



# HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?

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# Acknowledgements

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# CONTENTS

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<b>1</b>	<b>Abbreviations</b>	<b>06</b>
<b>2</b>	<b>Executive Summary</b>	<b>07</b>
<b>3</b>	<b>What Ails India's Public Supply Chain for Essential Medicines?</b>	<b>08</b>
<b>4</b>	<b>The 6 R's of Supply Chain Management for Essential Medicines</b>	<b>10</b>
<b>5</b>	<b>Levers for an Efficient Supply Chain of Essential Medicines</b>	<b>13</b>
<b>6</b>	<b>Promising Technological Solutions for Pharmaceutical Supply Chain Management</b>	<b>15</b>
<b>7</b>	<b>Encouraging Research and Innovation with Philanthropic Investments</b>	<b>20</b>
<b>8</b>	<b>Conclusion</b>	<b>22</b>
<b>9</b>	<b>References</b>	<b>23</b>

### Abbreviations

<b>AI</b>	: Artificial Intelligence
<b>API</b>	: Active Pharmaceutical Ingredient
<b>CapEx</b>	: Capital Expenditure
<b>C-DAC</b>	: Centre for Development of Advanced Computing
<b>CDSCO</b>	: Central Drugs Standard Control Organisation
<b>DDMS</b>	: Drugs Distribution Management System
<b>DEG</b>	: Diethylene Glycol
<b>DVDMS</b>	: Drugs and Vaccines Distribution Management System
<b>GDP</b>	: Gross Domestic Product
<b>HIV</b>	: Human Immunodeficiency Virus
<b>ICT</b>	: Information and Communications Technology
<b>IoT</b>	: Internet of Things
<b>KDLWS</b>	: Karnataka State Drugs and Logistics Warehouse Society
<b>KSMSCL</b>	: Karnataka State Medical Supplies Corporation Limited
<b>MoHFW</b>	: Ministry of Health and Family Welfare
<b>NHM</b>	: National Health Mission
<b>NIB</b>	: National Institute of Biologicals
<b>NIC</b>	: National Informatics Centre
<b>NSQ</b>	: Not of Standard Quality
<b>OOPE</b>	: Out-of-Pocket Expenditure
<b>PHC</b>	: Primary Health Centre
<b>SMS</b>	: Short Messaging Service
<b>TNMSC</b>	: Tamil Nadu Medical Services Corporation
<b>UNDP</b>	: United Nations Development Programme
<b>UPMSC</b>	: Uttar Pradesh Medical Supplies Corporation

## Executive Summary

Pharmaceutical production in India has been a formidable force for healthcare, so much so that no written report ever fails to eulogise India as the “pharmacy of the world”. Despite the prowess of Indian pharmaceutical industries in manufacturing affordable generic medicines, **poor quality and unavailability of essential drugs, vaccines, and consumables at the last mile has been endemic to Indian public health**, and it worsened during the COVID-19 pandemic.

The menace of *not of standard quality* (NSQ) drugs has been a public problem for India. Reports of deaths in India and abroad, caused by the consumption of Indian-manufactured medicines have been recently flagged by the WHO. Therefore, **the need to strengthen the pharmaceutical supply chain is acute**. This is important for ensuring the quality of drugs. Strengthening the supply chain is also essential to ensuring their availability and affordability at the last mile, as medicines constitute the highest share in out-of-pocket expenditure (OOPE) in India.

Stock-outs have been a common concern even in states with mature supply chain operations. Inventory management, demand forecasting, and breakdown of cold chain infrastructure are some of the perennial issues in pharmaceutical supply chain management. Therefore, **streamlining operational processes, competence building of pharmaceutical supply chain professionals, governance of process and accountability, and strengthening infrastructure are essential for a robust supply chain**.

Technological solutions for transparent tendering, end-to-end order and inventory management, quality control, smart warehousing, transportation, and cold-chain monitoring have the potential to strengthen the pharmaceutical supply chain systemically. Solutions developed by the Indian government, like **e-Aushadhi, Drug Distribution Management System (DDMS), and AKS software**, and privately developed solutions, such as **Logistimo’s inventory management and demand forecasting software, StaTwig’s blockchain-enabled tracking system for vaccines, and portable refrigeration devices called Emvolio by Blackfrog** have the potential to strengthen the pharmaceutical supply chain in public health. Philanthropic foundations can play a role in enabling the adoption of these solutions by investing in their further development, generating knowledge based on evidence, and helping states pilot these solutions to make essential medicines available at the last mile.

This report explores the state of the pharmaceutical supply chain vis-à-vis Essential Medicines in Indian public health and the ways in which it can be made more resilient to contingencies. While secondary research has informed most of this report, key informant interviews with pharmaceutical supply chain experts provided crucial insights for shaping its narrative. It identifies key challenges in ensuring the availability of essential drugs, vaccines and consumables at the last mile. Further, it explores how technology can lessen the burden of the state in governing non-care services within the public health system. Lastly, it also profiles some of the promising technological solutions and provides recommendations to philanthropists on how to invest in the development of these supply chain solutions for the greater good of public health.

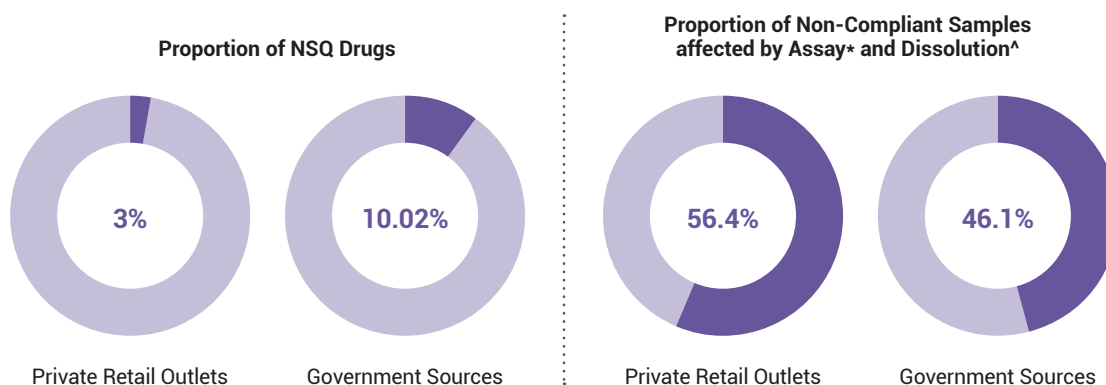
## What Ails India's Public Supply Chain for Essential Medicines?

The origin of the concept of the essential medicine list dates back to 1977 when the WHO deemed some medicines - which were often inaccessible to the vast majority - to be more essential than others (Laing et al. 2003). Among the building blocks of a health system as conceptualised by WHO, access to essential medicines is a crucial determinant of universal health coverage (WHO 2010). Before that, under the historic Alma-Ata Declaration, provision of essential medicines was one of the eight components of primary health care (WHO 1978). Therefore, the WHO undertook the practice of maintaining a list of essential medicines, which is revised every two years. WHO member states have also adopted this concept and modified their lists on the basis of public health relevance, efficacy, safety, and cost-effectiveness.

In India, providing access to essential medicines is largely undertaken by constituent states, since public health is a State subject. With the exception of vaccines and medicines of verticalised health programmes under NHM and products of family planning, which are procured by the union government and distributed to the states, each state takes care of procurement from its own list of Essential Medicines. While the National List of Essential Medicines (NLEM) has been created with the objective of price control for Essential Medicines, each Indian state has the flexibility of creating and routinely revising its own list for procurement based on disease burden. There are inter-state differences in operational processes, but the procured medicines are distributed from the states to all the public medical establishments within.

The Indian pharmaceutical industry and drug regulators have long struggled with the problem of Not of Standard Quality (NSQ) medicines for domestic and export stocks. The Drugs and Cosmetics Act of 1940 classifies NSQ medicines as misbranded drugs, adulterated drugs, and spurious drugs (GoI 2016).

**Figure 1: 47,954 drug samples were tested in National Drug Survey 2014-16**



\* Assay - drug does not contain the desired amount of active ingredient

^ Dissolution - drug is unable to dissolve properly in the stomach

Source: National Drug Survey 2014-16



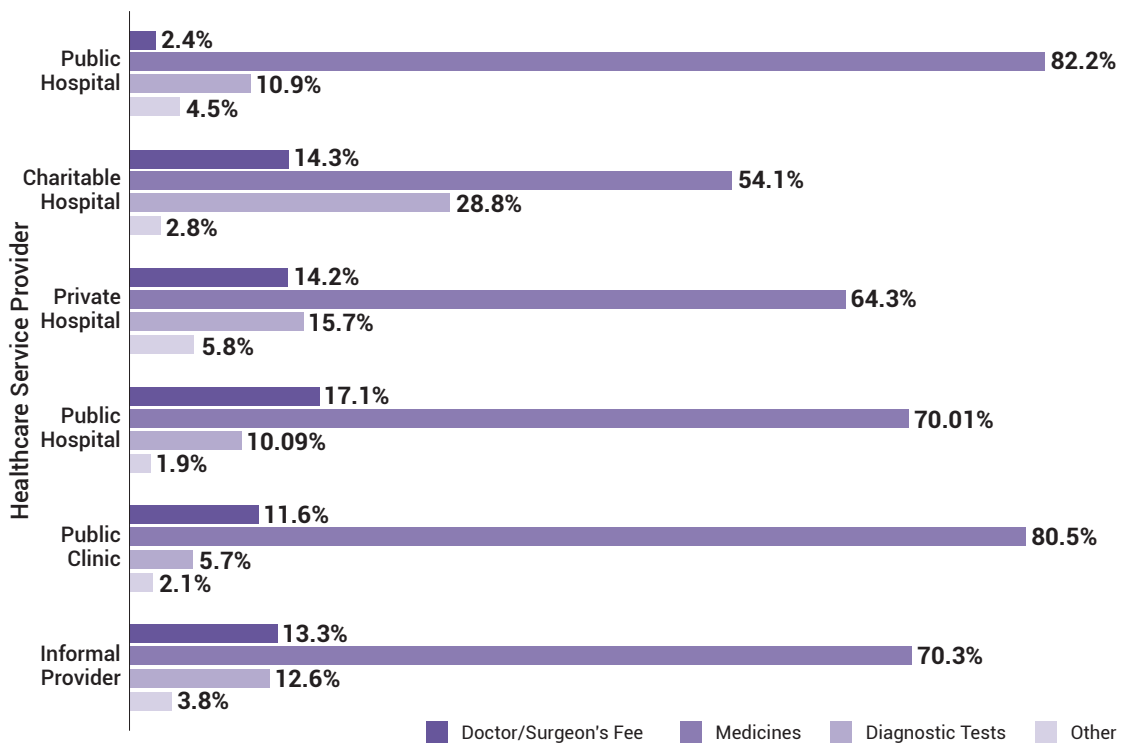
## HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?

The proportion of NSQ drugs at government sources were found to be 3.17 times higher, which led the authors to ring alarm bells about the procurement processes in states with the proportion of NSQ drugs higher than the national average. Consumption of NSQ drugs has also led to deaths in India and abroad, which led the WHO to issue warnings to regulators (Kaur 2023).

At the national level, the Pradhan Mantri Bhartiya Jan Aushadhi Pariyojana - launched in 2015 as a rebranded version of the Indian People's Medicine Scheme of 2008 - aims to ensure the affordability and availability of quality generic medicines at the Pradhan Mantri Jan Aushadhi Kendras. A recent study, however, found 50% of the listed medicines to be out of stock for a period of three months (Lavtepatil & Ghosh 2022). Poor supply chain management deprives patients of access to free medicines, thereby forcing an out-of-pocket expenditure (OOPE) on medicines from private retail outlets (Selvaraj et al. 2022).

India is one of the five countries - alongside Thailand, Indonesia, Kenya, and Malaysia - to have the lowest median prices for branded and generic drugs on the whole (Medbelle 2019). Although price control ceilings for Essential Medicines help to reduce OOPE for the public, the proportion of OOPE and household expenditure is still significantly high for medicines. The 75th Round of the National Sample Survey of social consumption expenditure for non-hospitalised treatment showed that the highest proportion of OOPE was incurred on medicines across all types of healthcare providers. While Essential Medicines are bound by regulatory price control, medicines in general accounted for 42.3% of household expenditure on health as per CMIE's Consumer Pyramid Household Survey (Chawla 2023).

**Figure 2: Key Indicators of Social Consumption in India: Health (July 2017 - June 2018)**



Source: NSS 75<sup>th</sup> Round, 2019

## HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?

Cost of logistics and supply chain are some of the highest in India, as it amounts to 14% of the GDP (Confederation of Indian Industries 2020). A flawed supply chain will directly raise unnecessary operational costs for the state and hinder the delivery of Essential Medicines to patients at the last mile. Given the perishable nature of drugs and vaccines, it is all the more crucial for the supply chain to account for quality concerns.

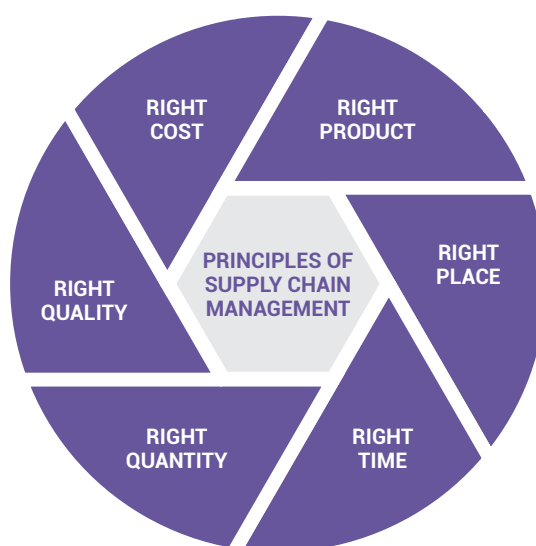
*Note: All essential drugs, vaccines and consumables from the National List of Essential Medicines will be referred to as 'Essential Medicines' in this report.*

### The 6 R's of Supply Chain Management for Essential Medicines

Efforts in ensuring the availability of Essential Medicines have been encumbered by issues such as stock-outs, pilferage, quality compromise, governance issues, corruption in procurement, lack of accountability, etc. Derived from the 'Seven Rights of Logistics Management' (Swamidass 2000), we base the key strategic objectives for supply chain management of Essential Medicines on six self-evident 'R's, namely the **right product, right place, right time, right quantity, right quality, and right cost**.

The right product implies the most appropriate and updated drug with the dosage form and strength as required. It also includes the vaccines and consumables determined essential by the appropriate authority. The right products have to be made available at all public health facilities, and emergency supplies should be accessible in case of an outbreak. This should also be done in a timely manner since certain medical conditions can be urgent. Moreover, the Essential Medicines need to be of standard quality and have the appropriate stock at the last mile. Ensuring their availability at the last mile will prevent the need to purchase them from private retailers, thereby preventing unnecessary OOPE.

**Figure 3: The 6R's for Essential Medicines**



Source: Adapted from Swamidass 2000

Achievement of these key strategic objectives is hindered by the absence of streamlined processes, governance and accountability, and weak infrastructure (including data infrastructure). This section identifies some of the critical challenges to these objectives.

### Product-related challenges

While the WHO revises its list of Essential Medicines every two years based on priority needs, the List of Essential Medicines at national and state levels, respectively, is not revised frequently enough. The latest edition of the National List of Essential Medicines (NLEM) was released in 2022. Before that, the NLEM was revised in 2015 and 2011 (MoHFW 2022). The WHO list mentions the dosage form and strength of each drug. But for some items on the NLEM, the dosage form and strength is deferred to “as licensed”, which is not informative as there are many licensed formulations of a drug. This could hinder the states from being able to make informed procurement decisions (Manikandan 2023). States also need to ensure routine revision of their lists in accordance with evolving profile of diseases and the advancements in pharmacology.

### Place-based challenges

To fulfil the imperative of ensuring availability and access to Essential Medicines at all public health establishments, it is important to monitor localised outbreaks, especially during monsoon, after a cyclone, and other climate extremities. In the post-pandemic period, a shortage of antiretroviral therapy drugs for patients of HIV and AIDS was reported to be emerging in Assam, Bihar, Haryana, Jharkhand, and Himachal Pradesh (Deol 2022). Dolutegravir, an antiretroviral medication on the NLEM, had been in short supply in these states since November 2021. Therefore, procurement processes need to be informed by data on place-based disease burden and real-time medicine stock.

### Timeliness challenges

Time-sensitive medical conditions require urgent interventions, for which the availability of and accessibility to Essential Medicines is critical. The second wave of COVID-19 in May 2021 was a testament to the scramble for medical oxygen in India. This shortage was largely due to the inability of the distribution network to ensure an efficient supply. From production capacity constraints of existing plants to the lack of infrastructure connecting the point of production, the point of bottling, and finally, the point of use added to the logistical hurdles (Roy & Nair 2021). As most of the oxygen-producing industrial plants were located in the eastern states, logistical hurdles during the pandemic increased the transportation time of medical oxygen to high-burden states in the north (UN 2022; Mirza et al. 2023). This crisis situation pushed the central government to accelerate some improvements in the supply chain of medical oxygen (Ministry of Commerce & Industry 2021).

### Stock-outs and inadequate quantities

The issue of localised stockouts during an endemic situation compels public hospitals to resort to procurement through local distributors. But this means the hospitals are forced to pay a higher price while not being able to ensure quality. Ad-hoc purchases are not factored into the demand, which indicates the absence of contingency planning in process governance. The shortage of clofazimine, an important drug for the treatment of leprosy, has been one such long-standing problem wherein one private firm has held a production monopoly, affecting availability in the right quantity (Jayanth 2022). Although this issue of a

## HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?

single supplier for this drug is an exception, issues of stockouts should be addressed for all Essential Medicines.

### Quality-related challenges

Corruption, lack of quality supervision and other irregularities in procurement prevents patients from having medicines of standard quality. Diethylene glycol (DEG) poisoning from consumption of paediatric cough syrups has led to deaths of children in Tamil Nadu, Maharashtra, Bihar, Haryana, and Jammu & Kashmir; internationally, reports of deaths have also emerged from Nigeria, Gambia, Cameroon, Uzbekistan and Sri Lanka (Porecha 2023; Boom 2022). From a process governance perspective, the empanelment of the right manufacturers through policy measures, a standardised mechanism to assess and test their produced batches, quality inspection, and timely payment are all crucial to ensuring the quality of drugs. Experts have also called upon the Central Drugs Standard Control Organisation (CDSCO) to fill vacancies of drug inspectors across all states (Agnihotri & Chandrashekharan 2019).

### Cost-related challenges

Since Essential Medicines are bound by regulatory price control, patients are generally protected from cost-related challenges. However, the rise in prices of drugs after the COVID-19 pandemic had led to contractual and procurement problems, because of which even Tamil Nadu—known to have a strong public health system—was suffering from drug shortages (Josephine 2022). In general, drug manufacturers procure Active Pharmaceutical Ingredients (APIs) and start production only after receiving the final purchase order, but sources for APIs are few (Bolineni 2016). The consequent delay in availability of drugs pushes people to spend on medicines at private retail outlets instead of being able to avail them at public health facilities. Therefore, timely initiation of rate-card contracting and procurement based on inventory data is crucial to ensuring the affordability of Essential Medicines.

There are many more unique systemic challenges across Indian states affecting the achievement of the aforementioned strategic objectives (Agnihotri & Chandrashekharan 2019). These include

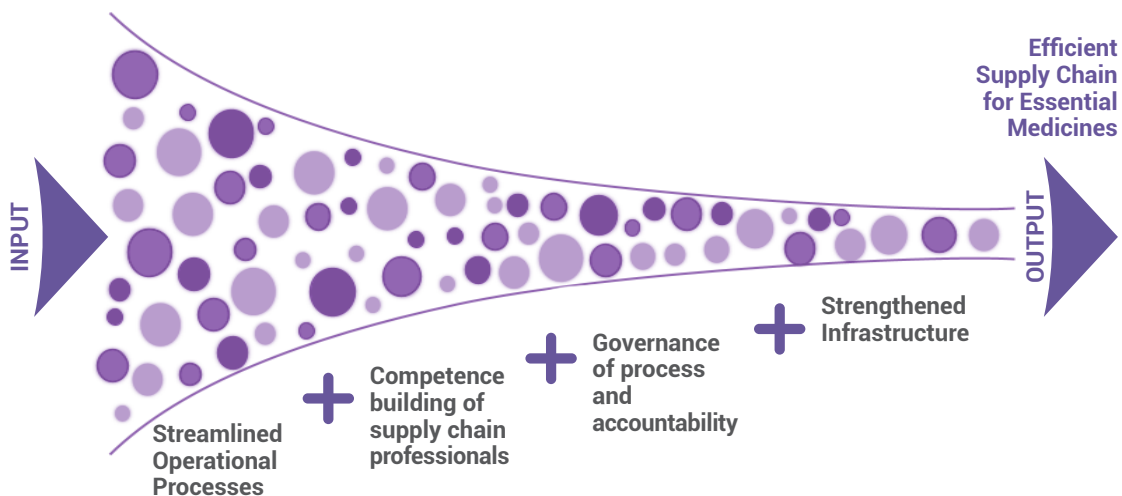
- Low prosecution of violators
- Low strength of inspection capacity
- Absence of a streamlined process to recall orders
- Lack of accreditation of labs across states
- Piecemeal implementation of reforms and digital infrastructure, and
- Absence of regular training for inspection officers.

Developing the state's capacity and will to resolve these governance problems is of utmost importance, not only to the supply chain of Essential Medicines but also to restore the health and save lives of Indians, and consumers of Indian medicines abroad. The next section looks into a few of the tactical ways in which some challenges in pharmaceutical supply chain management can be addressed.

## Levers for an Efficient Supply Chain of Essential Medicines

Challenges in pharmaceutical supply chain management can be addressed by optimising processes, governance mechanisms, human resources and infrastructure.

Figure 4: Levers for an efficient supply chain of essential medicines



Source: SKI Analysis

### Streamlined operational processes

For streamlining the operational processes of the supply chain for Essential Medicines, the sequential flow of activities from tendering, rate-card contracting, procuring, quality testing, storing and distributing must happen systematically. States have found varying levels of success and lessons from experimenting with decentralised and centralised models of the supply chain for Essential Medicines. Transparency in tendering, rate-card contracting, final procurement, and quality testing is an indispensable principle for accountability to the public, and it needs to be built into the operational processes. Moreover, data input and maintenance at every point in the supply chain will ensure the necessary flow of information for effective decision making within the public health system.

The centralised consumption-based pooled procurement model of the Tamil Nadu Medical Services Corporation (TNMSC) has had immense success in ensuring the availability of Essential Medicines within the public health system at the last mile. TNMSC's success is attributed largely to governance and process reforms centred around autonomy, strong leadership, committed public budgets, and information management, which were introduced in 1994 (Cohen 2014). Deputy Director at UPTSU, Manuj Purwar, explained that the Uttar Pradesh Medical Supplies Corporation (UPMSC) -

## HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?

inspired by TNMSC - has also been able to improve the availability of Essential Medicines in the state by adopting the centralised consumption-based pooled procurement model. Within the Essential Medicine supply chain system of Uttar Pradesh, tendering is undertaken through the public e-procurement portal and procurement is done through DVDMS. Then, the centralised purchase of medicines done by UPMSC is entered into its web portal, and Essential Medicines are made available at all district warehouses. Each batch of Essential Medicines supplied to the district warehouses is tested at NABL-accredited labs for quality check. Once approved, medicines are ready for distribution. Public health facilities in the district are responsible for collecting the medicines as per their requirement. These supply chain reforms have streamlined operational processes and facilitated the availability of Essential Medicines. However, it is also important to note that the mere replication of the TNMSC model would not act as a magic wand for all supply chain issues. Rigorous analysis of the existing conditions in the state, its monetary and administrative abilities, and checks and balances against corruption are important prerequisites for reforms (Singh et al. 2012).

### **Competence building of supply chain professionals**

Smooth functioning of the supply chain is highly dependent on the strength and competence of supply chain professionals within the public health system in every state. The execution of these operational processes requires trained and competent personnel, not just in the upstream position of the supply chain, but also at public health facilities at the community level. The National Institute of Biologicals recommends the upgradation of the National Training Academy to a University of Drug Regulatory Sciences, and the creation of a National Regulatory Knowledge Sharing Platform to achieve transparency, accountability, and traceability in the drug supply chain management (NIB 2017). Moreover, increasing the number of inspection officers for oversight and filling existing vacancies are prerequisites for improving the regulatory capacity of the state. Additionally, skills training for demand planning and forecasting should be strengthened.

### **Governance of process and accountability**

Assigning accountability for process management will ensure that responsibilities are clearly defined in the value chain. These responsibilities include, oversight of the supply chain to enable corruption-free procurement through transparent tendering, timely procurement to avoid delays in making Essential Medicines available, quality control, and routine audits to confirm the availability of Essential Medicines at the last mile.

### **Strengthened infrastructure**

The Indian pharmaceutical supply chain - with its high capital costs - is riddled with end-to-end complexities, given its high dependence on road freight transport (Biospectrum 2021; Doshi 2023). Unfavourable climatic and geographical conditions, poor cold chain infrastructure for warehousing and transportation, and poor quality data management ultimately lead to the breakdown of medical supplies and have disastrous consequences for public health.

Interruptions in power supply in remote areas also pose a big risk to the quality of Essential Medicines. The absence of robust monitoring and information management systems to detect breakdowns in the supply chain hinders the deployment of timely intervention by state authorities. Thus, greater investments must be made in strengthening infrastructure for warehousing, transportation, and data management. Sustainable and cost-effective technological solutions have an important role in infrastructure strengthening.

## Promising Technological Solutions for Pharmaceutical Supply Chain Management

**Figure 5: Types of technological solutions for supply chain management**

Streamlined Operational Processes	Competence Building of Supply Chain Professionals*	Governance of Process and Accountability	Strengthened Infrastructure
Transparent tendering solutions		Quality control solutions	Smart warehouse solutions
End-to-end order and inventory management solutions		Reporting mechanism for malfeasance and non-availability of drugs	Portable cold chain containers for transporting vaccines
			Temperature and cold chain monitoring solutions

Source: SKI Analysis

\* Due to limited availability of tech solutions

As seen so far, the supply chain for Essential Medicines has many intricate and complex moving parts. As a result, many of these moving parts have to align for a systemic transformation that enables access to Essential Medicines. Although technology cannot be a panacea for all that ails the supply chain of Essential Medicines, some technological solutions have the potential to improve and strengthen the supply chain system. These select solutions have been profiled across the three levers:

### 1. Streamlined operational processes

#### a. Transparent tendering solutions

- i. **Central Public Procurement Portal:** This public procurement portal has been developed by the National Informatics Centre for the union government and the state governments to enhance transparency in procurement procedures. The portal claims to bring a drastic reduction in the tendering cycle time and most of the indirect costs (Gol n.d.). Interested bidders can download and apply for tenders on this portal. It has been integrated with the Government e-Marketplace portal since 2020 towards a Unified Procurement System (The Economic Times 2020).

## HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?

### b. End-to-end order and inventory management solutions:

i. **Karnataka State Drugs Logistics and Warehousing Society (KDLWS) portal:** Under the aegis of the Karnataka State Medical Supplies Corporation (KSMSC), the KDLWS portal has been created with the objective of centralising procurement and distribution of medicines, chemicals, and medical equipment, and for ensuring that Essential Medicines are adequately available at all public health facilities in the state. Pharmacists of public health facilities are required to maintain inventory data for every medicine in stock.

ii. **Drug Distribution Management System (DDMS) by TNMSC:** The DDMS portal by TNMSC is also a state-owned web supply chain management system for streamlining procurement, storage, and distribution of Essential Medicines to all public health facilities within the state. Order management, supply tracking, and mature forecasting of demand have been enabled within DDMS (The Hindu 2023).

iii. **Electronic Vaccine Intelligence Network (eVin) by MoHFW and UNDP:** eVin is a digital solution for real-time monitoring of vaccine stock and storage temperature at multiple locations in India (UNDP n.d.). In 2020, eVin was used to monitor supply chain management of vaccines in response to the COVID-19 pandemic (MoHFW 2020). According to UNDP, eVin has been implemented in all 733 districts, for over 29,000 vaccine storage centres.

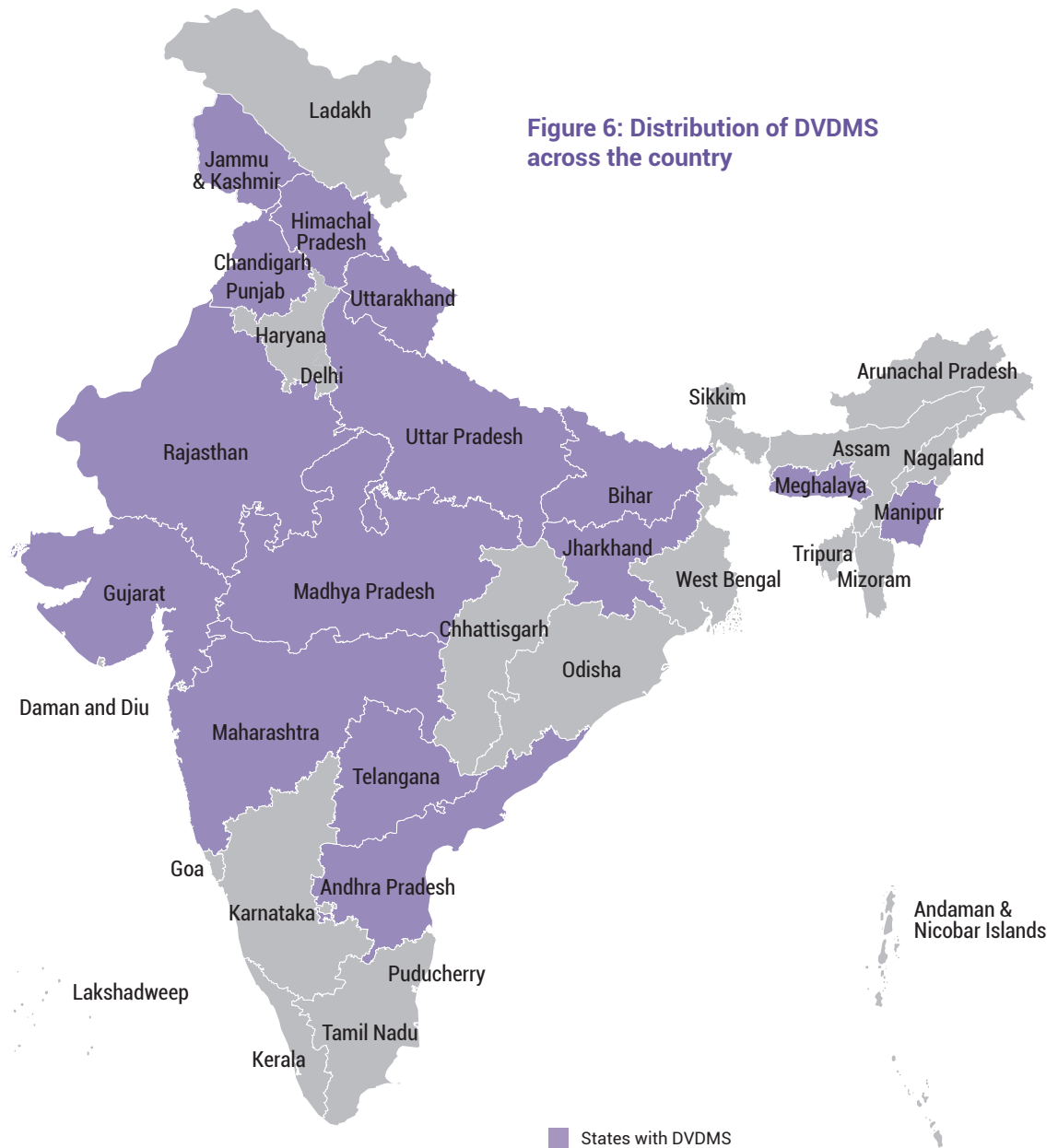


iv. **E-aushadhi or Drugs & Vaccine Distribution and Management System (DVDMS):** DVDMS has been developed by the Centre for Development of Advanced Computing (C-DAC) under the Ministry of Electronics & Information Technology, and it has been implemented in 27 Indian states and union territories. Purchase, inventory management, and distribution of Essential Medicines across all public health facilities and Drug Distribution Counters can be done through DVDMS. Its central dashboard contains aggregation tools, triangulation systems, and business intelligence tools for real-time analytics. It also helps to track key performance indicators of

stock-outs, consumption patterns, patterns of demand and supply, storage, quality control, procurement, logistics, and more (MoHFW; PIB 2019).



## HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?



Source: dvdms.in

**v. Logistimo:** Logistimo - a mature solution - boasts of rich functional features, such as inventory management, demand forecasting, order tracking, and cold-chain monitoring. Logistimo's dashboards can be accessed on web and mobile applications, and it can function on 2G mobile networks or even offline. The system sends SMS alerts to pharmacists based on inventory data to avoid stock-outs. Today, Logistimo is being used at 27 PHCs in Karnataka, 24 PHCs in Arunachal Pradesh, and 8 PHCs in Meghalaya, all supported by the Karuna Trust.

*“Logistimo is mobile-friendly. The inventory can be viewed on the mobile phone. Any emergency drugs at PHC level can be viewed on Logistimo's application. It helps to determine a stockout situation. The disadvantage of Logistimo is that the inward process is done manually. The inward process has to be done manually because there is no interoperability between Logistimo and KDLWS. KDLWS is granular in data collection, however Logistimo only helps to view the stock in general. Bin cards are also maintained for every medicine, and this information is transferred to Logistimo every week. Then physical stock is checked against the stock entry on Logistimo. The bin card entry, the Logistimo dashboard figures, and physical stock have to be the same.”*

- **Rajkumar Rudrapanavar**, Administrator of Idaguru PHC, Chikkaballapur district

## 2. Governance and accountability

### a. Anti-counterfeit medicine system and quality control

- i. **Portable NQR spectroscopy:** Portable NQR spectroscopy is a low-cost and non-invasive solution under development to detect low quality or fake medicines in low and middle-income countries. This solution can enable two spectroscopic analyses to check whether the packaging information matches the contents of the medicine (Technology Networks 2016). It was developed by instrumentation researcher Soumyajit Mandal along with research participants from the University of Florida and King's College, London, to address the menace of counterfeit and NSQ drugs found in Asian and African countries. However, this solution has not found large-scale use in health systems as yet.
- ii. **Vaccine Ledger:** StaTwig's VaccineLedger is an emerging app-based solution that ensures the quality and safety of vaccines using blockchain with unique digital IDs for each vial and unit-level tracking and traceability. It provides actionable insights to enhance visibility and put an end to supply chain failures such as counterfeiting, black marketing, cold chain failures, and stockouts. It can also trace every stakeholder including suppliers, distributors, retailers, consumers, and users. One of Vaccine Ledger's successes lies in reducing the failure rate for the Pfizer vaccine in Costa Rica during the pandemic. With a fast-approaching expiration date, the consignment of vaccine vials was at risk of going to waste. But the alert system based on real-time data enabled the decision-makers to act quickly and expedite the distribution of vaccines.
- iii. **AKS Software:** AKS Software has been developed by the National Institute of Biologicals, MoHFW, Government of India. The software enables data transmission of sample survey drugs to testing laboratories and also enables the reception of analysis reports. It can also be useful in statistical analysis of field drug surveys and laboratory findings (PharmaBiz 2015).

## HOW CAN TECHNOLOGICAL SOLUTIONS STRENGTHEN THE PHARMACEUTICAL SUPPLY CHAIN?

In 2022, the MoHFW-issued guidelines necessitated all APIs manufactured in India and abroad to have QR codes in the packaging for tracking purposes (Hindustan Times 2022). Subsequently, the National Pharmaceuticals Pricing Authority (NPPA) also shortlisted the top 300 drug brands required to bear QR codes in the packaging for authenticity and traceability (ET Bureau 2022).

### b. Reporting mechanism for malfeasance and non-availability of drugs

i. **The complaint redressal system by TNMSC and KSMSC** allows vendors to officially register their complaints and grievances. However, the registration and resolution of the complaints are not publicly available. There is scope for improvement in opening the grievance redressal window to public health facilities as well, so that process governance issues can also be documented and addressed.

## 3. Strengthened infrastructure

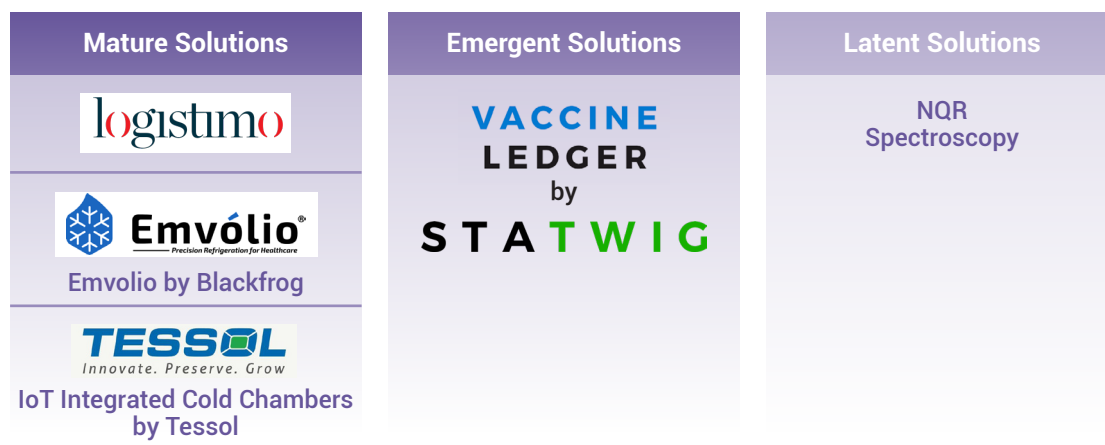
### a. Smart warehouse solutions

i. **Tessol's IoT Integrated Smart Cold Chambers:** This solution provides temperature-controlled storage with high-density polyurethane panels that insulate the walls and ceiling of the storage space by preventing heat transfer and maintaining temperature stability. Tessol's cold chambers are also CFC-free (Tessol n.d.).

### b. Portable cold-chain containers for transporting vaccines

i. **Emvolio by Blackfrog:** Emvolio by Blackfrog is a portable refrigeration device that is battery-operated. It can help in the delivery of vaccines and all other biologicals like blood, serums, and viral culture which require a strict temperature-controlled environment at all times. Continuous temperature monitoring, location tracking, state-of-charge indication, and communication with headquarters via live tracking and vital statistics for improved coverage are all possible through Emvolio. It is also compatible with solar charging. Over 1,50,000 vaccines were delivered using Emvolio in 'hard to reach areas' in over 12 states (Blackfrog Technologies n.d.).

Figure 7: Spectrum of technological solutions for the pharmaceutical supply chain

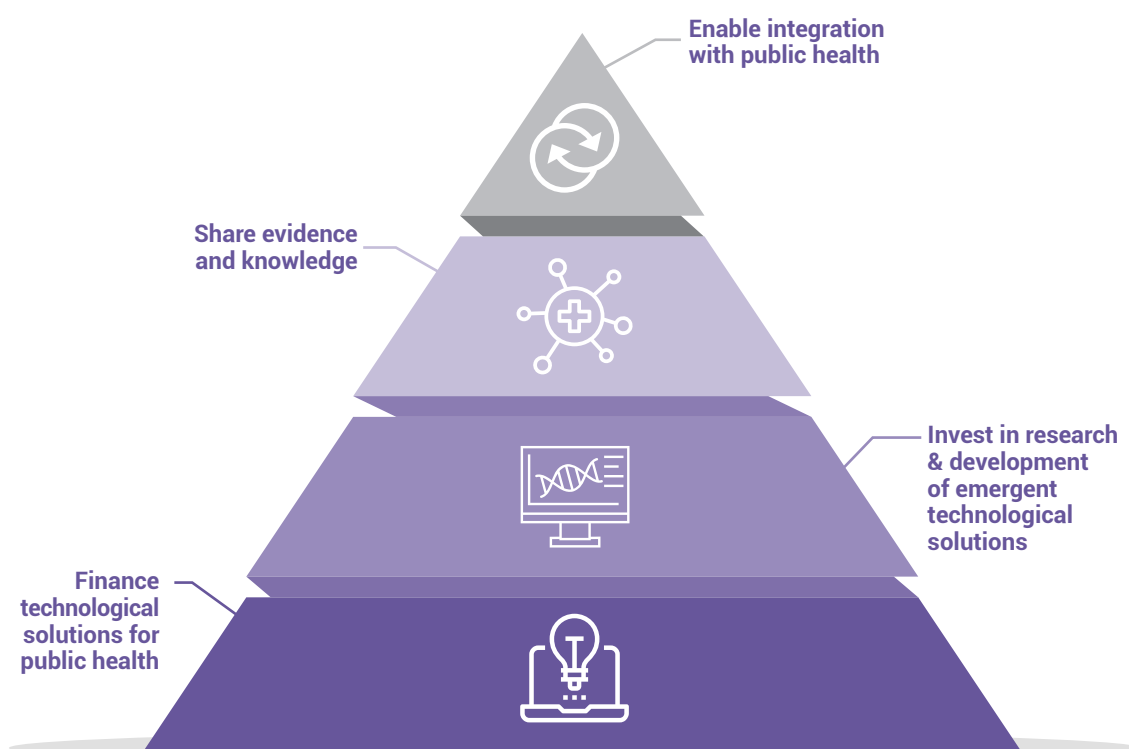


Source: SKI Analysis

# Encouraging Research and Innovation with Philanthropic Investments

The potential of philanthropic investments in strengthening the supply chain is multifold. From participating in infrastructure development, research, and development of low-cost technological solutions, knowledge dissemination, and facilitating strategic partnerships to helping supply chain professionals, philanthropic stakeholders could help in making Essential Medicines available at the last mile.

**Figure 8: Role of Philanthropy**



Source: SKI Analysis

### **Finance technological solutions for public health**

Philanthropic assistance by donating tactical technological solutions to the state during the COVID-19 pandemic was an urgent form of engagement to address the public health crisis. In 2021, the Government of Japan announced aid assistance to the Government of India for the purchase of walk-in coolers, walk-in freezers, solar direct drives, vaccine carriers, and voltage stabilisers, which are all part of the cold chain system (UNICEF 2021). Similarly, the Rotary Club of Madras donated refrigeration trucks, ice-lined refrigerators, and vaccine carriers - all worth ₹1 crore - to the state government of Tamil Nadu in 2021 through an MoU with the Department of Health and Family Welfare (The Hindu 2021).

*“Philanthropy did a good job during the pandemic. The government needed refrigerated vans, and philanthropy came in to plug this gap. Now vaccines can be distributed in one-go at a maximum of three days. Even oxygen management systems needed by the government was donated by corporations through CSR. There is scope for partnership. Maintenance issues will be there since electricity bills will be running high, and if equipments are just kept, it will be a waste. Regarding ICT platforms, it has to be on NIC servers. Private servers integrating into NIC servers would have to be thought through.”*

- **Vikas Patil**, Ex. Consultant at National Cold Chain Resource Centre (Pune)

### **Invest in the research and development of technological solutions**

Systematic research into technological solutions that can successfully detect NSQ drugs is of utmost importance to India's pharmaceutical supply chain. Therefore, philanthropic investments toward this objective will be of great value to the public health system. Additionally, emerging solutions will also greatly benefit from philanthropic involvement, as has been the case with Logistimo. If philanthropic organisations wish to engage in strategic aid, they could facilitate partnerships within their networks and pilot these technological solutions for remote areas with high need.

### **Share evidence and knowledge**

Such pilot integrations can be evaluated based on evidence. Findings from the pilots should be published and disseminated to government stakeholders and other philanthropic funders for shared learning. For this, the pilot integrations facilitated by philanthropies will need to be monitored routinely to capture the contextual particularities that enable or disable the availability of standard quality Essential Medicines at the last mile. The enabling and disabling factors should inform the final evaluation findings of the pilot integration. However, ethics of social research will have to be followed within the research design, and all possible externalities will have to be accounted for, since tinkering with the existing supply chain could potentially lead to unavailability of Essential Medicines.

### **Enable integration of successful solutions with the public health system**

Philanthropic foundations working with the state governments with mature supply chain systems could explore the integration of sophisticated technologies into the system to strengthen it further. Monitoring and tracking solutions for inventory management and demand forecasting could also be customised based on the requirements of the concerned state medical supplies corporation. Integration potential with NIC servers and shouldering a greater share in costs of electrification and maintenance of cold chain systems will be important pathways to explore for funders.

*“The measure of a successful supply chain is availability of drugs, and not digitisation of the supply chain. There can be a fully digitised supply chain and yet not be able to ensure availability of drugs. Digitisation of supply chain is a tool to improve visibility and to enable changes. It is not making changes automatically. There are other allied factors coming into play to ensure availability of drugs at facilities of various levels.”*

- **Manuj Purwar**, Deputy Director for Health Systems, Uttar Pradesh Technical Support Unit

## Conclusion

A robust supply chain for Essential Medicines in public health is fundamental in meeting the priority healthcare needs of the population. Operational processes at the state level must be formalised and streamlined through the body in charge of procurement and subsequent supply chain processes. The operational design of the supply chain must account for transparency at every point of the supply chain. The efficient functioning of the supply chain depends greatly on a well-staffed cadre of competent supply chain professionals. Therefore, states need to ensure that the human resource requirements of all responsible bodies are appropriately mapped, sanctioned, and filled. Routine training at various levels also has to be undertaken to equip the staff with the necessary skills and knowledge. Assigning accountability at every functional level of the supply chain is vital for the implementation and governance of reforms in the system. Capital investments have to be made to strengthen the supply chain infrastructure for warehousing, transportation and distribution, and data management, as these are key tangible assets of any supply chain.

Philanthropies have an opportunity to strengthen the supply chain by donating cold chain infrastructure assets to the public health system, investing in research and development of latent and mature solutions, sharing the knowledge and evidence from such research activities, and working with state governments with mature supply chain to enable the integration of successful technological solutions in strengthening it further and reducing the negative impact of contingencies.

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