Technology, Artificial Intelligence, and the Public Sector Supply Chain: Challenges and Opportunities

___

August 2025

Pamela Steele, Adin Chan, Kaiyan Wang, Virginia Onchiri, Ashpenaz Ayub

Pamela Steele Associates is **a member of the** CPD Certification Service, membership number 16108. CPD points can be awarded on completion of an accredited training course.

Pamela Steele Associates Limited is registered in Kenya with company registration number CPR/2015/2197478531307

Executive Summary....................3
Methodology....................5
Step-by-step Analysis....................5
Planning & Demand Management....................5
Sourcing & Procurement....................8
Manufacturing....................9
Distribution & Warehousing....................9
Delivery....................10
Usage....................11
Mapping The Supply Chain....................14
Conclusions....................15
Endnotes....................17

Executive Summary

This report reviews common problems across five steps of the public sector supply chain, from planning and demand management to delivery and patient usage. It examines both academic literature and real-world case studies to identify areas where new technologies can provide meaningful solutions to supply chain challenges. While some innovations incorporate artificial intelligence (AI), there are many readily available solutions which rely on much simpler technical capabilities, such as electronic inventory management systems and mobile applications.

After outlining key issue areas across the supply chain, the report then maps the Kenya Medical Supplies Authority KEMSA network to investigate areas which would benefit the most from technological intervention. Persistent challenges of poor record keeping and procurement inefficiencies reveal that workforce training remains a critical room for improvement in the KEMSA supply chain. The Kenya Medical Supplies Authority (KEMSA) was selected as the focal point for this study because it is the central node of Kenya's public health supply chain and a critical determinant of the country's ability to deliver essential medicines and commodities. Nearly 70% of Kenya's health services depend on KEMSA's procurement, warehousing, and distribution operations. Historical challenges, including inventory leakages, delayed procurement, stockouts of essential medicines, and financial constraints, have made KEMSA a high-impact case for exploring technological and AI-driven solutions. By focusing on KEMSA, the study is able to demonstrate how targeted digital interventions can address real-world supply chain inefficiencies in a representative LMIC context, generating lessons applicable to similar public sector supply chains across Africa. Chatbots and personalised training services could be a helpful step towards solving these challenges.

Supply Chain Stage	Issue Areas	Solutions	Case Study
Planning & Demand Management	Poor Forecasting	LSTM Forecasting*	Rwanda
	Inaccurate Data	Integrated Databases	Kenyan NDW
Sourcing & Procurement	Intellectual Property	Pooled Procurement	Global Fund
		Voluntary Licensing	Medicines Patent Pool
	Unclear Procedures	Digital Procurement	Kenyan e-GP
	Supplier Selection	Supplier Analysis*	
		Workforce Training*	
Manufacturing	Maintenance	Predictive Maintenance*	
	Quality Control	Image-based QC*	
	Prototype Design	Generative AI*	
Distribution	Corruption & Theft	Blockchain	Cash Transfers
Delivery	Infrastructure	Route Optimization*	Zipline

	Delivery Tracking	e-POD	Kenyan e-POD
Usage	Stock Imbalances	IM Software	India’s e-Vin Program

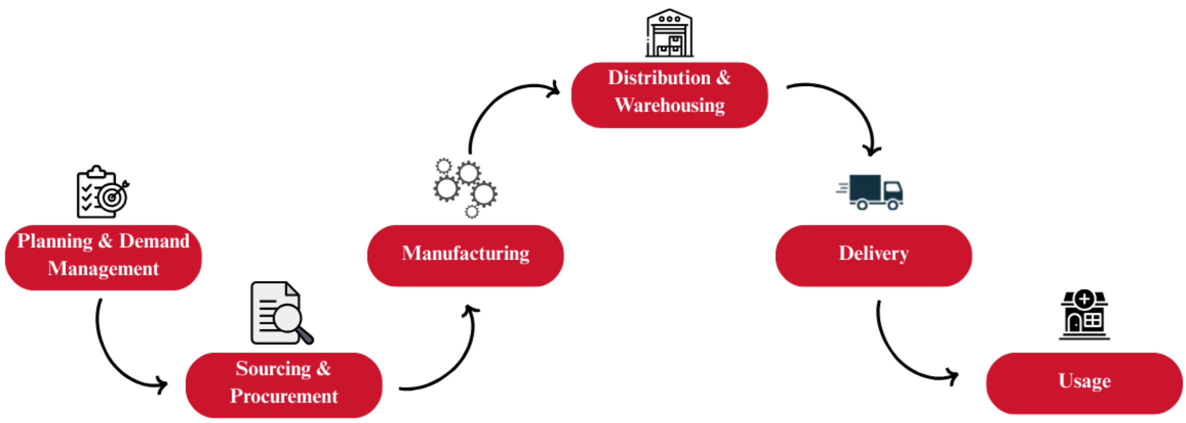
** Indicates AI solution*

Methodology

The motivation for this report is to identify existing solutions to common problems in the public sector supply chain and, where appropriate, to highlight relevant artificial intelligence use cases for low- and middle-income countries (LMICs). Our research team conducted desk research to identify existing start-ups and government initiatives to find real world implementation of technology across the supply chain.

We also drew from peer-reviewed research, which included literature reviews, empirical analyses, and focused case studies. Of particular interest for us was finding good empirical work that quantified the impact of technology and artificial intelligence on operational outcomes. Additional publications were found through a snowball literature review.

Step-by-step Analysis



Planning & Demand Management

Public health demand forecasting is the ongoing process of **predicting** which health commodities will be needed, in what quantities, where and when they will be required, and who will need them. As the primary step in the supply chain, inaccurate demand forecasting for public healthcare supply chains can have a profound impact on the later steps in the supply chain. For example, KEMSA today faces diverse challenges stemming from planning inefficiencies, such as overpriced health supplies and technology, frequent stockouts of essential medicines, and poor supply chain visibility.

These problems can be improved by more accurate demand forecasting. The primary concern in this procedure is incomplete/missing data provided by health facilities, especially in low- and mid- income countries (LMICs). In many LMICs, there is a lack of an integrated technological platform for health institutions and suppliers to share data and increase efficiency. Some researchers have estimated that missing data within LMIC health information systems could range from 19% to 50%, and only half of the countries studied had data that was at least 80% accurate.[1] With better data, management can match supply with demand proactively and execute the plan with minimal disruptions.

The Ministry of Health (MoH) in Kenya has made a push for digitisation of records and patient data, albeit mostly in its efforts to combat **Human Immunodeficiency Virus** (HIV). The MoH requires all facilities to upload de-identified data to the National Data Warehouse (NDW) at least once every month.[2] The data warehouse hosts data for over 2.2 million HIV positive persons and over 1.1M testing records for tested individuals from 8 **Electronic Medical Record** (EMRs)in over 1200 facilities with an EMR. However, this level of reporting with an integrated data repository is not yet achieved for a broader range of diseases. According to Kenya HMIS (Kenya Health Management Information Systems), many health facilities in the country still rely on manual, paper-based reporting systems.

The most relevant tech-driven solution is to generate a **sharable database** that connects the data of various stakeholders, from the government to health facilities. KEMSA recently initiated a new strategy for improving forecasting and quantifying health product needs using stakeholder collaboration and data analysis to maintain over 95% stock availability.[3] KEMSA will implement a logistics management information system (iLMIS) and Enterprise Resource Planning (ERP) programme which will collect and analyse real-time logistics and procurement data, enabling trend analysis and forecasting of future supply chain needs. Developed in 2024, the I-LMIS system integrates three components: the Commodity Early Warning and Alerts System (CEWAS), the Logistics Information Management System (LMIS), and the e-POD app, which ensures timely delivery of health products and technologies to health facilities.[4]

Yet even with quality data, planners still face the challenge of matching demand and supply. Given the often unpredictable nature of public health emergencies, this can often lead to errors at the demand forecasting stage. Artificial Intelligence (AI) offers some promising use-cases for public health supply chain demand management, particularly in the realm of **predictive analysis**. According to Aramex, 35% of health organisations already use AI in demand forecasting. AI-driven predictive analytics enhance demand forecasting by utilising extensive datasets that include historical sales data, customer orders, economic factors, website traffic, social media engagement, and current market trends.[5] Research has shown that incorporating AI-powered predictive models can continuously learn from new data inputs, adapt to changing market conditions and patient needs, and provide healthcare organizations with real-time insights into their supply chain performance.[6] The common time series forecasting models include classical statistical models like ARIMA and machine learning models like LSTM.

- **ARIMA (autoregressive integrated moving average)** is a classical statistical model that analyses time-series data to make forecasts. It is effective for predicting linear trends and is relatively simple to implement, making it a good starting point for organizations with limited data or technical capacity. However, its major limitation is its inability to handle complex, non-linear relationships or incorporate external variables, and it requires the data to be stationary.
- **Long Short-Term Memory (LSTM)** is a sophisticated type of recurrent neural network (RNN) specifically designed to recognize patterns in sequences of data, such as time-series consumption data. LSTMs excel at capturing long-term dependencies and complex, non-linear patterns, making them powerful for forecasting dynamic health demand. A comparative study using health supply chain data from Rwanda found that an LSTM model dramatically outperformed an ARIMA model, achieving over 90% accuracy in predicting medicine demand compared to ARIMA.[7] The primary drawbacks of LSTM are its need for large amounts of high-quality historical data and significant computational resources.

Key Finding:

For low- and mid-income countries, an integrated database shared across the public healthcare supply chain with a machine learning model LSTM could greatly increase the accuracy of demand forecasting.

Sourcing & Procurement

Public procurement is essential for securing health supplies and technology, particularly in low- and middle-income countries. Given the large expenditure in public procurement, which consumes 60% of Kenya's annual budget and 26% of its GDP, finding efficiencies at the procurement level is essential to build effective health supply chains and provide citizens with the medicines and equipment they need.[8] Medical procurement can also intersect with other national priorities. In Indonesia, for example, public procurement has boosted local production and industrial development by ensuring market access for domestic products.[9]

A World Bank presentation in 2024 found public medical equipment procurement challenges in the Kenyan and African context, including high import costs, global supply chain disruptions, and inadequate technical expertise when selecting and maintaining complex medical equipment.[10]

A UNICEF report in Namibia took an even deeper look at procurement challenges by asking different government ministries which issues they believed to be most pressing.[11] The Ministry of Health cited the complexity of procurement, with thousands of products each with numerous competitors, and delayed payments negatively impacting supplier relations. The Ministry of Finance critiqued the lack of agreement on process and operating procedures and a reliance on emergency procurements, which often faced limited competition.

Even with sufficient funds and best practices, intellectual property rights pose another challenge in public health procurement. Protected patents elevate the cost of drugs and can make imports difficult. High profile cases include South Africa's legal dispute over generic HIV/AIDS medications and the vaccine monopolies during the COVID-19 pandemic which led to vaccine shortages in LMICs.[12]

Procurement challenges arise, therefore, at two levels of analysis. On a macro-level, geopolitical tensions, intellectual property, and foreign exchange all pose barriers to efficient sourcing. On a national-level, fiscal pressures, unclear operating procedures, corruption, and inadequate training mean that health officials often do not make cost or resource efficient procurement decisions.

While some of these challenges lie beyond the scope of supply chain management, there are still proven solutions which can improve procurement processes in LMICs. Pooled procurement mechanisms, such as the Global Fund, and the UN-backed Medicines Patent Pool (MPP) have been shown to reduce prices for pharmaceuticals.[13] Electronic procurement systems have been introduced across the continent, including in Kenya, which promise to streamline procedures, monitor data, and minimise procurement cycle time.[14]

While AI may not have immediate use cases in public sector procurement, powerful data analysis and pattern recognition software may one day tap into large datasets to analyse supplier databases, historical data, and identify supply chain risks.[15] Moreover, generative AI can also speed up the writing of requests for proposals (RFPs), requests for quotations (RFQs) and other time-intensive documents.

Key Finding:

The digitisation of the public procurement process is a welcome development in public health supply chains. Future applications in AI will likely be to more thoroughly vet different suppliers, monitor supplier risk, and boost workforce productivity.

Manufacturing

The manufacturing process for medical goods and supplies is, of course, a crucial step in the public health supply chain: the efficient production of vaccines, mosquito nets, antivirals, or facemasks is essential for a functioning public health system. Though optimisation at the manufacturing stage lies somewhat outside the core value-added expertise of PSA, which focuses more on broader processes across the supply chain, there are still several tech-driven advancements in manufacturing worth noting to better appreciate the scale and pace of change in this crucial step of the supply chain.

According to IBM, the most impactful use case of AI in manufacturing will be predictive maintenance, where machines can quickly analyse data to forecast future failures.[16] Image recognition will lead to automatic defect detection, which will transform the quality control process. Generative AI can also help with customer service automation and prototype new designs to quickly adapt to changing needs. By integrating real-time data from across the shop floor, AI systems can also improve productivity by suggesting the most important next task for workers to undertake, while simultaneously scanning for any potential hazards and workplace risks.

Key Finding:

AI will lead to improvements in manufacturing through (i) predictive maintenance, (ii) quality control, (iii) customer service automation, (iv) faster product development, and (v) improved labour productivity.

Distribution & Warehousing

Once the medical supplies are manufactured they must be transported to a warehouse for storage before moving on to their final destination. In the case of medical imports and foreign donations, the supply chain process begins at this stage, as material is transported from foreign countries into the domestic supply chain.

There are numerous challenges in the distribution and warehousing step in the public health supply chain. Temperature sensitive goods, for example, require timely delivery and a reliable cold chain throughout their journey. Efficient placement of logistical warehouse centres requires significant strategic thinking, as decisionmakers optimise between proximity to population centres and available transportation connections.

Corruption presents a significant, non-technical challenge to distribution and warehousing. Influential individuals may act as gatekeepers for access to local communities. According to a report by Transparency International, the influence of corruption on aid delivery is particularly acute for humanitarian assistance in conflict zones, where armed groups frequently divert aid, interfere in registration, and embezzle goods.[17]

Yet even in peacetime leakage through corruption or theft is not uncommon. Individuals involved in the transport and storage of valuable medical goods may also take some of the supplies for themselves and sell it on the private market. In March 2022, it was revealed that KEMSA lost 908,000 mosquito nets, 1.1 million condoms, and tuberculosis drugs worth Sh10 million ($77k USD) from theft.[18] The lack of traceability and inventory visibility clearly entails significant costs for the public health supply chain, which presents an opportunity for tech-driven solutions.

The most promising area for innovation for distribution and warehousing is **Blockchain** technology, which acts as a secure and transparent ledger to record transactions. Blockchain enjoyed a significant hype cycle in the late 2010s, promising to transform industries and fundamentally decentralise our financial system.[19] While that vision ultimately came to pass, the transparency and traceability of blockchain ledgers did find some traction in the private sector supply chain. Walmart uses blockchain technology for proof of delivery and approvals of payment, which has decreased invoice disputes with distributors from 70% of transactions to less than 1%.[20] Other cases have not been as successful. In late 2022, Maersk and IBM ended their 'TradeLens' blockchain platform for sharing shipping information due to disappointing return on investment.[21]

Blockchain has been employed in humanitarian supply chains, albeit on a relatively small scale. Zwitter & Boisse-Despiaux (2018) highlight the technology's potential to earmark donations for specific services or recipients, thereby reducing corruption and theft.[22] The most ambitious initiative thus far has been the World Food Programme's **Building Blocks** initiative, which enables tracking and coordination of cash, food, water, medicine, and other essential products. The programme allows multiple relief organisations to keep up-to-date records of who has already received assistance, which avoids service duplication. Other case studies in for blockchain in the humanitarian sector abound, although they have primarily pertained to cash transfer rather than goods deliveries:

- The Kenyan Red Cross combined blockchain and M-Pesa technology to assist thousands of households in Isiolo County affected by drought.[23] (Spring/Summer 2018)
- The Startup Network used a €50k grant from the Estonian government to trial blockchain technology for financial transfers between international NGOs and domestic partner agencies.[24] (Spring 2018)
- The UNHCR launched a pilot project in 2022 which used blockchain for cash transfers to internally displaced persons in Ukraine.[25] (Fall 2022)

While promising, blockchain technology is no panacea to goods distribution. Hunt et al. (2022) outline several challenges to their implementation, including the lack of empirical evidence of their effectiveness, expensive development costs, difficulties in scalability and integrating with existing systems, and the significant training required for blockchain operations.[26] Moreover, fixing corruption may not be so easily fixed by improved tracing and visibility. In contexts such as conflict zones, where goods-for-access is the price of doing business, blockchain is unlikely to significantly reduce corruption barriers to aid distribution.

> **Key Finding**:
>
> Blockchain offers a promising technological solution to the problem of corruption and theft in public health and humanitarian supply chains. However, financial, technical, and coordination problems will limit the degree to which they can scale up to system-wide solutions.

Delivery

Across resource-limited settings, effective public health delivery remains a challenge due to **inadequate infrastructure** and **logistical inefficiencies**. One of the most critical bottlenecks lies in the "last mile", which is the final leg of the supply chain where essential medicines and healthcare services are delivered to healthcare facilities or patients. In African countries, breakdowns in this stage have led to medicine shortages, treatment delays, and increased death rates, especially in rural areas.

According to a study, healthcare delivery in LMICs face complex and deep-rooted challenges such as historical conflicts, poverty and geographic isolation with many communities located in **remote areas** with poor transportation networks which become impassable during rainy seasons.[27] Moreover, healthcare delivery systems suffer from **limited human resources** due to low wages and poor working conditions. This shortage has led to many facilities operating with insufficient staff, often with one or two healthcare workers attending to more patients than usual.

One digital technology which has shown considerable promise in addressing problems in last-mile delivery has been the introduction of **unmanned aerial vehicles** (UAVs), also known as drones. For example, the USAID Global Healthy Supply Chain Program introduced a drone delivery programme to remote areas of Northern Malawi.[28] The initiative aimed to address transportation challenges faced by healthcare facilities, particularly in delivering HIV and tuberculosis (TB) samples, test results, and essential medical supplies. The project significantly reduced turnaround time for sample deliveries and improved access to health services for communities that were previously hard to reach.

In Kenya, drone delivery services are rapidly transforming last-mile health supply chains, especially in rural and hard-to-reach areas.[29] In 2023, Zipline launched its first drone hub in Chemelil, Kisumu County, and expanded operations to serve Kisumu, Homa Bay, Nyamira, and Kericho.[30] These drones have been used to transport vaccines, HIV test kits, anti-rabies treatments, blood products, and other critical medical supplies directly to remote health centers, bypassing significant terrain challenges.

Apart from drones, Kenya deployed the Electronic Proof of Delivery (e-POD), developed by KEMSA in collaboration with Coca-Cola Beverage Africa and supported by UNFPA, for last-mile delivery verification and tracking of healthcare commodities.[31] The system has enabled healthcare workers to digitally confirm receipt of essential medicines and family planning commodities. The app captures delivery data including GPS coordinates, timestamps and quantities received, enhancing transparency and preventing supply chain discrepancies.

Artificial intelligence (AI) has been used in the delivery phase of the public health supply chain primarily for **route optimisation** which can determine the most efficient routes for delivering essential medicines and vaccines, minimizing time and fuel consumption. Zipline, the drone delivery company, uses AI to sift through weather data, traffic, terrain, and airspace restrictions to calculate the best route for its autonomous vehicles.[32]

Key Finding

The last mile is the most critical and fragile link in public health supply chains, especially in rural areas. Issues of poor infrastructure, logistical inefficiencies, and geographic isolation can lead to medicine shortages, treatment delays, and increased mortality.

Usage

We now turn to the last step of the health supply chain, where patients access care and receive those medicines and vaccines which have travelled across the supply chain – from forecasting to sourcing to manufacturing to distribution and into the delivery vehicle. When there is an issue upstream, whether that be poor regional demand planning, insufficient procurement, or a breakdown of delivery vehicles, those impacts are ultimately felt at the usage-level, when patients require medicine but the clinic has stocked out, or when clinics unnecessarily waste medicine as a result of overstocking. This section explores the dual challenges of **over/understocking**. While the causes of over/understocking lie throughout the supply chain, this report looks at it at the usage stage, since it is ultimately at the point of access where patients and health workers most acutely face this supply chain inefficiency.

Poor inventory management may lead to waste or stockouts, which consequently affect the healthcare providers and patients. The occurrence of either problem points to a deeper breakdown in inventory management systems, forecasting capabilities and logistics. It implies a crucial absence of data visibility, adaptive planning and coordinated decision making, leading to misallocation of resources rather than a straightforward shortage or excess supply. Studies show that millions of dollars are lost in revenue annually due to drug waste.[33] Surplus leads to wastage while shortages lead to patients lacking essential medicine and increased mortality rates.

Regulatory compliance plays a significant role in shaping inventory management practices. Regulatory agencies stress that institutions maintain detailed records of their inventories including information on drug sourcing, expiration dates and disposal procedures. Ensuring that these records are accurate and up-to-date requires significant administrative resources.

Other factors that affect effective inventory management in LMICs include inadequate infrastructure, lack of technological integration and unstable political or economic conditions. Also, reliance on external support makes healthcare systems vulnerable to global supply chain shock such as during COVID-19 pandemic.

Using **automated inventory management systems** will help in tracking medication expiration dates and ensuring older stock is used first. Using inventory systems that support predictive analytics may help predict future stock needs and trigger automatic reordering when inventory fails below a certain threshold. Also, integrating machine learning with data analytics enables real-time inventory tracking, ensuring healthcare providers have up-to-date stock levels information, expiration dates and order history. This precision level allows for more efficient use of resources, reduced drug shortages risk and minimized waste due to expired products.

One promising electronic inventory management system has been the **e-Vin** (Electronic Vaccine Intelligence Network) program in India, which digitised information on vaccine stocks and temperatures across the country.[34] With real-time monitoring of storage temperatures and implementation in all 73 districts of India, the country now sees a vaccine availability rate of over 99% at all cold chain points. The success of the e-Vin program has seen the technology spread to other LMICs, such as Indonesia.[35]

Machine learning (ML) can complement these inventory management systems by continuously learning and adapting based on new data, which allows them to refine predictions over time. These models take into account factors such as seasonal trends, historical data and external factors like disease outbreaks to improve accuracy. ML models can **identify complex patterns** that may not be obvious through traditional statistical methods. For instance, ML algorithms can detect correlations between seemingly unrelated factors such as increase in hospital admissions and a rise in demand for a certain medication. Uncovering these hidden relationships can help healthcare providers anticipate demand shifts that would have gone unnoticed.

Effective collaboration between healthcare facilities and their suppliers/distributors is important to ensure steady and reliable drug supply. Facilities should regularly share data on drug usage, inventory levels and anticipated needs with suppliers to help them plan for future deliveries and avoid disruptions in the supply chain. Another alternative is facilities entering into vendor-managed inventory (VMI) agreements where suppliers are responsible for monitoring and maintaining inventory levels.

Key Finding:

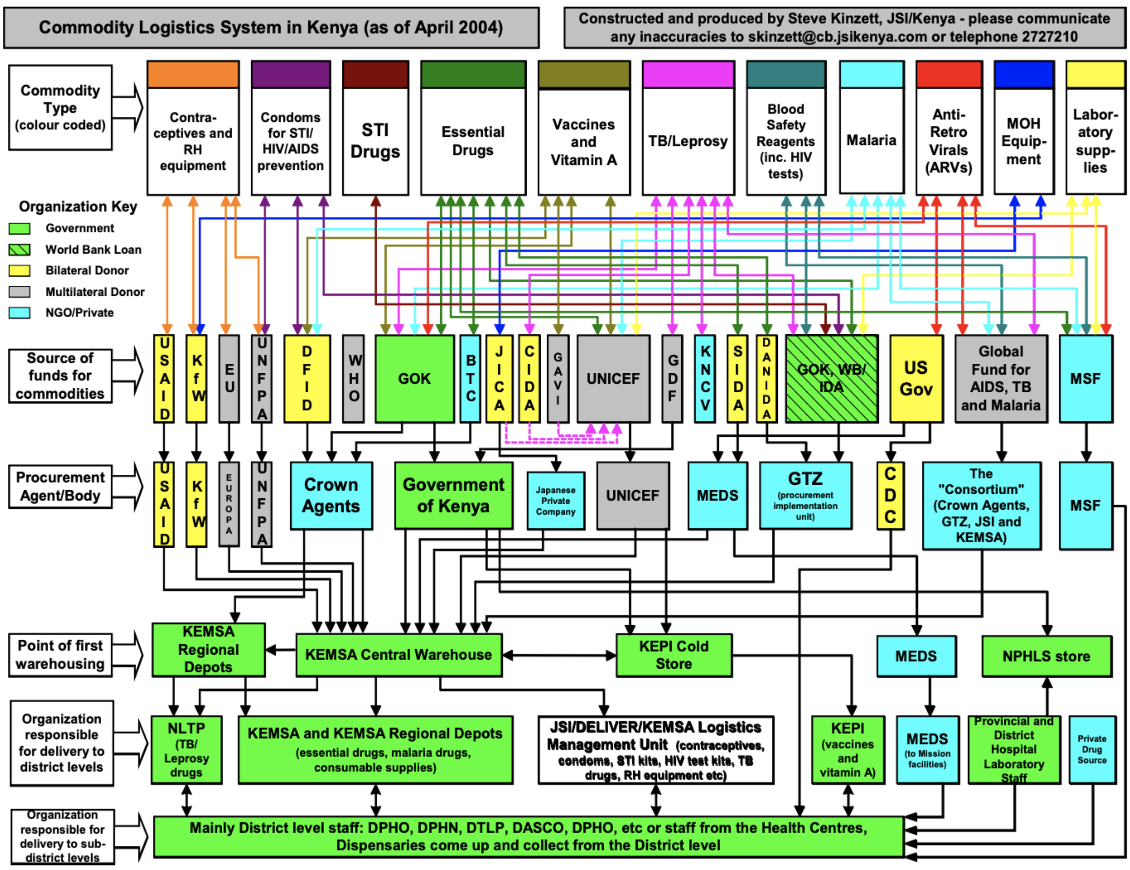
Digital and automated inventory management systems are essential for inventory visibility and reducing over/understocking.

Mapping The Supply Chain

Having outlined the challenges and opportunities at each step of the public sector supply chain at a high-level, this report now turns to the specific case of the Kenya Medical Supplies Authority (KEMSA) supply chain to consider where exactly technology-driven solutions may be most useful. KEMSA works within a broader public health system in Kenya comprising various domestic and international agencies and health organisations. Nearly 70% of Kenya's healthcare services are provided by the public sector, through the Ministry of Health (MoH) and other government-funded bodies. Private companies, NGOs, and faith-based organisations also provide healthcare services through their own hospitals and clinics. Emergency ambulance services and disaster relief management are provided by the Kenyan Red Cross. Kenya is also currently the largest producer of pharmaceutical products in the COMESA region, supplying about 50% of the region's market.[36]

In PSA's 2017 study, *KEMSA After Devolution*, Steele describes a 'spaghetti supply chain' with overlapping responsibilities as outlined in Figure 1.[37] The diagram clearly illustrates the complexity of the system in Kenya, where multiple funding sources intersect as various NGOs, multilevel donors, and the Kenyan government each assume procurement roles.

Figure 1: The KEMSA Supply Chain



KEMSA introduced an integrated **logistics information management system** (LMIS) in 2022, which has been adopted by over 8,500 health facilities across Kenya.[38] The system receives data on average monthly consumption from health facilities to determine what should be replenished from KEMSA. According to KEMSA officials, the system has reduced stock-out rates, expiries, and improved delivery timelines. KEMSA undergoes an annual stock-taking exercise to verify whether its inventory of health products aligns with the digital records in its warehouse management systems.[39] The final results are then posted with KEMSA's financial statements to ensure accountability and transparency.

KEMSA also uses an **electronic proof of delivery** (e-POD) app, where healthcare workers can track deliveries to primary health facilities.[40] The app also is equipped with receipt and acknowledgement modules in order to ensure commodities are handed over to the right facilities, in the right quantities, and at the right time.

There is strong evidence to suggest that the biggest threat facing the public sector supply chain today is primarily **fiscal**. At a press briefing in April 2025, the Health Cabinet Secretary, Aden Duale, reported that the current order-to-full rate of health products at KEMSA stood at **43%** due to a **lack of finances**, in part due to the USAID cuts.[41] Yet, even before those cuts, financial troubles were inhibiting KEMSA operations. An investigation by Citizen Digital in 2023 revealed that KEMSA stores faced a stockout of 390 out of a possible 462 medical commodities, including painkillers, bandages, and yellow fever vaccines.[42] This arose in part because of KEMSA's outstanding Ks. 4 billion ($31 mil USD) debt to suppliers. Indeed, KEMSA's *Turnaround Strategic Plan 2023-24* identified numerous economic factors which have negatively impacted KEMSA's performance, such as the weakening of the Kenya Shilling, high inflation, high national debt burden, and a reduction in NHIF premiums as a result of rising unemployment.[43]

These challenges notwithstanding, there are still **operational mistakes** and **inventory leakages** which can be addressed through better system design and accountability mechanisms. The supply chain process **breaks down** at a variety of levels:

- A bungled procurement process for anti-mosquito nets led to Ks. 3.7 billion ($28 mil USD) funding from the Global Fund being withdrawn. Over-procurement of COVID-19 supplies similarly cost KEMSA significant funds and damaged its institutional reputation.[44]
- Kenya loses an estimated KSh 9.5 billion ($74 mil USD) annually due to wastage from expired drugs.[45]
- Theft and reselling of essential medicines from local hospitals remains a challenge. The aforementioned case of missing mosquito nets, condoms, and other drugs in 2022 serves as an example, as is the case of USAID-funded HIV drugs which were stolen and later resold on the private market.[46]

Without full access to KEMSA's internal processes, it remains difficult for outside observers to pin-point precisely where these errors originate. Given that KEMSA already uses electronic inventory management and proof of delivery systems, which should provide transparency and traceability to the supply chain, it is likely that mistakes arise from **workforce training** and **poor implementation** of best practices. For example, if workers at a KEMSA warehouse do not always update stocks in real time to the digital software, then it provides an opportunity for theft and misallocation. An annual stock audit is insufficient to completely tackle this issue.

Conclusions

The analysis of AI and digital technologies highlights multiple solutions that could directly mitigate KEMSA's persistent gaps. AI-driven demand forecasting models, such as LSTM, can improve the accuracy of stock planning and reduce the frequent stockouts caused by poor forecasting and incomplete facility data. Chatbot-assisted workforce training can strengthen compliance with procurement and inventory procedures, reducing human errors and leakages. Blockchain-based tracking and electronic proof of delivery systems can enhance transparency, curtail theft, and build trust with donors and suppliers. Finally, predictive analytics in inventory and procurement can optimize resource allocation under fiscal constraints. Together, these AI-enabled interventions present a clear roadmap for KEMSA to improve operational efficiency, reduce losses, and enhance resilience in Kenya's public health supply chain.

> **Key Finding**:
>
> Despite the introduction of digital recordkeeping and integrated inventory management, KEMSA still faces challenges related to poor procurement practices and inventory leakage. Initial analysis suggests that chatbots can play a role in **workforce training** to ensure best practices are implemented across the supply chain.

Endnotes

1. O'Neil, S., Taylor, S., & Sivasankaran, A. (2021). 'Data Equity to Advance Health and Health Equity in Low- and Middle-Income Countries: A Scoping Review', *Digital health*, 7. doi.org/10.1177/20552076211061922.

2. National AIDS and STIs Control Program (2023). *HMIS Statistics*. Available at: dwh.nascop.org/#/.

3. KEMSA. (2024) 'KEMSA Undergoes Major Transformation Under New Leadership', *News*, May 8. Available at: kemsa.go.ke/content/181/news/kemsa-undergoes-major-transformation-under-new-leadership.

4. Etyang, P. (2024) 'How adoption of i-LMIS at Kemsa is improving medical supplies', *The Star*, December 19. Available at: www.the-star.co.ke/news/realtime/2024-12-19-how-adoption-of-i-lmis-at-kemsa-is-improving-medical-supplies.

5. Aramex. (2024) 'AI in logistics: Revolutionising healthcare supply chains for the future,' *Blogistics*, November 27. Available at: blogistics.aramex.com/ai-in-logistics-revolutionising-healthcare-supply-chains-for-the-future/.

6. Khan, F., Al Masum, A., Adam, J., Karim, Md., & Afrin, S. (2024) 'AI in Healthcare Supply Chain Management: Enhancing Efficiency and Reducing Costs with Predictive Analytics', *Journal of Computer Science and Technology Studies*, 6(5). 10.32996/jcsts.2024.6.5.8.

7. Mbonyinshuti, F., Nkurunziza, J., Niyobuhungiro, J., & Kayitare, E. (2024) 'Health supply chain forecasting: a comparison of ARIMA and LSTM time series models for demand prediction of medicines', *Acta logistica – International Scientific Journal about Logistics*, 11(2). doi.org/10.22306/al.v11i2.510.

8. Mbadi, J. & Barasa, D. (2025) 'The launch of the Electronic Government Procurement System', *The National Treasury and Economic Planning*, April 9. Available at: newsite.treasury.go.ke/launch-electronic-government-procurement-system.

9. WHO. (2025) 'Public procurement as a key tool to tackle health issues discussed at WHO-WIPO-WTO webinar', *News*, July 11. Available at: www.who.int/news/item/11-07-2025-public-procurement-as-a-key-tool-to-tackle-health-issues-discussed-at-who-wipo-wto-webinar.

10. Williamson, J. (2024) 'Strategic Planning for Medical Equipment Procurement', *International Finance Corporation*. Available at: khf.co.ke/wp-content/uploads/2024/11/Future-Ready-Healthcare-Strategic-Equipment-Procurement-Autosaved-1.pdf.

11. Mabugu, T. et al. (2021) 'Strengthening Health Procurement for Impact', *UNICEF*. Available at: www.unicef.org/esa/media/10466/file/UNICEF-Namibia-Strengthening-Health-Procurement-Impact-2021.pdf.

12. Stiglitz, J. (2017) 'Wealth before health? Why intellectual property laws are facing a counterattack', *The Guardian*, 19 October. Available at: www.theguardian.com/business/2017/oct/18/intellectual-property-laws-demand-a-21st-century-solution.

13. Wang, L., Zahur, N. (2025) 'Procurement institutions and essential drug supply in low and middle-income countries', *Journal of Health Economics*, 101. doi.org/10.1016/j.jhealeco.2025.102996.

14. Public Financial Management Reform Secretariat. (2023) 'Development and implementation of the Electronic Government Procurement (E-GP) system', *Wajibikia: PFMR Official Newsletter*, June. Available at: www.pfmr.

15. SAP. (2024) *AI in procurement: A comprehensive guide*. Available at: www.sap.com/resources/ai-in-procurement.

16. Finio, M., Downie, A. (2024) 'How is AI being used in manufacturing?', *IBM*, 15 November. Available at: www.ibm.com/think/topics/ai-in-manufacturing.

17. Jenkins, M. (2024) *Corruption in Humanitarian Assistance in Conflict Settings.* Bergen: U4 Anti-Corruption Resource Centre.

18. Ngugi, B. (2022) 'Drugs, condoms, more billions vanish at Kemsa', *Business Daily*, 16 March. Available at: www.businessdailyafrica.com/bd/corporate/health/more-billions-condoms-drugs-vanish-at-kemsa-3749264.

19. Lipnickas, G. (2025) 'The AI hype is just like the blockchain frenzy – here's what happens when the hype dies', *The Conversation*, 11 June. Available at: theconversation.com/the-ai-hype-is-just-like-the-blockchain-frenzy-heres-what-happens-when-the-hype-dies-258071.

20. Vitasek, K., Bayliss, J., Owen, L., Srivastava, N. (2022) 'How Walmart Canada Uses Blockchain to Solve Supply-Chain Challenges', *Harvard Business Review*. Available at: hbr.org/2022/01/how-walmart-canada-uses-blockchain-to-solve-supply-chain-challenges.

21. Wragg, E. (2022) 'Maersk and IBM pull the plug on TradeLens', *Global Trade Review*, 29 November. Available at: www.gtreview.com/news/top-stories/maersk-and-ibm-pull-the-plug-on-tradelens/.

22. Zwitter, A., & Boisse-Despiaux, M. (2018). 'Blockchain for humanitarian action and development aid'. *Journal of International Humanitarian Action*, *3*(1), 16. https://doi.org/10.1186/s41018-018-0044-5.

23. International Federation of Red Cross and Red Crescent Societies. (2018) *Learning Review: Blockchain Open Loop Cash Transfer Pilot Project*.

24. Poorterman, A. (2018) *Blockchain – Plot II: Summary of Learnings*. London: Startup Network.

25. UNHCR. (2022) 'UNHCR launches pilot Cash-Based Intervention Using Blockchain Technology for Humanitarian Payments to People Displaced and Impacted by the War in Ukraine', *Press Releases*, 15 December. Available at: www.unhcr.org/ua/en/news/unhcr-launches-pilot-cash-based-intervention; Hunt, K., Narayanan, A., Zhuang, J. (2022) 'Blockchain in humanitarian operations management: A review of research and practice', *Socio-Economic Planning Sciences*, 80. https://doi.org/10.1016/j.seps.2021.101175.

26. Achieng, N. (2024) 'Challenges of Malaria Control in Northern Uganda: Infrastructure, Access, and Healthcare Delivery', *Newport International Journal of Research in Medical Sciences*, 5(3). https://doi.org/10.59298/NIJRMS/2024/5.3.7175.

27. Triche, R., Greve, A., Dubin, S. (2020) 'UAVs and Their Role in the Health Supply Chain: A Case Study from Malawi', *2020 International Conference on Unmanned Aircraft Systems (ICUAS)*.

28. Radarr Africa. (2025) 'Drones Are Helping Deliver Medicine Faster in Kenya's Rural Areas', *Development*, 16 June. Available at: radarr.africa/drones-are-helping-deliver-medicine-faster-in-kenyas-rural-areas/.

29. Zipline. (2022) 'Zipline and Kisumu County Seal Partnership', *News*, 16 February. Available at: www.zipline.com/newsroom/news/announcements/zipline-and-kisumu-county-seal-partnership.

30. UNFPA. (2021) 'e-POD App for last-mile delivery of family planning commodities wins Global Health Supply Chain award', *News*, 27 December. Available at: kenya.unfpa.org/en news/e-pod-app-last-mile-delivery-family-planning-commodities-wins-global-health-supply-chain-award.

31. Stonor, C. (2023) 'The Use of AI in Zipline's Drone Delivery Structure', *eVTOL*, 11 July. Available at: evtolinsights.com/2023/07/the-use-of-ai-in-ziplines-drone-delivery-structure/.

32. Ogbewele, E., Mbata, A., Nwosu, N. (2024) 'Optimizing pharmaceutical inventory management: A global framework for efficiency and cost reduction', *International Journal of Management & Entrepreneurship Research*, 6(10), 10.51594/ijmer.v6i10.1638.

33. UNDP. (2025) *Improving Vaccination Systems - eVIN*. Available at: www.undp.org/india/projects/improving-vaccination-systems-evin.

34. Logistimo. (2022) *Indonesia*. Available at: logistimo.com/indonesia.

35. Wilson, M. (2012) 'The determinants of capital structure: evidence from the Asia Pacific region'. *Journal of Multinational Financial Management*. 4(3), pp.34-45.

36. Steele, P. (2017) *KEMSA after the Devolution: Financial Sustainability through a Supply Chain Strategy with a Strong Focus on Human Resources and Leadership*. Copenhagen: UNICEF Supply Division.

37. Etyang, P. (2024) 'How adoption of i-LMIS at Kemsa is improving medical supplies', *The Star*, December 19. Available at: www.the-star.co.ke/news/realtime/2024-12-19-how-adoption-of-i-lmis-at-kemsa-is-improving-medical-supplies.

38. Muchira, C. (2025) 'KEMSA launches nationwide stocktaking to strengthen Kenya's health supply chain', *KBC*, July 3. Available at: www.kbc.co.ke/kemsa-launches-nationwide-stocktaking-to-strengthen-kenyas-health-supply-chain/.

39. UNFPA. (2022) 'Game-changing app tracks essential family planning supplies in Kenya', *News*, January 5. Available at: www.unfpa.org/news/game-changing-app-tracks-essential-family-planning-supplies-kenya.

40. Muthomi, K. (2025) 'Ministry of Health Reveals KEMSA Drug Stock-out Months After USAID Funding Cut', *Kenyans*, April 1. Available at: www.kenyans.co.ke/news/110570-ministry-health-reveals-kemsa-drug-stock-out-months-after-usaid-funding-cut.

41. Wanga, B. (2023) 'Inside the financial crisis at KEMSA that has caused shortage of crucial drugs, supplies', *Citizen Digital*, May 14. Available at: www.citizen.digital/news/inside-the-financial-crisis-at-kemsa-that-has-caused-shortage-of-crucial-drugs-supplies-n319706.

42. KEMSA. (2023) *Turnaround Strategic Plan 2023-24*. Nairobi: KEMSA.

43. Muriuki, B. (2023) 'KEMSA defends companies blamed for bungled Ksh.3.7 billion anti-mosquito nets tender', *Citizen Digital*, May 10. Available at: www.citizen.digital/news/inside-the-financial-crisis-at-kemsa-that-has-caused-shortage-of-crucial-drugs-supplies-n319706.

44. Cheloti, J. (2025) 'Kenyan Government to Introduce Digital Tracking System for Medicines to Curb Wastage: "It Must End" ', *Tuko*, June 20. Available at: www.tuko.co.ke/kenya/counties/593466-kenyan-government-introduce-digital-tracking-system-medicines-curb-wastage/.

45. Ngugi, B. (2022) 'Drugs, condoms, more billions vanish at Kemsa', *Business Daily*, March 16. Available at: www.businessdailyafrica.com/bd/corporate/health/more-billions-condoms-drugs-vanish-at-kemsa-3749264; Murumba, S. (2017) 'USAid's free HIV drugs stolen, sold in Nairobi', *Nairobi News*, July 25. Available at: nairobinews.nation.africa/usaids-hiv-drugs-stolen-nairobi/; Murumba, S. (2017) 'Kemsa now shifts blame on theft, sale of HIV drugs', *Business Daily*, July 16. Available at: www.businessdailyafrica.com/bd/economy/kemsa-now-shifts-blame-on-theft-sale-of-hiv-drugs-2162706/.