

Report

Strengthening of medical supply chain and improvement of access to health by technology-supported reform of public procurement and cold chain

Consideration from three cases

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1. Introduction

In order to improve and increase people's access to health, many elements need to function properly. Among them are the essential medical products, vaccines and technologies of assured quality and safety which need to be available at healthcare facilities for quality services. As a premise, these products must be fairly and properly provided through an adequate procurement system in public and private sectors and furthermore, these products need to be delivered to healthcare facilities in a timely manner.

Looking back to the Global Financial Crisis of 2007, the worldwide incident triggered the awareness towards reforming the public procurement system. The reform has involved the procurement entities and authorities, the citizens as the end-users, and the supplies. The reform has been further boosted by information and communication technologies (ICT) in the recent years. The following section overviews the transition of the public procurement system, as well as its uniqueness in the health sector and then introduces the case of Ukraine's "ProZorro", a digital platform for public procurement. It is followed by the section which focuses on the delivery aspect to enhance access to health, introducing the two cases both of which are characterized by using advanced technologies: delivery of pharmaceuticals and specimens by drones and a unique information management system called "Electronic Vaccine Intelligence Network" (eVIN). These cases also discuss the potential power in contributing to the public health emergencies such as the current COVID-19. Finally, it concludes that the stakeholder collaboration could maximize the merits of these technologies.

2. Transition of the public procurement system

Public procurement is one of the main activities of the public sector, and the share of public procurement in global GDP is estimated at 14.4%.¹ Public procurement is carried out on various scales, from local governments to international organizations such as UN agencies and the Global Fund. All scales of procurement involve actors such as procurement entities and authorities (purchasers), the citizens and suppliers.

Transition and reforms of public procurement

The trend towards reforming public procurement, particularly in Europe, started to respond to declining confidence in fight against bribery, corruption and the growing costs of previous schemes. The Latham Report of 1994² is believed as an origin to increase the requirement for "Value for Money." The trend focused mainly on reform of purchasers (procurement system and governance). While the need and effectiveness of procurement reforms were well recognized and reforms were implemented in other countries, the Global Financial Crisis of 2007 had prompted calls for more effective uses of public funds, and the procurement reforms spread worldwide. It led implementation of e-procurement, centralized purchasing and framework agreement which cut off both direct

¹ Open Contracting Partnership (2020) "How governments spend: Opening up the value of global public procurement", <https://www.open-contracting.org/wp-content/uploads/2020/08/OCP2020-Global-Public-Procurement-Spend.pdf>, accessed May 25, 2021.

² Latham M. (1994) "The Latham report: Constructing the team. Joint Review of Procurement and Contractual Arrangements in the United Kingdom Construction Industry".

and indirect costs and promoted transparency.

In terms of the transparency of the procurement process, there were actions taken both by both public and private sectors. From the public sector, OECD published “OECD recommendation on public procurement” in 2015, and the World Bank Group issued “Benchmarking Public Procurement Report” in 2015 and 2017. From the private sector, Transparency International, a global civil society, created the tool “Integrity Pacts” to prevent corruption in public contracting. Integrity Pact is featured in “Compendium of Good Practices for Promoting Integrity and Transparency in Infrastructure Development” issued during the G20 Osaka summit in 2019³, as a resolution for transparent procurement. These private and public actions brought visualization of procurement process and data supported by ICT and enabled civil society to access and monitor procuring process and results.

In the era of SDGs, procurement reforms are expected to contribute to achieving Sustainable Consumption and Production (SDG 12). That needs reforms not only for transparency but also for optimization of supply chain and cost-efficiency. For this purpose, actions by purchasers, suppliers and demand-side as civil society are further accelerated at the global, national and regional levels.

Challenges and transition of the global health procurement

While public procurement reforms are underway, global health procurement faces transition challenges. The early 2000s marked the beginning of the MDGs era and the establishment of relevant international organizations such as the Bill & Melinda Gates Foundation, GAVI, and the Global Fund. Despite the economic crisis, spending on global health has increased from over \$10 billion in the 2000s to nearly \$40 billion in 2018⁴. Traditionally, products purchased by donors and funds in the global health arena were mainly vaccines, contraceptives, and products for the prevention and treatment of infectious diseases such as HIV/AIDS, tuberculosis and malaria. However, this has been changing with the advent of economic growth of recipient countries, epidemic transition and universal health coverage.

On this transition, Silverman et al. state that recipient countries face challenges as follows:⁵

- Recipient countries have to undertake their own procurement, as they improve their incomes and are no longer included in the list of recipient countries.
- More and more diverse items are required to supply along with changes in demand due to epidemic transition.
- The national government and global health partners have to select “Value for Money” products to achieve UHC with limited funds after the independence from single disease programs and donor funding.

Furthermore, these transition challenges are linked with existing challenges such as workforce constraints, supply chain and delivery issues, corruption which most of the low-and middle-income countries (LMICs) is tackling. The existing challenges are expected to be resolved by optimization of the procurement process and supply chain.

COVID-19 and global health procurement

The global health procurement in response to COVID-19 is considerably challenging. While most products like pharmaceuticals and medical consumables for certain communicable diseases are demanded only from the LMICs at ordinary times, rapid growth of demand occurs in many countries including developed countries worldwide in a pandemic. The supply of masks and other personal protective equipment (PPE) was seriously affected both in terms of manufacturing and delivery in the early stage of the pandemic. There were many calls for emergency procurement by UN agencies in the first half of 2020 - they actively approached suppliers to source required products sufficiently. One of the main features of the emergency procurement for COVID-19 is flexibility. For example, direct purchasing was considered as force majeure in some cases, and required specifications for essential supplies were eased.

Deployment of essential products like PPE, diagnostics, pharmaceuticals for the LMICs is a critical issue. In April 2020, the United Nations established the UN COVID-19 Supply Chain Task Force to prevent an acute shortage of essential supplies and provided a sourcing channel for the LMICs who usually have limited bargaining power. The COVID-19 Supply Portal was launched in the following month and it enabled countries to request and receive supplies, using online system. Actions were also planned and implemented by initiatives such as ACT-Accelerator, COVAX facility to support the LMICs.

³ OECD (2019) “G20 Compendium of Good Practices for Promoting Integrity and Transparency in Infrastructure Development”, <https://www.oecd.org/g20/summits/osaka/G20-Compendium-of-Good-Practices-in-Infrastructure-Development.pdf> , accessed on March 12, 2021.

⁴ IHME. “Financing global health”, <http://www.healthdata.org/data-visualization/financing-global-health> , accessed on March 12, 2021.

⁵ Silverman R, et al. (2019) “Tackling the Triple Transition in Global Health Procurement”. <https://www.cgdev.org/better-health-procurement> , accessed on March 12, 2021.

Procurement for COVID-19 response is required globally, and global health procurement still faces challenges accompanying deployment of medical supplies and vaccines, even the above-mentioned actions. However, there are lessons learned such as; creating a playbook on roles of stakeholders and a system to coordinate are the key, according to an assessment of the COVID-19 Supply Chain System⁶. To summarize, to analyze and provide lessons learned makes a more optimized procurement system and robust preparedness in the future.

2.1. Case 1: Ukraine’s digital platform for public procurement, ProZorro Background

It is said that the health sector procurement is particularly vulnerable to corruption mainly due to its technical complexity. In Ukraine, where they were suffering from the “inefficient, corrupted, non-transparent” public medicines procurement system until around 2014, there were a lot of casualties due to a lack of essential life-sustaining medicines, affecting those suffering from tuberculosis, viral hepatitis, hemophilia, and orphan and other diseases⁷.

In order to solve the problems, Ukraine temporarily outsourced its healthcare procurement to international organizations like UNDP, UNICEF, Crown Agents, and simultaneously through the collaboration between the Ministry of Economic Development and Trade and the civil society launched ProZorro - a digital platform for public procurement. Many efforts were made to overcome the resistance and setbacks, and in 2015, the Law on Public Procurement and the Law on Peculiarities of Goods, Works and Services to Provide the Needs of Defense were passed to eliminate the corruption-prone norms, and in the following year, the use of the ProZorro became mandatory for all public agents⁸.

Overview

ProZorro is an online public procurement platform which is characterized by the use of advanced technology and ensures open access to public procurement. It is a hybrid of centralized public and decentralized private marketplaces. All functionalities are available to the general public without the need to register. ProZorro ensures transparent and efficient spending of public funds by simplifying oversight opportunities for the civil society and by enabling enhanced, open competition among business that aim to supply goods and services to the government entities in Ukraine⁹. Through ProZorro, the government provides the legal framework that allows the procuring entities to streamline the tendering process while attaining savings on the goods and services purchased. ProZorro enables easy access to the tendering process, connecting both the purchasers and the potential commercial supplies.

In order to maximize the benefit of ProZorro, training materials and courses were offered for the government entities about the use of the digital platform. At the same time, the project Transparency and Accountability in Public Administration and Services (TAPAS)¹⁰ was implemented to ensure the e-procurement procedures and practices are appropriately monitored by enforcement agencies, Civil Society Organizations (CSOs) and the general public. Among other things it focused on building the capacity of the CSOs to serve as independent monitors of public procurement procedures and processes with the goal of enhancing the transparency and fairness of public procurement in Ukraine¹¹.

The distinctive feature of Ukraine’s public procurement is the healthy tension between the authorities and procurement entities and the civil society. Open Contracting Partnerships (OCP) and Transparency International Ukraine and CSOs standardized the procurement monitoring process and developed a monitoring management system for the CSOs as the government-run procurement monitoring had a huge problem. This initiative later grew as DoZorro, a community of CSOs, businesses, government, media, etc., who are working on improving public

⁶ The Yellow House (2021) “Assessment of the Covid-19 Supply Chain System (CSCS) Summary Report”, <https://www.who.int/publications/m/item/assessment-of-the-covid-19-supply-chain-system-report> , accessed on May 11, 2021.

⁷ Mackey T., et al. (2016) “The Disease of corruption: views on how to fight corruption to advance 21st century global health goals”, <https://bmcmmedicine.biomedcentral.com/articles/10.1186/s12916-016-0696-1> , accessed on August 9, 2020.

⁸ Offerman A. “ProZorro public procurement platform spreads its wings (ProZorro)”, <https://joinup.ec.europa.eu/collection/eprocurement/document/prozorro-public-procurement-platform-spreads-its-wings-prozorro> , accessed on August 9, 2020.

⁹ Ukrainian Government website on ProZorro, <https://prozorro.gov.ua/en> ,accessed on August 9, 2020.

¹⁰ The project supported by USAID/UKaid funds to fight corruption and improve open data work. <https://tapas.org.ua/en/about-project/> accessed on June 9, 2021.

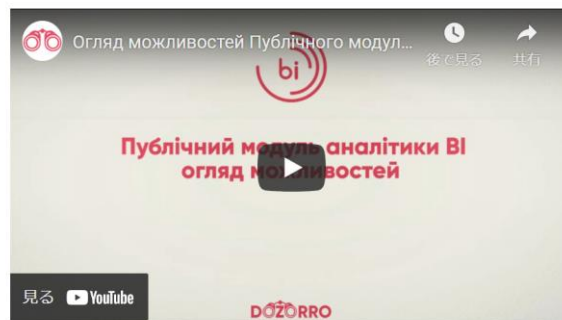
¹¹ USAID Website <https://www.usaid.gov/digital-development/digis> accessed on June 9, 2021.

procurement in Ukraine. Accessing and analyzing the massive data attained from ProZorro, they designed a platform where CSOs were able to see the riskiest tenders according to the red flags methodology with AI. As a result, the State Audit Service of Ukraine, which was hardly open to the society, decided to cooperate with the DoZorro community and it now uses the same monitoring approach as DoZorro¹².

ProZorro Website on public monitoring (English translation) Public monitoring

Every citizen of Ukraine can see how the state spends its taxes

You can immediately go to the [Analytics Module](#), which allows you to control the public procurement system and influence its improvement.



Source: ProZorro website

As of October 2019, by introducing ProZorro, from an annual procurement budget of UAH 300 billion, potential savings are estimated at UAH 60 billion, which corresponds to 20% of the budget. Half of the existing losses are due to corruption and the other half due to lack of competition⁸. In the health sector, ProZorro reduced medicines prices for approximately 6%, which would allow the savings to be used for additional medicines procurement¹³. Later an institutional reform and establishment of a strategic centralized procurement body “Medical Procurement of Ukraine” helped to reduce medicines prices by more than 20%¹⁴.

Challenges

While the implementation of ProZorro has shown the successes of reducing corruption and of promoting competition, some challenges have become apparent.

The project of Improving Transparency and Effectiveness of Public Procurement in Ukraine through Cooperation with Civil Society reports that since there are few penalties for violations of the Law on Procurement, even if CSOs identify and report on a violation and the responsible agency and courts take action to investigate, it is not clear if those who may have violated the law respond and bear the responsibilities¹⁰.

The World Bank reports that facility managers and officials point out the followings: 1) given that firms within ProZorro compete only on price, quality of goods offered is hard to control; 2) since any firms can enter competition in ProZorro, sometimes unreliable firms could win tenders and end up in failing to meet conditions.; 3) some drugs have to be shipped under defined conditions and some supplies may not be able to respect these conditions; and 4) small facilities have difficulties attracting suppliers since they face higher transaction costs¹⁵.

There are also concerns about monopolization. Transparency International Ukraine reported that only 11 suppliers (1% of all suppliers) received over 60% of all medical procurement¹⁶, while according to Open

¹² Nestuliz, V. (2020), “How do you build a network of citizen corruption fighters? Ask Ukraine’s revolutionaries”, <https://www.open-contracting.org/2020/09/14/dozorro-a-network-of-citizen-corruption-fighters/>, accessed on August 9, 2020.

¹³ From email communication with OCP on 21 August 2020.

¹⁴ <https://www.open-contracting.org/2021/02/22/fight-for-life-how-ukraine-is-fixing-medical-procurement-and-serving-patients-better/>

¹⁵ The World Bank (2018), “Tracking the Health Resources in Ukraine”, <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/911321531228767532/tracking-the-health-resources-in-ukraine>, accessed on August 9, 2020.

¹⁶ TI Ukraine, “Medical Procurement in ProZorro: Observations”, <https://ti-ukraine.org/en/research/medical-procurement-in->

Contracting Partnership (OCP) in 2019 the total value of healthcare contracts (medicines, devices and equipment) was UAH 16.8 billion and in the same year 34 suppliers provide approximately 50% of the contract value¹³.

In the midst of the COVID-19 pandemic, DoZorro and Transparency International Ukraine analyzed the data from ProZorro and reports that the rapid price increases and the big gap between the average and maximum price of masks may indicate price gouging¹⁷. Taking into consideration that in the time of emergency, price gouging could tend to occur easily, the importance of monitoring of public procurement should be highlighted.

Way forward

The introduction of ProZorro, supported by using advanced technology and accountable monitoring by the DoZorro, is nurturing the culture of transparent and competitive public procurement among concerning parties and it is already generating savings. At the same time, there are some challenges introduced above.

As a part of its health reform, Ukraine is introducing eHealth for improved transparency and efficiency of the health systems with strong leadership of the Ministry of Health. According to OCP, there is an ongoing project to develop e-Stock system which will be integrated with eHealth and ProZorro which is supposed to provide live data on medicines and devices stocks, utilization and future needs¹³. Such integration is much awaited for better health of the people in Ukraine.

3. Optimization of public procurement and delivery by cold chain reform

Cold chain reform

The vaccine delivery in LMICs has met with a lot of difficulties rooted in operational and technical environment. Most vaccines are recommended for storage at a temperature of 2 to 8 degrees Celsius to maintain quality, which requires “cold chain” system for transporting and storing vaccines at low temperatures. Cold chain needs a steady supply of electric power, but it is frequently unavailable in LMICs. Therefore, various reforms of cold chain have been promoted in the past decades by WHO and other international organizations. WHO initiated the Expanded Programme on Immunization (EPI) in 1974. It aimed to provide children with routine vaccinations and recommended the use of vaccines to prevent six diseases including tuberculosis and diphtheria.¹⁸ This EPI promotion led to the development of cold chain. Since then, WHO has improved the cold chain through: 1) establishing a temperature monitoring system for vaccines; 2) developing appropriate equipment for storage and transport of vaccines; and 3) training for personnel who handle vaccine.

For vaccine monitoring, WHO and PATH¹⁹ developed Vaccine Vial Monitors (VVMs)²⁰ for the careful storage and transport to the point of use. VVMs are small stickers that adhere to vaccine vials and change color as the vaccine is exposed to heat, which gives a visual indication of temperature rise and allows vaccines to be safely stored and used for immunization. Today, VVMs are available for nearly all vaccines used in immunization programmes of WHO, UNICEF and GAVI Alliance. In addition, Cold Chain Monitor (CCM)²¹ was also developed as a temperature control tracking system for transportation from manufacturers to countries.

The equipment and devices to store and transport vaccines have been improved by using innovative technologies. Today, solar-powered refrigerators are used in areas with power shortages. Many cold box temperature studies done between 1990 and 2010²² for examining vaccine supply chains contributed to its technology development. New-generation vaccine carriers can provide up to seven days of cooling at an outside temperature of 32°C. These improvements enable last-mile delivery of vaccines.

WHO has also focused on building a local capacity in routine work of immunization. The latest manual

[prozorro-observations/](#), accessed on August 9, 2020.

¹⁷ Pylypenko Y. (2020), “COVID-19 data-driven monitoring in Ukraine: how much do masks cost?”, <https://www.open-contracting.org/2020/04/07/covid-19-data-driven-monitoring-in-ukraine-how-much-do-masks-cost/>, accessed August 9, 2020.

¹⁸ WHO website, https://www.who.int/immunization/programmes_systems/en/, accessed on March 10, 2021.

¹⁹ PATH (2005), “A HealthTech Historical Profile: Vaccine Vial Monitors”, https://path.azureedge.net/media/documents/TS_hthp_vvms.pdf, accessed on March 10, 2021.

²⁰ WHO and PATH (2011), “Vaccine Vial Monitors: FAQs”, https://www.who.int/immunization/programmes_systems/supply_chain/optimize/vaccine_vial_monitors_faqs.pdf?ua=1, accessed on March 10, 2021.

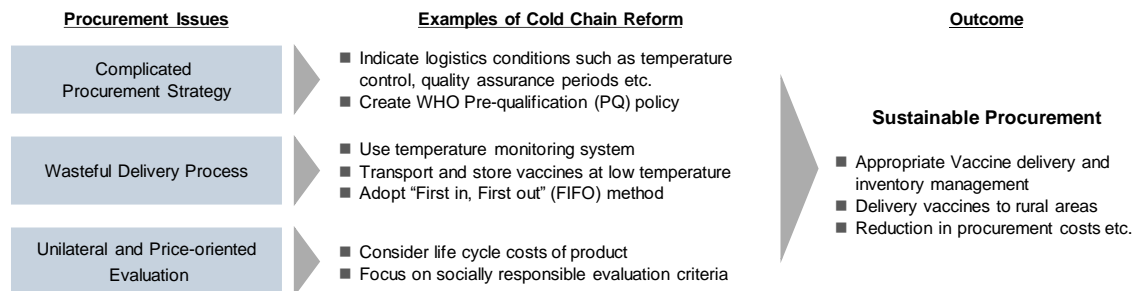
²¹ WHO (1999), “Temperature monitors for vaccines and the cold chain,” https://apps.who.int/iris/bitstream/handle/10665/65964/WHO_V&B_99.15_en.pdf;jsessionid=106859CE240575695CC0556A0F96C24C?sequence=1, accessed March 10, 2021.

²² WHO and PATH (2013), “Innovative passive cooling options for vaccines”, https://www.who.int/immunization/programmes_systems/supply_chain/optimize/evidence_brief_passive_cooling.pdf, accessed on March 10, 2021.

“Immunization in Practice”²³ published in 2015 has been used throughout the world.

These cold chain reforms have reduced the risks of vaccine stockout, expiration and heat damage, which enabled delivery to rural areas. Therefore, WHO has indicated that cold chain reform is a key component for ensuring stable delivery of high-quality vaccines and expected the partnership with national governments which allow continuous and efficient vaccine delivery with a greater patient outreach.

Optimization of procurement through cold chain reform



Source: Developed by the author

Optimization of public procurement

The procurement process for vaccines and other medical products differs significantly by types such as drugs and medical devices. Vaccine inventory management is characterized by “First in, First out (FIFO)”²⁴ method in terms of its expiration date. Unlike other healthcare products, the bid for vaccines must include logistics-related conditions, such as the indication of temperature control, quality assurance periods and delivery times, etc. In order to optimize cold chain system, WHO adopts “Prequalification (PQ)” of vaccines and immunization-related equipment and devices which aims to ensure the global standards of quality, safety and efficacy. There are several categories of prequalified products for cold chain like a cold box, freezer room, refrigerator, coolant-pack, temperature monitoring device, etc. As of 2021, there are 50 cold boxes and vaccine carriers prequalified by WHO²⁵. In many national immunization programmes, vaccines are procured through bulk purchase by UNICEF, GAVI the Vaccine Alliance and other agencies. Thanks to this PQ process, more than 90% of vaccine quality in national immunization programmes is guaranteed²⁶.

In addition, efficient cold chain with aforementioned technologies has the positive effect of reducing procurement waste. For example, UNICEF has emphasized a sustainable procurement approach since 2018 with consideration of economic and social impacts. Through focusing on the whole life cost and procuring appropriate quality cold chain equipment, UNICEF has reduced the number of unnecessary procurements and their procurement costs. As for vaccine procurement, optimization of cold chain and establishment of inventory monitoring has successfully reduced vaccine waste by 10 to 15%²⁷.

Also, this sustainable procurement has resulted in involvement of diversified suppliers and reduced product prices and procurement costs. Since the total annual amount of procurement by UNICEF reached \$3.8 billion in 2019, representing 19% of total UN global spending, the economic and social impact through this procurement reform is significant. The cold chain reform has improved the procurement process and contributed to efficient procurement.

²³ WHO (2015), “Immunization in Practice”,

https://apps.who.int/iris/bitstream/handle/10665/193412/9789241549097_eng.pdf , accessed on March 10, 2021.

²⁴ WHO (2006), “Vaccine stock management”,

https://apps.who.int/iris/bitstream/handle/10665/69629/WHO_IVB_06.12_eng.pdf;jsessionid=DD41358A63BD17EA02D75D8989EA4029?sequence=1 , accessed on March 10, 2021.

²⁵ WHO website, https://apps.who.int/immunization_standards/vaccine_quality/pgs_catalogue/categorypage.aspx?id_cat=18 , accessed on March 10, 2021.

²⁶ WHO website, <https://www.who.int/bulletin/volumes/92/5/14-020514/en/> , accessed on 10, March 2021.

²⁷ UNICEF (2018), “UNICEF Implements Sustainable Procurement”,

<https://www.unicef.org/supply/sites/unicef.org/supply/files/2019-06/sustainable-procurement-information-note.pdf> , accessed on March 10, 2021.

3.1. Case 2: Medical Drone Delivery

Background

The innovative technology has improved the access to and delivery of medical products. Unmanned Aerial Vehicles (UAV), known as drones, are expected to modernize the last-mile delivery in healthcare sector. Nearly half of the planet's population live in rural areas²⁸ and many people face challenges in accessing healthcare due to poor infrastructure or ground transport networks. Drones can provide speedy and on-demand delivery regardless of location at low cost compared to ground-based transportations which usually entail huge infrastructure construction. This would be a new solution to deliver medical products especially in emergency situations like disaster or pandemic.

Overview

Both public and private sectors have investigated and demonstrated how drones can be used to bridge the healthcare access gap. For example, UNICEF expects the benefits in improving transport efficiency, supply chain management such as inventory tracking and control temperature and emergency medical services²⁹. Many countries with healthcare access challenges have incorporated the use of medical drones into their national development plans and implemented several programmes.

In recent projects, medical drones deliver various products like blood, medicines, serum for snake bite, birth control products, diagnosis kits, and other medical products to healthcare facilities in rural and remote areas. The size of the global medical drone market is estimated at US\$88 million in 2018 and is projected to reach US\$399 million by 2025 at a compound annual growth rate (CAGR) of 25%³⁰. Currently, the blood transportation has a large share of the medical drone market. Zipline, American drone service provider, launched a drone delivery operation in Rwanda in 2016, which reduced blood delivery time from four hours to just 15 minutes in some cases. Zipline has expanded their operations which cover 160 different medical products for nearly 2,500 health facilities across Rwanda and Ghana³¹. Matternet, another American drone company, succeeded in blood delivery in Switzerland and has delivered other medications to Haiti, Dominican Republic and Papua New Guinea³².

Another surge in demand in healthcare sector is caused by vaccine delivery. UNICEF collaborated with the local government in Vanuatu in 2018 and they launched the vaccine delivery operation which covered almost 40 kilometers of rugged mountainous terrain³³. In such a location of warm weather and limited road network, a cold box with a temperature logger enables to deliver vaccine at its adequate temperatures. This project has improved the vaccine delivery situation where almost 20% of the children in Vanuatu used to miss their essential childhood vaccines in 2016.

Under the circumstances of COVID-19, various demonstration projects using drones are accelerated for the purpose of commercialization, such as delivery for vaccine with an ultra-low temperature transport system, test kits and medical samples. In this way, drones are playing key roles to create innovative solutions especially in emergency situations. In addition, we can see various collaborations between drone companies and pharmaceutical companies like Novartis and Pfizer or logistics companies like DHL and UPS for testing the use of drones³⁴. These partnerships among various stakeholders are expected to create an innovative supply chain to strengthen healthcare systems.

Challenges

Although various advantages have been discovered through many demonstration projects, there are still challenges to be addressed such as stability of drone transport, payload capacity and especially regulation. Partly

²⁸ World Bank website, "Rural population"

<https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?end=2018&start=1960&view=chart>, accessed on March 10, 2021.

²⁹ UNICEF website, <https://www.unicef.org/innovation/drones>, accessed on March 10, 2021.

³⁰ Global Market Insights website, "Medical Drones Market Size By Application", <https://www.gminsights.com/industry-analysis/medical-drones-market>, accessed on March 10, 2021.

³¹ Business Insider website, <https://www.businessinsider.com/zipline-drone-coronavirus-supplies-africa-rwanda-ghana-2020-5>, accessed on March 10, 2021.

³² Proceedings of the 50th Hawaii International Conference on System Sciences (2017), "Drone Delivery Models for Healthcare", <https://pdfs.semanticscholar.org/622a/d97506e882bf30ba4dab9c0748ce540ecee3.pdf>, accessed on March 10, 2021.

³³ UNICEF website, <https://www.unicef.org/press-releases/child-given-worlds-first-drone-delivered-vaccine-vanuatu-unicef>, accessed on March 10, 2021.

³⁴ Pharmaceutical online website, "COVID-19, Medical Drones & The Last Mile of the Pharma Supply Chain", <https://www.pharmaceuticalonline.com/doc/covid-medical-drones-the-last-mile-of-the-pharma-supply-chain-0001>, accessed on March 10, 2021.

because drone business is advanced so quickly, drone regulations vary from country to country. In general, drones are considered as aircraft which requires restrictions on non-visual flight, weight and altitude. In addition, drone operators need to obtain an authorization for commercial use through a complex process. In response to this situation, civil aviation authorities are required to develop regulations that will allow drones to be used effectively while maintaining safety.

The framework for international drone standard has been studied, as calls for common standards for each country to ensure a minimum level of safety and quality grew in response to the accelerating pace of technological innovation worldwide. The new ISO standard for safe commercial operations was published in 2019, which is the first international standard for UAV³⁵. This standard will lead to a competitive market of the drone business and to induce fair commercialization. In addition to this drone flight regulation, it is necessary to comply with national pharmaceutical and medical devices law.

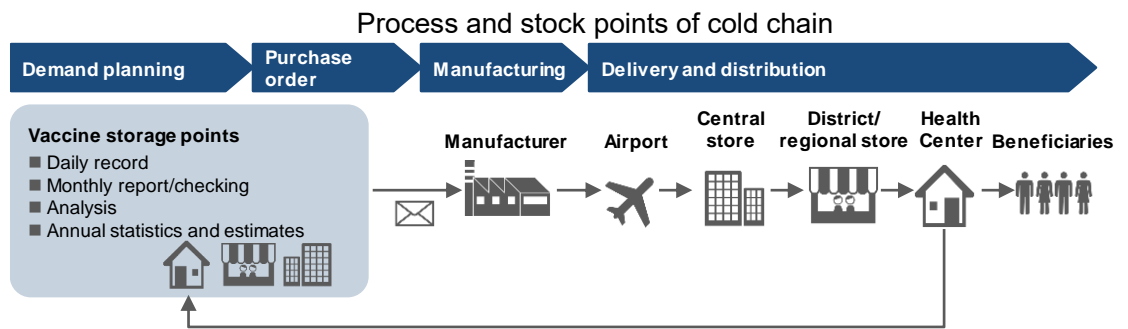
Way forward

Due to the changes in the social environment caused by the COVID-19 pandemic, the need for drone delivery businesses is increasing. In fact, drone achieves more rapid and cost-efficient delivery than ground-based transportations in some cases³⁶. While there are still many projects in the demonstration stage before commercialization, drones can play a greater role in medical delivery through technology revolution and optimization of related regulation in the future. In addition, various collaborations between drone companies and other industries have a significant impact on healthcare logistics market and accelerate development of efficient delivery system. The medical drone delivery could eventually be a valuable infrastructure and boost optimization of supply chain system.

3.2. Case 3: Electronic Vaccine Intelligence Network (eVIN)

Background

The complexity of cold chain has been one of the challenges in optimal management of vaccine supply. At the process of decision-making of purchasing vaccines, generally, the results of daily stock record keeping and analysis are summarized in a purchase order on a regular basis. After releasing orders, there would be several stock points from manufacturer to those who need them, as described in the figure below. Since vaccines are so temperature-sensitive that they easily get damaged, if they are exposed to inappropriate conditions at any point in the whole chain. Also, accurate demand planning is critical not to supply excessive vaccines which have an expiration date as biological products. UNDP points out that “a widespread inequality in immunization coverage” is caused by limitations in such cold chain infrastructure, temperature management and real-time stock management³⁷.



Source: arranged by the author based on WHO (2015)³⁸

Overview

eVIN was started in India in 2017 by the Ministry of Health and Family Welfare of India (MoH) and UNDP. It consists of four components: 1) eVIN mobile app that Cold Chain Handlers (CCH) record the vaccine stock, 2)

³⁵ ISO website, <https://www.iso.org/news/ref2461.html> , accessed on March 10, 2021.

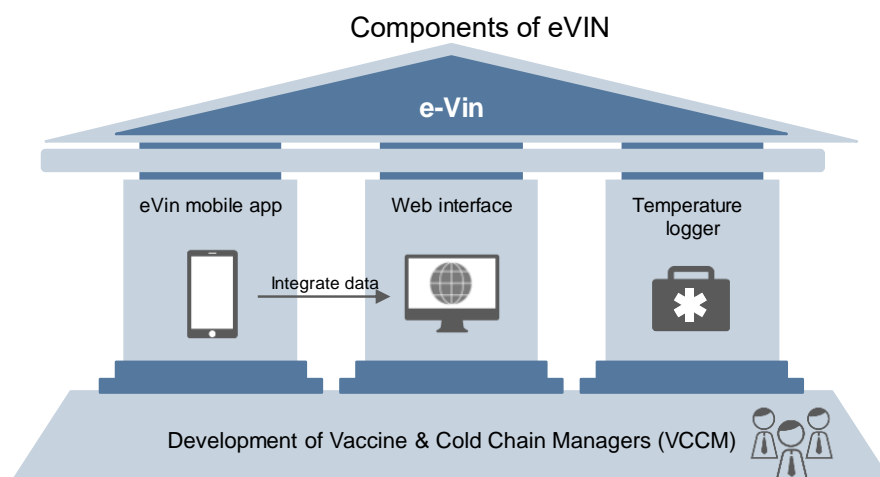
³⁶ IEEE Spectrum website, <https://spectrum.ieee.org/automaton/robotics/drones/the-economics-of-drone-delivery> , accessed on March 10, 2021.

³⁷ UNDP (n.d.), eVIN Fact Sheet, <https://www.in.undp.org/content/india/en/home/projects/gavi1.html> , accessed on October 13, 2020.

³⁸ WHO (2015), “Immunization in practice: a practical guide for health staff, 2015 update”, <https://apps.who.int/iris/handle/10665/193412> , accessed on October 10, 2020.

web interface to integrate the information from the app, 3) temperature logger attached with the cold chain equipment such as refrigerator and cold boxes, and 4) training and deployment of Vaccine & Cold Chain Managers (VCCM) who are in charge of maintaining stock data, troubleshooting and distribution planning at each cold chain points (see the figure above). The VCCM can check the changes in stock due to arrival, use and discarding of vaccines, information on individual stock (batch number, expiration date, manufacturer, date of manufacture, etc.), and log data of temperature logger for vaccine storage equipment. Temperature alarm will be delivered if it goes above or below the necessary temperature level at the storage equipment³⁹.

eVIN has been implemented in 508 districts, across 21 states and Union territories of India as of 2019³⁷.



Source: Developed by the author

Outcome

The most important value of eVIN is considered as the simplification of stock management operation and visualization of real-time stock data. According to Kumar et al (2019)⁴⁰, most of the users are satisfied with the tool as it enabled “real-time visibility of vaccine stocks across all cold chain points encouraging effective vaccine logistics management.” The operational improvement is attained with the regular and frequent update of stock information, which is essential to keep the quality of vaccine stock management.

Equally important is the fact that eVIN’s data utilization has already seen both health and economic impacts in just a couple of years from its introduction. As health achievement, more than 80% reduction of vaccine stock-outs ensured improved availability of adequate and potent Universal Immunization Programme (UIP) vaccines to all targeted children and pregnant women. On the economic side, the vaccine requirements were reduced from 3,053 lakh doses to 2,149 lakh doses in the firstly introduced 12 states, because eVIN prevented the vaccine handlers from inappropriate management which results in disposal of vaccines⁴¹.

Challenges

Overall, there are positive opinions about eVIN app heard from CCHs, while some mentioned the operational difficulty of the mobile app and network connectivity issues⁴⁰. Despite the relatively good performance of the app, MoH recognizes a challenge in human resource which stems from high turnover of CCHs due to the high average age and routine transfer of the staff⁴². It seems that the challenge is more about the transfer of management skills utilizing information from eVIN systems rather than teaching how to use the app to staff in the field.

Another challenge is the weak accuracy of the stock management. According to the MoH’s report, more than a forth of facilities observed stock-outs in the post-eVIN phase. There are several reasons: the demographic

³⁹ Ministry of Health and Family Welfare of India (2016), “Handbook on eVIN Application for Vaccines and Cold Chain Managers”, <https://www.in.undp.org/content/india/en/home/projects/gavi1.html> , accessed on October 13, 2020.

⁴⁰ Kumar, D. et al. (2019) Electronic Vaccine Intelligence Network (eVIN): Are Cold Chain Handlers Supporting this mHealth? An Application of Kurt Lewin theory of Change Management, *International Journal of Health Systems and Implementation Research*, Vol.3(1), 33-40.

⁴¹ UNDP website, <https://www.in.undp.org/content/india/en/home/projects/gavi1.html> , accessed on October 13, 2020.

⁴² Ministry of Health and Family Welfare, Government of India (2018) *Techno-Economic Assessment of Electronic Vaccine Intelligence Network*. New Delhi: Ministry of Health and Family Welfare.

information is not updated when assigning the allocation of vaccines for each Cold Chain Point (CCP); irregular push/pull of vaccine stock happens; and disposal of vaccines are not recorded, etc. How to detect the stock change in different stages of stock management (demand planning, ordering and goods receiving/issuing) remains a challenge and this requires approaches from both the system and operational sides.

Potential roles in case of public health emergency

While immunization itself is needed whether during a public health emergency or peacetime, the role of eVIN could be more important during the emergency to rapidly respond to the significant change of demand and stock of vaccines. Considering the limited availability of vaccines in COVID-19 pandemic, immunization for those with high risk should be prioritized. In order to realize this, it is critical to establish both the appropriate management of vaccine supply and good collaboration with the government agencies in charge of coping with such emergency.

Way forward

There is no doubt that eVIN brought an innovation in vaccine supply chain by reducing the vaccine stock-outs at CCPs and workload of CCHs. The solution is now moving to the next step with the experiences and lessons from the initial phase. Considering the existing challenges raised by MoH, some possible areas of upgrading would be as below:

- Further functional improvements linked to operations
- Improvement of update frequency by automating manual operations (e.g. reading stock information, filling out stock management sheets, etc.).
- Introduction of a mechanism for faster and less costly stock adjustment for nationwide expansion (e.g. direct stock exchange between CCPs)
- Data utilization such as using accumulated data for long-term demand forecasting

4. Conclusion

The trend towards reforming public procurement originated in Europe with the idea of "Value for Money" in 1994 and spread quickly, triggered by the Global Financial Crisis of 2007 with the call for more effective use of public funds. For the case of global health procurement, it also required the improvement of the supply chain deliver the essential medicine to the people as the end-users. Vaccine delivery particularly needed improvement through cold chain reform by 1) establishing a temperature monitoring system for vaccines; 2) developing appropriate equipment for storage and transport of vaccines; and 3) training for personnel who handle vaccines.

These reforms of public procurement and supply chain made remarkable progresses in the past few decades, both pushed by the rapidly advancing ICT, global awareness towards SDGs and the public-private collaboration. In the case of Ukraine's ProZorro, we have seen that the use of advanced technology ensures open access to public procurement and simple oversight opportunities for the civil society. In addition to the technology, healthy tension as well as collaboration between the public procurement entities and the civil society made the success story. Drones have been proved to bridge the healthcare gap - improving transport efficiency, supply chain management and emergency medical services. eVIN implemented in India has four components, three of which are featured by the use of technology and the fourth one is training of VCCM whose burdens are dramatically reduced by simplification of stock management operation and visualization of real-time stock data.

Moreover, these innovative endeavors have already shown savings of public funds. Although there is no rigid evidence of their contribution to improve the health indicators yet, the funds saved could be spent for more procurement and delivery of health products as well as other healthcare services.

Economic and health impacts in each case

	Economic Impact	Health Impact
Case 1: ProZorro	<ul style="list-style-type: none"> Medicines prices have been reduced by approximately 6%. 	<ul style="list-style-type: none"> The saved funds may be spent for more medical products.
Case 2: Drones	<ul style="list-style-type: none"> The size of the global medical drone market is estimated at US\$88 million in 2018 and is projected to reach US\$399 million by 2025 at a compound annual growth rate (CAGR) of 25%. 	<ul style="list-style-type: none"> UNICEF's Vanuatu project improved the vaccine delivery situation where almost 20% of the children used to miss their essential childhood vaccines.
Case 3: eVIN	<ul style="list-style-type: none"> The vaccine requirements were reduced from 3,053 lakh doses to 2,149 lakh doses in the firstly introduced 12 states. 	<ul style="list-style-type: none"> More than 80% reduction of vaccine stock-outs ensured improved availability of adequate and potent UIP vaccines to all targeted children and pregnant women.

In addition, these technologies have the potential to make public procurement and delivery transparent and efficient during public health emergencies. The global demand by LMICs as well as high-income countries for the masks and PPEs increases markedly and the COVID-19 Supply Portal is expected to help balance for the equitable allocation. When the price gouging of these products occurs, the civil society can quickly monitor through the ProZorro and sound the alarm. Drones have been tested for vaccine delivery with an ultra-low temperature transport system, test kits and medical samples. eVIN is expected to play an important role by rapidly responding to the significant change in demand and stock of vaccines.

All cases still have some challenges - mostly in terms of how the merits of these technologies are maximized by the collaboration of all the stakeholders. The current pandemic could be the touchstone of the improvement.

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