preference to SSI units. Payments were made within 15 days of the supply. They directed the manufacturers to use only strip/ blister packing for all tablets and capsules with inner and outer packing bearing Government logo to avoid their misuse. The bottom-up approach was applied in indenting process and took earnest steps to prevent overstocking and wastage due to expiry. TNMSC introduced the ‘first expiry first out’ (FEFO) practice for picking and dispensing process. All transactions including the generation of material receipt certificate and inward goods register were maintained through a paperless, IT-enabled the logistical management information system (MIS) which was supported by periodical physical verifications. MIS generates daily stock reports including a brief executive summary to enable officers for stock monitoring, forecasting, procurement and distribution. The vendors were directed to supply the ordered items within 30 – 60 days of the order to the designated warehouses. Liquidated damages at the rate of 0.5% per day subject to a maximum of 15% were levied to the vendors for non-compliance. TNMSC introduced separate technical and financial documents for the bid and vendors were rated based on their performance. Hand Books for pharmacists and newsletters for health care professionals were regularly published to educate them on the concept of rational drug use. Taking into consideration the fact that medicines other than those specified in the list may be required in certain cases at certain centers in small quantities, they made a decision to use only 90 percent of the medicine budget for their purchase. The balance of 10 percent is divided among the various health care centers with the condition that funds cannot be used to buy drugs that are on the TNMSC list. The system of distributing 10 percent of the annual budget to hospitals has helped the Corporation to counter the criticism that the drug list is inadequate (R. Poornalingam 1996). Well designed warehouses were established in 23 districts at the beginning that could increase about 30% efficiency of the storage system. Distribution schedules were given to the hospitals to enable them timely deliveries. The passbook system introduced helped to make the hospitals aware of their budget utilization at any point of time. The warehouses maintain a minimum of three months stock and hospitals permitted to draw a month requirement at a time. The safety stock limit was fixed as one-month requirement though it depends on the turnover of a particular item and its leads time for obtaining supplies. Pre-dispatch and post-dispatch quality tests were ensured for quality assurance. Through random sampling supplied items were sent to designated labs for quality check and punishments including penalty and black-listing introduced for quality failure. Table-5 shows the impact of introducing centralized procurement system at the prices of medicines.

Table 5 *Price comparison*

Comparison of Prices before and After TNMSC in rupees					
Year / Drug	Pyrazinamide tab-let 10 x 10	Cloxacillin cap-sule 10 x 10	Norfloxacin tab-let 10 x 10	Atenolol tab-let 14 x 10	Ciprofloxacin tab-let 10 x 10
1992 – 94 (Pre TNMSC)	135	158.25	290	117.12	525
2002-03 Post TNMSC	62.8	72.6	51.3	14.68	88
Source: TNMSC					

In the year 2004 the World Bank appreciated the TNMSC for decreasing the inefficiencies in medicines procurement and improving rural health services. Hence, we suggest the TMMSC model to decrease the supply chain problems in the drug distribution system..

8. Strategic Agenda III: How to Reduce the Pricing Problems?

Drug prices play a significant role in the access to medicines, particularly in low-income countries. Policy changes in the 1990s reduced the treatment of drug price control from about 90% of the market in late 1970s to about 10% of the market in 1995. The variation in the market and procurement price of similar drugs could range anywhere between 100% to 5000 %. Studies in the past few years have clearly established the efficiency of price control. Sengupta et al. (2008) reported a nearly 40% increase in all drug prices between the period of 1996 and 2006. During the same period, the price of controlled drugs rose only by 0.02% while the price of EDL drugs (Essential Drug List) rose by 15%. In contrast, the cost of drugs that were neither under price control nor below the EDL grew by 137%. The price decontrol policies of the 1990s have contributed near a massive price increase during the last 15 years. To solve the problem of pricing issues, we examined the case study of Government owned medical stores that are proving medicines at discounted price.

The government of Tamil Nadu introduced discounted medical stores (branded as “Amma” medical stores) in 2014. For that purpose Rs 20 crore was used from the Price Stabilisation Fund for running the pharmacies. It aims to provide medicines at a discount of 10 to 15%. The co-operative department undertook the establishment of outlets. They have identified localities where the demand is high and where there were a few or no medical shops. The objective is to use the cooperative network to stock up medicines purchased in bulk from drug companies at a marginal discount. Within the first six months of the introduction of these pharmacies, it reported a profit of Rs 9 lakhs even though it aim is not to earn the profit. The inventories are classified into three categories for sourcing system. They are selling around one lakh branded medicines. However, 380 drugs address the 90% ailments in Tamil Nadu. The procurements are made directly from the drug manufacturers through TNMSC. The cost price is 7-8 times less than the market price. It attracts 150 customers per day and earns Rs 26,000 per day in a retail outlet. (Ajay, 2015).This model would bring the drug prices as affordable to all segments of the public.

9. Findings and Policy Indications

The drug stock outs for essential medicines are due to unpredictable drug demand systems, risk in sourcing and unreasonable drug pricing. To overcome the unpredictable drug demand system, we propose to introduce demand sensing system using the exponential smoothing parameter. As there is a spill over between medical coverage schemes and demand sensing, the database of the customers having medical coverage is used as the parameter to discover the demand. According to this model, the shipment history of clients having medical coverage can be used as the past indicator and open customer orders as a present indicator to estimate the demand for essential medicines. The success of the model has been proved empirically in a chain medical store and discussed in the first phase of this research. The second problem of risk in sourcing can be reduced by implementing TNMSC model of procurement. TNMSC model suggests that the transparent systems of sourcing and demand-driven inventory classification are essential to solving the problems in sourcing. The third problem of pricing can be reduced by implementing direct procurement system based on the co-operative model as used in Tamil Nadu Government owned discounted medical stores.

10. Conclusion

The technology-driven sourcing and demand sensing system is essential in the healthcare sector. There is a need for the integrated system to reduce the pitfalls in the supply of medicines. The medical coverage schemes will act as a core value in the integrated health care system. Supply chain management system can be promulgated to facilitate the core value. The health insurance plan covers 17% of the Tamil Nadu population. If it increases by 1%, the demand for essential drug increases by 2.2%. As the supply chain network depends upon the demand, the constraints in the health care delivery are streamlined based on the medical coverage schemes. The essential medicines delivery can be smoothened based on the demand-driven networks of the integrated system.

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12. Annexure – Customers' Demand in a Chain Medical Store (Demand for Six Medicines Combined as whole Unit)

Sl. No	Period	Customers under medical coverage	Customers under Non-medical coverage	Demand (''000 units)
1	2005 -Jun	3480	15343	187
2	2005-Dec	4265	16891	281
3	2006-Jun	5670	18832	485
4	2006-Dec	6890	21786	714
5	2007-Jun	7211	24577	787
6	2007-Dec	7900	26821	953
7	2008-Jun	8665	28254	1156
8	2008-Dec	9345	30865	1356
9	2009-Jun	10345	32425	1675
10	2009-Dec	17458	33541	4210
11	2010-Jun	20675	36783	5916
12	2010-Dec	24876	40987	8562
13	2011-Jun	30432	44284	12769
14	2011-Dec	34211	45732	16257
15	2012-Jun	37921	47765	20136
16	2012 Dec	42717	48189	25738
17	2013-Jul	46911	49385	31298
18	2013-Dec	50753	51408	36937
19	2014-Jul	56581	52207	46269
20	2014-De	61923	53345	55880