

The Role of the eELMIS as a Tool of Public Health Emergency Supply Chain Management during Uganda's COVID-19 Emergency Response

John Hans Wasswa^{1,2}, Martin Olowo Oteba^{1,2}, Michael Kavuma^{1,2}, Sam Muwanguzi^{1,2}, Jude Opolot^{1,2}, Ahmed Katumba⁴, Henry Oundo^{1,2}, Sarah Taratwebirwe^{1,2,3}, Jakira Ambrose^{1,2,3}

¹Management Sciences for Health (MSH), Kampala, Uganda

²Uganda Health Supply Chain program (UHSC)

³Ministry of Health, Kampala Uganda

⁴United Nations Children's Fund (UNICEF), Kampala, Uganda

Abstract: After registering its first Coronavirus disease 2019 (COVID-19) case on 21st March 2020, Uganda's Ministry of Health (MoH) declared the COVID-19 pandemic outbreak in Uganda, triggering activation of the Public Health Emergency (PHE) supply chain system. At the center of Uganda's PHE supply chain system lies a robust electronic information system known as the electronic Emergency Logistics Management Information System (eELMIS). This paper describes in detail the role of the eELMIS as a tool of supply chain management during Uganda's COVID-19 emergency response. All the key functionalities and activities supported by the eELMIS were examined. Through the eELMIS, movement of COVID-19 Medical countermeasures (MCMs) was tracked for 16 Regional referral hospitals (RRHs), 8 regional prepositioning centers, 28 high risk districts, more than 80 public hospitals, 71 quarantine centers, and 54 points of entry (PoE). A total of 254 orders for COVID-19 MCMs were processed and fully issued through the eELMIS to ensure constant availability of MCMs at frontlines. Quantification, forecasting and pipeline monitoring for the entire country was successfully conducted through the eELMIS. Real time data visibility of COVID-19 supplies at treatment centers, district stores, regional prepositioning centers, central warehouses and partner stores was ensured. The eELMIS further provided routine reports to the Logistic subcommittee (LSC) on the country's emergency stock-status, stock gap analysis, and national aggregate stock to support top management decision making for the country. In conclusion, the eELMIS formed the backbone of a seamless COVID-19 supply chain emergency response for Uganda, linking the national level, sub-national levels, and health facilities and hence improving response time. This paper therefore shares Uganda's experiences in using the eELMIS as a tool of supply chain management during Uganda's COVID-19 pandemic response from which other countries without established emergency electronic logistic information systems to support their existing health supply chain systems can learn from.

Keywords: eELMIS, Public health emergency, Health supply chain system, information system, COVID-19 emergency preparedness and response, Uganda

1. Introduction

On 11th March 2020 the World Health Organization (WHO) declared the coronavirus disease (COVID-19) a global pandemic after a rapid worldwide spread in over 110 countries and a prolonged sustained threat of further spread [1]. A week later, Uganda registered its first case of COVID-19 on 21st March 2020, triggering a declaration of the COVID-19 pandemic outbreak in the Uganda. This consequently led to activation of the National Task Force (NTF) with its different sub-committees supporting the 6 major pillars of COVID-19 emergency response i.e. Coordination and leadership; Surveillance and laboratory; Case Management, Information and Communication Technology (ICT) and Innovation; Risk Communication, Social Mobilization and Community engagement; and lastly the Logistics pillar [2]. Each pillar detailed out the strategy and all activities supposed to be executed under that pillar. The Logistic sub-committee (LSC) was responsible for the coordination of all COVID-19 response activities in the Logistics pillar. This was executed through the Public Health Emergency (PHE) supply chain system. Uganda's PHE supply chain system is composed of a coordination

structure at National, Regional, District and facility or Emergency treatment unit (ETU) levels.

The PHE supply chain system is supported by a robust electronic information system known as the electronic Emergency Logistics Management Information System (eELMIS). The eELMIS is a Ministry of Health (MoH) web-based tool that tracks movement of Medical Countermeasures (MCMs) from central warehouses to regional prepositioning centers (nodes), district stores then lastly to ETUs and also routine tracking of real time emergency transactions of orders, receipts, issues and reports of emergency supplies (National MCM plan) [3]. It facilitates receiving and responding in real time to node, district or facility (ETU) orders for MCMs in any public health emergency.

Through the eELMIS health facilities and partners at the national, regional, district, and facility levels can enter their emergency stock requests into the system. The LSC then processes the orders through the Emergency Operations Centre (EOC) (figure 1). In addition, through the eELMIS, different donors, like Global Fund, United Nations Children's Fund (UNICEF), World Food Program (WFP),

Red Cross Organization, among others, are able to coordinate and share information on commodities electronically to support the response operation. This creates

transparency and accountability, and prevents duplication of efforts.

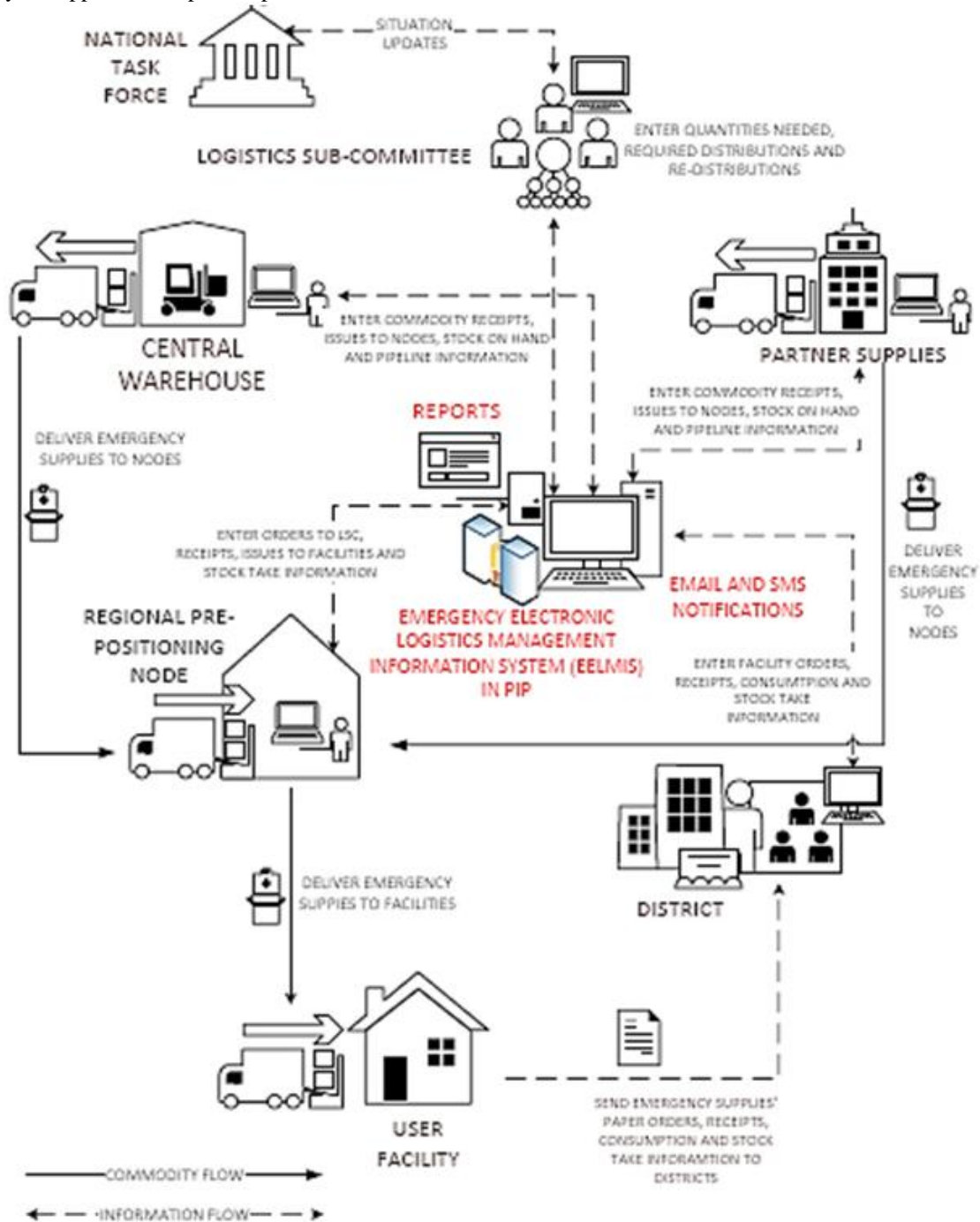


Figure 1: The electronic emergency logistics management information system (eELMIS) model
Source: Uganda National MCM plan, 2019

The eELMIS is accessed on-line through the MoH web-site sub-domain *ofeelmis.health.go.ug*. At every level i.e. national, regional, district and facility, every member who plays a part in logistics is given access to the system through a personal account. Every transaction at every level triggers an auto SMS, Email and WhatsApp notification to the persons responsible, alerting them to respond with urgency.

The eELMIS played a critical role in supporting Uganda’s supply chain COVID-19 emergency preparedness and response.

This paper focuses on the role of the eELMIS as a tool of supply chain management (SCM) during Uganda’s COVID-19 emergency preparedness and response. It examines in detail the key activities supported by the eELMIS in the awake Uganda’s COVID-19 response.

2. Method

This section describes the methodology used to examine the role of the eELMIS as tool of SCM in the COVID-19 emergency response. It focuses on the functionalities of the

eELMIS and all the COVID-19 emergency preparedness and response activities that were accomplished using the eELMIS by MoH and its partners from national to health facility levels. LSC reports, MoH COVID-19 reports, were received to inform the content of this paper.

3. Results

Supply chain activities that were effected using the eELMIS by MoH during Uganda’s COVID-19 emergency response efforts included: Tracking movement of MCMs from Central warehouses (National Medical Stores, NMS and Joint Medical Stores, JMS) to nodes, districts then lastly to ETUs; Quantification, Forecasting, and Pipeline Monitoring for COVID-19 Supplies for high risk level districts with Points of entry (PoEs); Supporting transactions of PHE commodities at every level of the supply chain i.e. Ordering, receiving and issuing; and Regular reporting and Data visibility.

3.1 Tracking movement of COVID-19 MCMs across the supply chain

The eELMIS became one of MoH’s strongest assets during Uganda’s COVID-19 emergency response. The LSC was

able to effectively execute its logistic coordination role especially tracking of movement of COVID-19 medical countermeasures to the dot.

Through the eELMIS, the LSC was able to meticulously track movement of COVID-19 supplies from central warehouses (NMS & JMS) to regional prepositioning centers, to District stores and lastly to treatment centers or ETUs (figure 1). At the ETU orders for COVID-19 supplies were compiled and entered in the eELMIS by the logistics focal person, then submitted to district stores. The district task force (DTF) commander, who is the District Health Officer (DHO) is responsible for approving the orders at the district level depending on the availability MCMs. If the MCMs are not available at the district stores, the DHO aggregates all the orders from the ETUs then submits them to the regional prepositioning center or node. The node commander approves the order and issues the COVID-19 MCMs back to the district. In the absence of sufficient stocks at the node. The node commander aggregates all the orders from all the districts served by the regional node (on average 20 districts), then submits them to the NTF through the LSC. The NTF approves the orders and allocates them to a central warehouse or partner for issuing back to the node (figure 2).

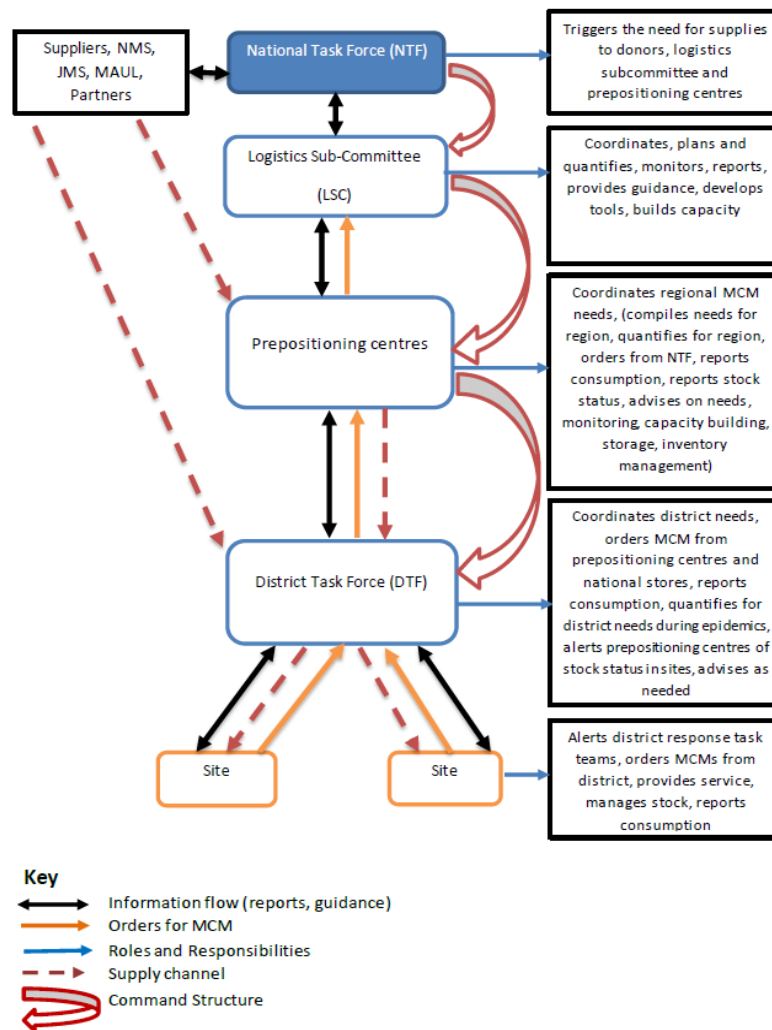


Figure 2: Conceptual flow of COVID-19 MCMs in the e-EMLS
Source: Uganda National MCM plan, 2019

Orders for all the 16 Regional Referral Hospitals (RRH) i.e. Lira, Mubende, Mbarara, Hoima, Kabale, Moroto, Soroti, Gulu, Masaka, Jinja, Entebbe, Bombo, Mbale, Naguru, Fortportal, and Arua, were processed through the eELMIS and deliveries made to the respective hospitals. During Uganda's COVID-19 emergency response, the accepted minimal level of treatment unit for any COVID-19 case by the MoH was the RRH. Added to the RRHs, orders for

MCMs such as PPEs for more than 80 other public hospitals in high risk districts and low risk districts were processed through the eELMIS (figure 8). Eight (8) prepositioning sites (Mbarara, Masindi, Arua, Kasese, Mbale, Entebbe, Kotido and Lira) were remotely supported on the eELMIS to submit their orders through the eELMIS to the LSC.

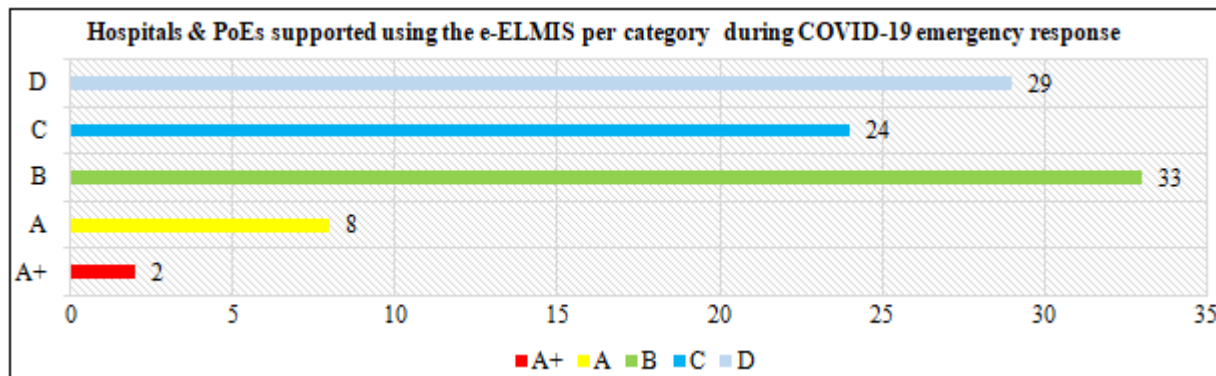


Figure 8: Hospitals and PoEs supported using the eELMIS per category during COVID-19 emergency response
Source: LSC report, May 2020

The eELMIS also supported tracking of COVID-19 supply procurements initiated by donors, Global Alliance for Vaccines & Immunization (GAVI), Global fund, Islamic development fund and MoH

3.2 Quantification, Forecasting, and Pipeline monitoring for COVID-19 Supplies

In the event of an epidemic outbreak, meticulous logistics planning is vital to avoid any scarcity of MCMs at treatment centers as stock-outs would easily lead to further deaths and sustained epidemic spread [4], [5].

The eELMIS supported routine planning, forecasting for future demand, and determining quantities of COVID-19 MCMs to be procured for both stockpiling during the preparedness and response phase, while taking into account the country's supply chain, service, and resource capacities. It is important to note that since quantification is dynamic i.e. keeps on changing depending on the progress of the epidemic, high risk districts, PoEs, and treatment centers updated their stock-status in the eELMIS on a weekly basis to give the LSC a clear picture of the available stocks,

average weekly consumption, quantities ordered, quantities received, and quantities issued out to ETUs to effectively carry out their quantification role without any impediments. All this information was readily available in the eELMIS.

The eELMIS provided an updated catalogue list of MCMs required and available for COVID-19 response. This enabled the LSC to support immediate deployment of COVID-19 supplies to the identified high risk level districts with PoEs, Public Hospitals and Quarantine centers basing on the quantified needs raised in the orders submitted in the eELMIS.

The eELMIS readily provided an MCM gap analysis i.e. stock-on-hand verses outbreak requirement amount which guided the LSC to make more mobilization for resources from donors and its partners (WHO, USAID, WFP, UNICEF, UNFPA, IOM etc.). The eELMIS further provided information on partner contribution in stock value and monetary value, this high level presentation of data inform of graphics on the eELMIS dashboard greatly supported the LSC in high level decision making (figure 4).

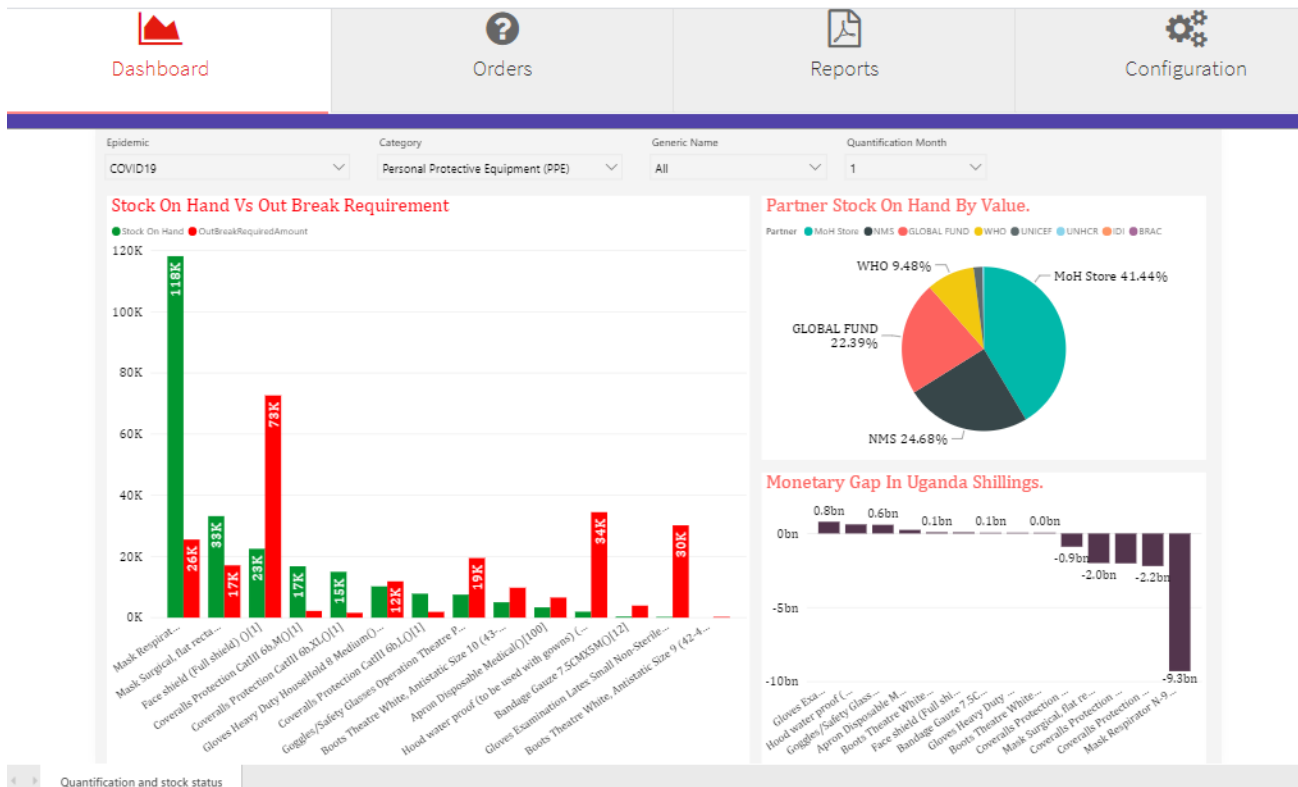


Figure 4: Dashboard from the eELMIS showing COVID-19 stock gap, partner contribution and monetary gap as of 1st June 2020

Source: eELMIS 1st June 2020

The quantification process was guided by an existing framework of guidelines for managing MCMs for public health emergency in Uganda that clearly details out a streamlined quantification methodology to be used during emergency response [6]. This was efficiently referenced and followed by the Quantification and procurement planning unit (QPPU) of the MoH which supports the LSC.

The QPPU gave daily updates to stakeholders in LSC meetings that were held every day at the Emergency Operations Center (EOC) about the stock-status, quantification, procurement tracking or pipeline stock information of COVID-19 emergency supplies in the country. The eELMIS was QPPU's tool of reference.

A COVID-19 emergency stock gap report was then compiled for the Commissioner Pharmacy department for planning and informing budget allocations. A report was also prepared to the Minister for Health on a weekly basis by the LSC which later the minister presented to the cabinet to give the country direction on the COVID-19 emergency response. All this information was generated by the eELMIS as a tool for PHE supply chain during Uganda's COVID-19 emergency response.

3.3 Support routine transactions of COVID-19 supplies at every level of the supply chain

The eELMIS is inbuilt with core functionalities of ordering stock, receiving stock, issuing stock and reporting. These functionalities are available at every level i.e. the district module, node module, partner module and national/NTF module. These help support routine transactions of COVID-19 supplies.

Ordering

Through the eELMIS, biweekly orders of COVID-19 emergency supplies of 16 RRHs, over 80 public hospitals, 8 prepositioning centers, 54 boarder points of entry, 28 high risk districts (category A+, A and B) were processed and issued. Other 107 low risk districts under category C and D were also supported to track their stock-status and make orders for COVID-19 supplies specifically PPEs, disinfectants and testing materials as a strategy for emergency preparedness in the event of a community based COVID-19 outbreak, (Figure 5).

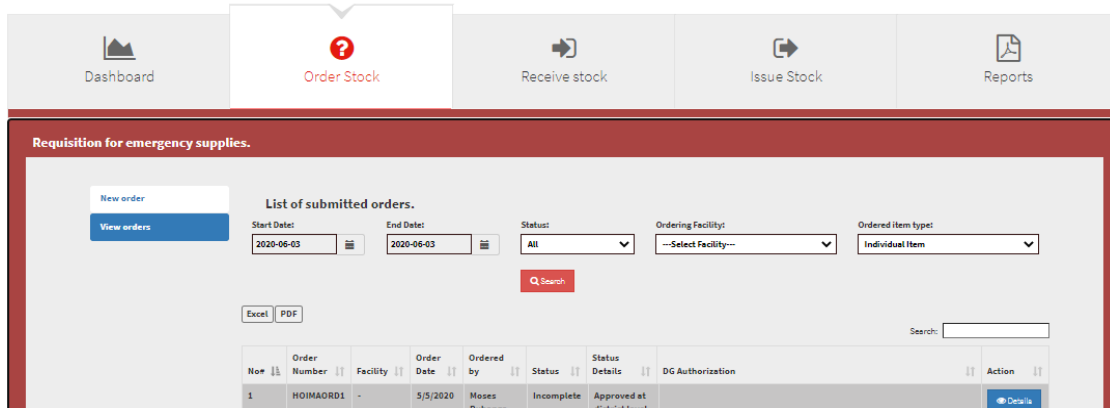
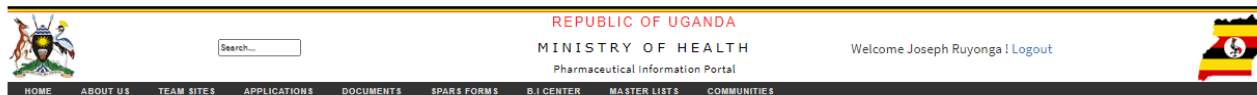


Figure 5: An order of Hoima district for COVID-19 supplies submitted in the eELMIS (eELMIS district module) Source: eELMIS 3rd June 2020

Receiving

The receiving transaction was performed across all levels. At the national level, this functionality is embedded within the national & partner module. This module tracks central warehouses (NMS & JMS) and also partner’s contributions. Within the central warehouses all COVID-19 MCMs procured are tracked in the eELMIS as receipts without an order. This necessitates declaration and visibility of stock (stock-status) within the central warehouse stores enabling the NTF to allocate it to incoming orders from the nodes, districts and RRHs. In addition to the central warehouses, partners such as WHO, UNICEF, WFP, UNFPA, IOM etc. also declared their stocks of COVID-19 MCMs within their stores by entering them in the eELMIS as receipts without an order to enable the stocks become visible at the NTF. At the regional level, the transition of receiving is tracked in the node module of the eELMIS. Once COVID-19 MCMs are delivered to the regional prepositioning center, they are received within the eELMIS system as either receipts with an order or receipts without an order. The same transaction is also performed at the district level within the district module.

Issuing

Upon receiving COVID-19 supplies at all levels, all orders or requests were responded to with urgency. Orders submitted to the NTF from the nodes and RRHs were worked on by issuing out COVID-19 supplies to those respective sites that demanded for supplies. At the regional or node level, requests or orders from the districts for COVID-19 supplies were worked on by issuing out supplies to the district stores. Furthermore, districts stores also continued the chain of supplying or issuing to individual health facilities basing on orders that were submitted to the district from those health facilities.

3.4 Reporting and data visibility

During Uganda’s COVID-19 supply chain emergency response, the eELMIS provided real time data visibility of COVID-19 supplies at treatment centers, district stores, regional prepositioning centers, central warehouses and partner stores. The eELMIS also provided daily reports to the LSC on the country’s emergency stock-status or stock on hand versus the outbreak requirement amount to provide a stock gap analysis to support in top management decision making, (figure 6).

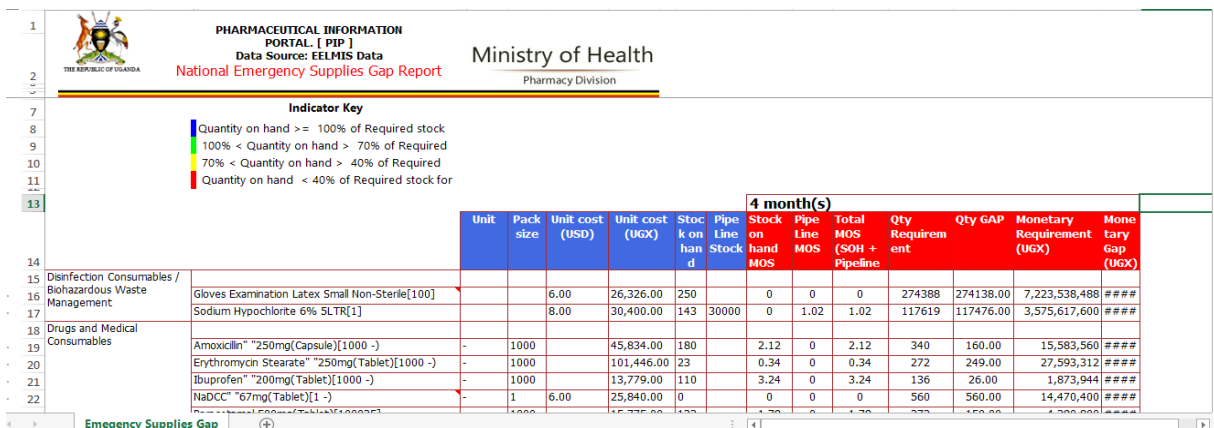


Figure 6: Example of emergency stock gap report auto-generated by the eELMIS Source: eELMIS

Added to that, the eELMIS provided a high level presentation of partner contribution in terms of physical COVID-19 logistics needs and monetary value through its dashboard (refer to figure 4 above).

Information on all COVID-19 MCMs with a focus on the key COVID-19 tracer items was readily available at all levels within the eELMIS to support the quantification process and other decisions, (figure 7).

eELMIS Stock Status of COVID-19 Tracer Commodities at Regional Referral Hospitals (1st - 26th May 2020)											
Arua Regional Referral Hospital						Individual Items Stock Status Report From: 2020-05-01 To : 2020-05-26.					
No#.	Item	Days out of stock	Average Consumption	Beginning balance	Qty Ordered	Qty received	Qty Issued	Adjustment	Closing Balance	Remarks	
1	Goggles/Safety Glasses Operation Theatre Pair[1]	0	22	103	7,390	112	22	-	193		
2	Respirators N95(Regular)[1]	0	420	432	12,020	12,346	420	-	12,358		
3	Face shield (Full shield) [1]	0	150	154	4,383	-	150	-	4		
4	Mask Surgical, flat rectangular with folds[50]	0	300	5200	16,695	30,480	300	-	35,380		
5	Gloves Examination Latex Medium Non-Sterile[100]	0	4952	395	24,051	12,994	4,952	-	12,948		

Entebbe Regional Referral Hospital											
Individual Items Stock Status Report From: 2020-05-01 To : 2020-05-26.											
No#.	Item	Days out of stock	Average Consumption	Beginning balance	Qty Ordered	Qty received	Qty Issued	Adjustment	Closing Balance	Remarks	
1	Goggles/Safety Glasses Operation Theatre Pair[1]	0	0	432	7,390	-	-	(26)	406		
2	Mask Respirator N-95 rated[20]	0	0	165	22,421	-	-	(150)	15		
3	Face shield (Full shield) [1]	0	0	250	4,383	-	-	-	250		
4	Mask Surgical, flat rectangular with folds[50]	0	0	819	16,695	-	-	(5)	814		
5	Gloves Examination Latex Medium Non-Sterile[100]	0	10	1484	24,051	125	10	2	1,601		

HOIMA_REF-NODE											
Individual Items Stock Status Report From: 2020-04-01 To : 2020-05-18.											
No#.	Item	Days out of stock	Average Consumption	Beginning balance	Qty Ordered	Qty received	Qty Issued	Adjustment	Closing Balance	Remarks	
1	Face mask Size 5 for Adult,AMBU[1]	29	0	0	60000	10400	0	0	10400	Update expected	
2	Respirators N95(Regular)[1]	29	0	0	22662	5916	0	0	5916		

Figure 7: Example of eELMIS stock status report (excel extraction) of COVID-19 tracer commodities at RRHs
Source: eELMIS

Data provided by the eELMIS helped the LSC prepare reports to the Health Minister on a weekly basis, which the minister presented to the cabinet to make top level executive decisions on mobilizing for more COVID-19 logistic resources.

4. Discussion

Use of novel technologies of information systems and ICT to support supply chain in epidemic emergency greatly improves logistic operations and emergency response [7], [8]. However it was observed by Landgren (2015) [8] that a number of low-income countries still rely on ad hoc paper based systems of simple tools and checklists to coordinate emergency supply chains as witnessed in West Africa during the Ebola response where supply chain operational information sharing was ad hoc. In emergency supply chain, minimal response time is the measure of how functional a PHE supply chain is [10]. This means lack of electronic information systems creates delays between information collection i.e. MCM ordering, reporting, and delivery on MCMs to frontlines, soaring the response time to greater levels and hence frustrating emergency response and teams at frontlines contributing to further spread of epidemics. This is still supported by a study done by Bartsch et al (2014) on the cost of Ebola response who observed that emergency supply chains not supported by electronic information systems faced critical challenges of information sharing, coordination of emergency supplies, donors and partner contribution [11].

During Uganda’s COVID-19 emergency response, Uganda leveraged on the investments previously made during the

2018-2019 Ebola preparedness that involved putting in place a robust and functional electronic system, known as the eELMIS. The eELMIS was built with a capacity to handle supply chain coordination of multiple epidemics, and in the awake of COVID-19 pandemic, its role was one of MoH’s strongest assets in providing accurate and timely information on COVID-19 logistics, tracking movement of MCMs at national, regional, district and ETU levels, handling real time transactions of ordering, receipts and issues at all levels, improving greater COVID-19 commodity security and ultimately improving response time during the COVID-19 emergency. However it must be noted that in other east African countries i.e. Kenya and Tanzania, through USAID funding in 2018, an Emergency supply chain framework using the Francophone Task order was adapted after the 2017 Joint External Evaluation by WHO, in a bid to streamline Emergency Supply Chain operations, but yet still, no standard electronic logistic management information system for the emergency supply chain existed in the awake of the COVID-19 pandemic [12], [13], [14].

5. Conclusion

The eELMIS formed the backbone of a seamless COVID-19 supply chain emergency response for Uganda, linking the national level, (central stakeholders, donors, and partners), sub-national levels (regional prepositioning centers and districts), and health facilities (emergency treatment centers). This greatly improved response time during the COVID-19 pandemic outbreak. MCMs were timely available at ETUs to support testing, treatment and protection of health workers, consequently containing further spread of COVID-19 within the communities and

COVID-19 related deaths in Uganda. At the time of writing this paper, the total number of COVID-19 cases stood at 724 and no COVID-19 related death had been registered.

This paper therefore shares Uganda's experiences in using the eELMIS as a tool of supply chain management during Uganda's COVID-19 pandemic response from which other countries without established emergency electronic logistic information systems to support their existing health supply chain systems can learn from.

6. Acknowledgements

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7. Author's Contributions

All authors contributed to the write up of this paper.

8. Ethics issues

Not applicable

9. Conflict of interest

The Authors declare no conflict of interest

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