Analysis of challenges of medical supply chains in sub-Saharan Africa regarding inventory management and transport and distribution

Project Thesis

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Executive Summary

The World Health Organization defines access to medicine as a priority for citizens, where a functioning medicine supply chain is necessary. This paper identifies challenges for reliable medicine supply chains with effective in-country distribution systems regarding the medicine availability due to inventory management and transport and distribution.

The findings in this paper are based on document analysis and semi-structured interviews. It identifies main challenges, outlines good practice based on country specific examples and recommends approaches to improve medicine availability. 20 interviews have been conducted with experts of medical supply chains. This comprehensive research is the first, which compares literature to findings from semi-structured interviews, based on supply chain challenges.

The paper contributes to a growing area of knowledge about challenges and approaches of medical supply chains in sub-Saharan Africa. Literature outlines difficulties of medical supply chains such as poor information, inadequate storage facilities and a lack of management procedures, whereas the interviews outline that human resource capacity and process management are the most critical factors for a well-functioning IM and T&D.

In general stakeholders should focus on well-functioning transport management systems and inventory management policies, with strong political involvement, clear responsibilities and roles, good supervision systems and adequate budgeting. Recommendations include aspects such as building up knowledge in innovative ways, providing easy access information, creating awareness about the importance of guidelines and standardization, designing appropriate process performance indicators, focusing on regular monitoring, hiring dedicated employees for quantification and using new technologies to enhance efficient communication, real time tracking and data transfer. Therefore particular countries need to be analyzed regarding individual structures and situation and an appropriate inventory management and transport and distribution network needs to be designed.

Future research should explore and build up understanding for IM and T&D about costs and distribution approaches, inventory and transportation policies, the use of new innovative technologies and incentives and change management approaches to enhance the health system and thus, improve life in sub-Saharan Africa.

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Acronyms

3PL	Third Party Logistics
BRAC	An international development organization
CDB	Community-based Distribution
CHAN	Churches Health Association in Nigeria
DLMS	District Level Medical Store
DTTU	Delivery Team Topping Up
eLMIS	Electronic Logistics Management Information System
EML	Essential Medicine List
FBO	Faith-based Organization
FE-FO	First-Expired-First-Out
HC	Health Centre
HIV/AIDS	Human immunodeficiency virus
HR	Human Resource
HW	Health Worker
iCCM	integrated Community Case Management
IM	Inventory Management
ISO	International Organization for Standardization
LMIS	Logistics Management Information System
M&E	Monitoring and Evaluation
MOH	Ministry of Health
NGO	Non-governmental Organization
NLMS	National Level Medical Store
OECD	Organization for Economic Co-operation and Development
RLMS	Regional Level Medical Store
SOP	Standard Operating Procedures
STG	Standard Treatment Guidelines
TB	Tuberculoses
T&D	Transport & Distribution
VMI	Vendor Managed Inventory
WHO	World Health Organization

1. Medicine Availability in developing countries

1.1. Background Information

The World Health Organization (WHO) defines access to medicine as a priority for citizens. It needs to be available at all times in adequate amounts, in appropriate dosage and quality and at an affordable price for individuals and communities (Marks, 2009 and Yadav et al., 2011). It is estimated that two billion people do not have access to medicines and four million lives per year could be saved in Africa and Southeast Asia with the appropriate treatment and medicine (Marks, 2009). With this estimate in mind, WHO and 192 states committed themselves to reaching eight Millennium Development Goals. The fourth millennium goal on the list is to reduce the child mortality rate, the fifth is to improve maternal health and the sixth, to combat HIV/AIDS, malaria and other diseases (WHO, 2012). WHO focuses on policies, access, quality and rational use, so as to ensure medicine availability, as is displayed in figure 1 (USAID, 2008a).

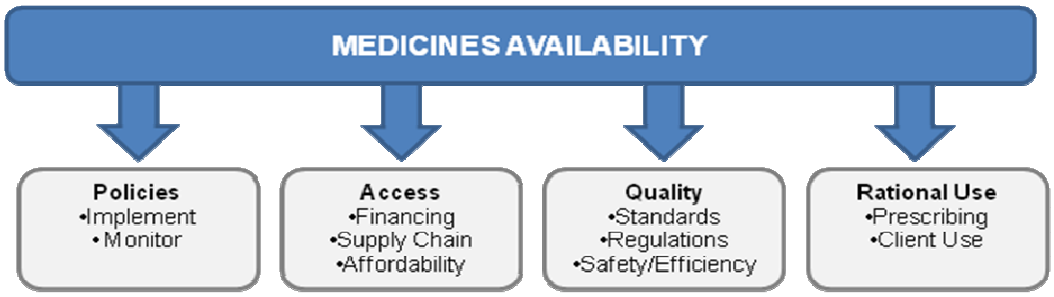


Figure 1: WHO's Medicines Access Strategy, USAID, 2008a

To ensure that people have access to essential medicines and to preserve the quality of the medicine, a functioning medicine supply chain is necessary, which includes procurement, appropriate warehousing and efficient transportation (Yadav et al., 2011).

1.2. Problems of the Health Systems in sub-Saharan Africa

Developing countries such as Nigeria have several issues with an appropriate supply of medicine to health centres (HC). Often the Ministry of Health (MOH) sets up semi-autonomous entities such as a National Level Medical Store (NLMS), who is responsible for the purchase, storage and distribution of medicine and medical supplies to health centres across the country including general hospitals and dispensaries. Typical challenges within the national health systems which impact the supply chains include inadequate forecasting, insufficient funds, delays in funding disbursements and long lead times (tendering and manufacturing). To add to the complexities, there are typically several donor funded program specific supply chains that run in

parallel to the national health systems. These potentially duplicative efforts across the supply chains can result in inefficiencies in an already resource constrained environment. From a distribution standpoint the NLMS struggles with distribution planning and vehicle routing due to a number of factors including ordering behaviour of HCs, poor communications and flow of information between the various stakeholders, limited use of technology solutions, poor road infrastructure and availability of vehicles. Furthermore it is difficult to measure performance indicators such as medicine availability and therefore often difficult to determine constraints and identify possibilities to improve the supply chain (WHO, 2006).

Nigeria is ranked 187 out of 192 countries regarding the performance of their health system. A report by WHO predicts that Nigeria will struggle to meet the Millennium goals, by 2015 (WHO, 2011). In 2011, Nigeria had a child mortality rate of 124 deaths per 1000 births; whereas the UK had a child mortality rate of 5 deaths per 1000 births (The World Bank, 2013). The main causes for child mortality are attributed to neonatal causes (26.1%), malaria (24.1%), acute respiratory tract infection (20.1%) diarrhoea (15.7%), measles (6.3%) and HIV (5.0%) (Federal Ministry of Health, 2010c). Many of these diseases could be prevented by the availability of vaccines or by being treated with available medicines (WHO, 2011). These figures are reflected in a study by the Nigerian Ministry of Health (2010b), which outlines how the supply of medicine is uncoordinated, unplanned and fragmented, which in turn results in redundant work, wastage of resources and an inability to optimize access to essential medicines for citizens.

This thesis will focus on not only the challenges, but reasons behind the challenges faced by medicine supply chains for inventory management (IM) and transport and distribution (T&D) in sub-Saharan Africa and will identify the constraints and possibilities needed to improve the IM and T&D of medicine, thus improving medicine availability.

1.3. Research Objective

The major objective of the research will be to identify challenges for reliable medicine supply chains with effective in-country distribution systems by analysing challenges of medicine supply regarding the medicine availability due to IM and T&D.

> What are the challenges for a constant availability of medicine at health centres in sub-Saharan Africa regarding inventory management and transport and distribution and why is it so challenging?

The research objective leads to research questions, which will be explored in the project:

1. What are the reasons for stock-outs at health centres?
2. Why is inventory management challenging and are there physical warehouse infrastructure constraints?
3. What are the reasons for inaccurate orders from health centres and what are the challenges involved in collecting consumption data?

4. What transportation systems are in use and what are the challenges?
5. What are the challenges regarding delivery from warehouses to health centres?
6. Why is it challenging to keep and maintain a vehicle fleet?
7. Why is the use of standard operating procedures and performance measurements so challenging?
8. What form of knowledge transfer and training would be helpful?

1.4. Limitations and Definitions of Research

The research will exclude challenges regarding

- Procurement of medicine
- Regulatory requirements and processes for medicines
- International supply chains
- Pharmaceutical manufacturing
- Special storage and distribution conditions for vaccines or other medicine e.g. cold chain

For an uncomplicated reading and for the purpose of this document, the following table explains the differing terminology used throughout the countries which have been looked at in this study.

Terminology in document	Abbreviation	Overall terminology
National Level Medical Store	NLMS	Central Medical Store (CMS) Federal Medical Store (FMS) National Medical Store (NMS)
Regional Level Medical Store	RLMS	Regional Medical Store Provincial Medical Store Zonal Medical Store
District Level Medical Store	DLMS	District Medical Store State Medical Store
Health Centre	HC	Tertiary Health Facility Secondary Health Facility Primary Health Facility (PHF) Service Delivery Points (SDP) Dispensary Points (DP) Clinics
Health Worker	HW	Community Health Worker (CHW) Community based distribution agent (CBD)

Table 1: Terminology

There is no standard approach in sub-Saharan Africa and every medical supply chain is different in terms of special commodities, special regions and special campaigns. The following work outlines common approaches or examples, but findings can hardly be generalized.

1.5. Structure of the Project Thesis

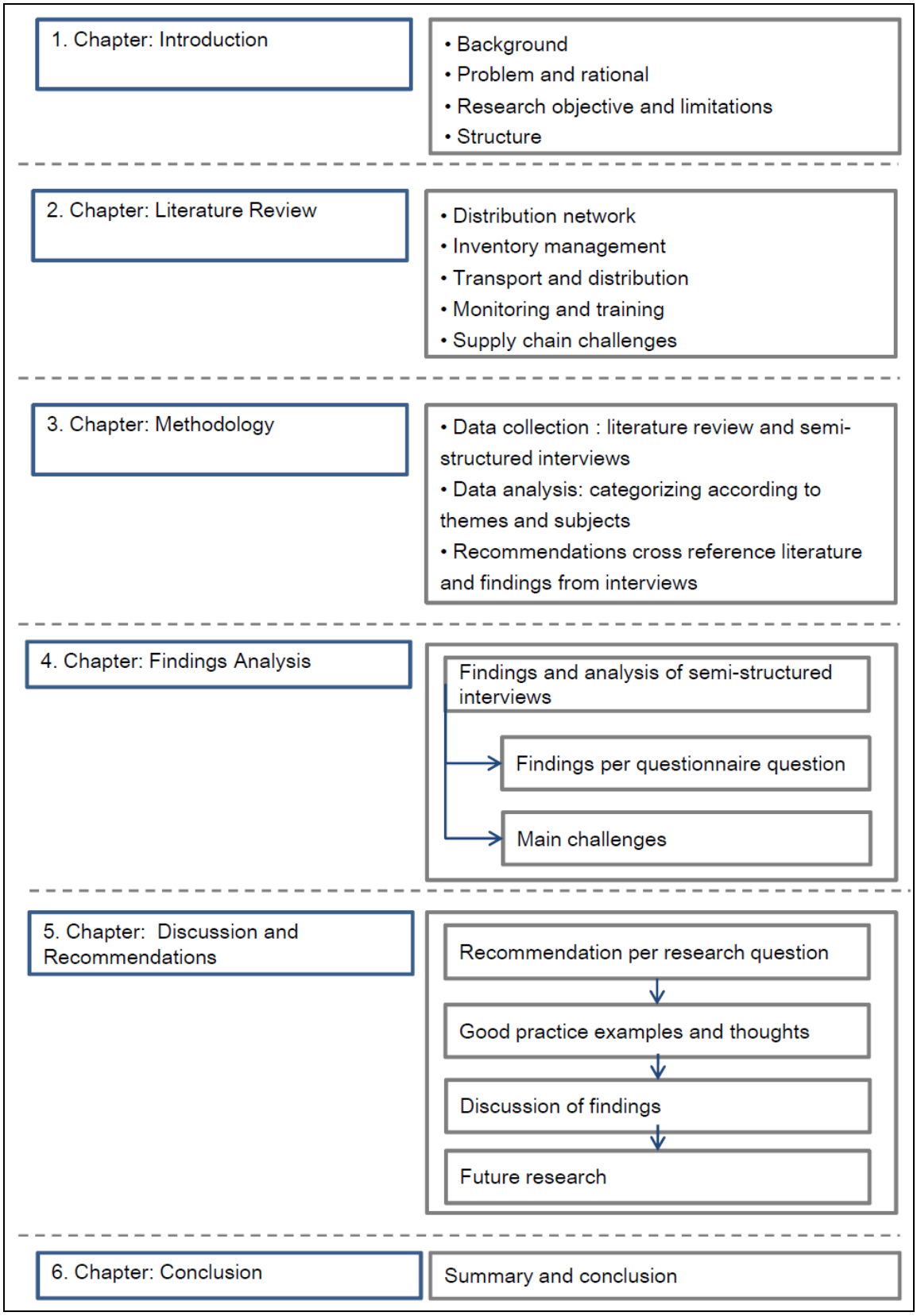


Figure 2: Structure of thesis

2. Literature Review regarding Medical Supply Chains

2.1. Distribution network and drug transportation requirements

The following work focuses on Inventory Management (IM) and Transport & Distribution (T&B). The distribution network for essential medicines is complex, with several active parties within the private, public and NGO sector and parallel distribution streams. This is displayed in figure 3.

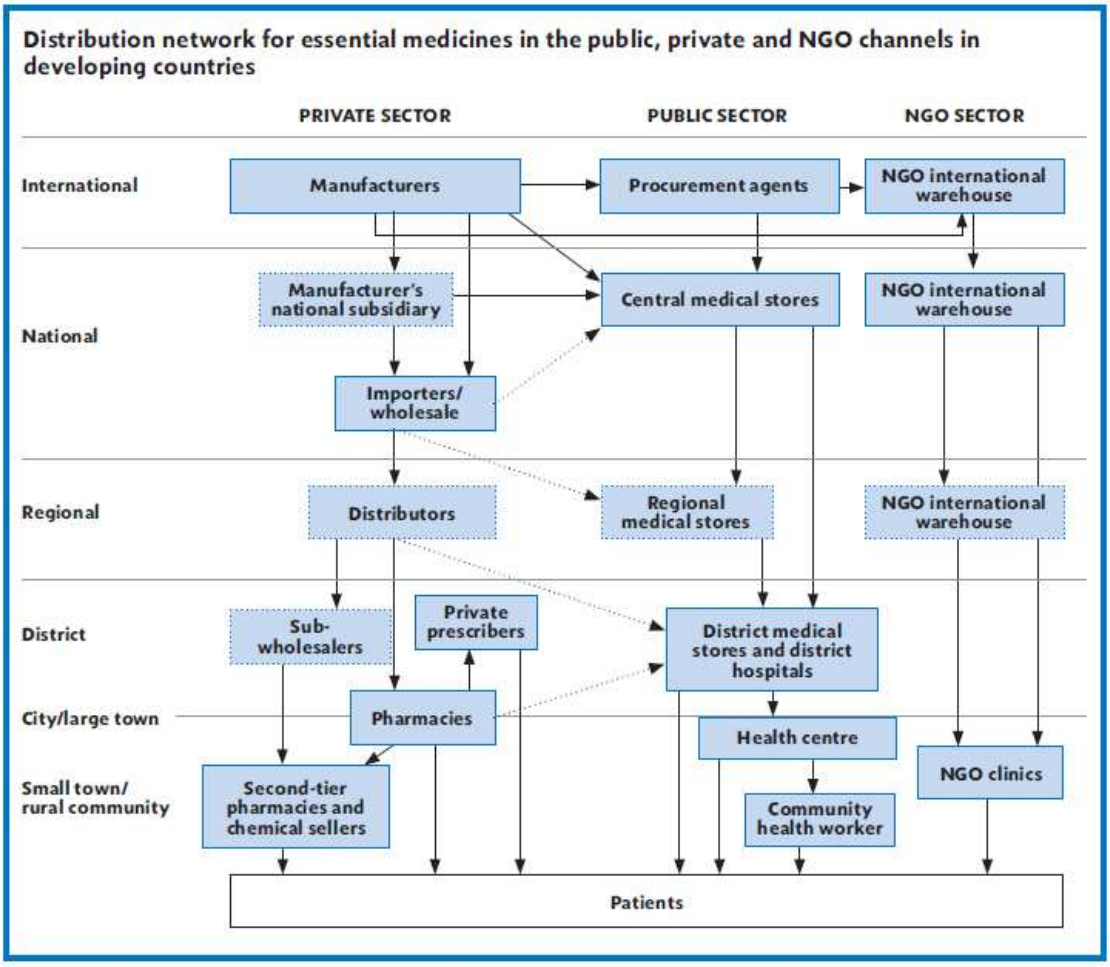


Figure 3: Distribution network for essential medicine, Yadav et al., 2011

The majority of public governmental distribution systems use National Level Medical Stores (NLMS), Regional Level Medical Stores (RLMS) and District Level Medical Stores (DLMS) for procurement and distribution, which usually operate as separate functions typically with poor, ir-regular communication and information sharing. This situation hinders a coordinated, coherent and efficient national procurement and distribution plan. An effective management of ordering, receipt, storage, distribution and resupply at each level of the distribution network is necessary.

One option is that a higher level distributes drugs to lower levels e.g. the NLMS is responsible for delivering medicine to the RLMSs. Burkina Faso has 1 NLMS, 7 RLMSs and 63 DLMSs, which is presented in figure 4. This distribution network is becoming more complex due to additional 14 primary and 7 secondary storage entities set up from partner organizations with vertical supply chains (Yadav et al., 2011). In Burkina Faso the procurement and delivery of drugs could take up to eight months (Saouadogo and Compaore, 2010).

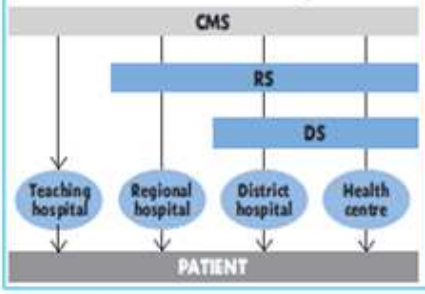
Distribution model	Country example	Key advantages	Key disadvantages
CMS to RS to DS to Health Facility 	Burkina Faso, Democratic Republic of Congo, Mali, Senegal	Except for DRC, RS is a branch of CMS, thus better visibility of consumption data at CMS level Stock positioned closer to health facilities Relies on district or regional store stock planning capacity More frequent deliveries	More total stock in the system

Figure 4: Typology of distribution model in Burkina Faso, Yadav et al., 2011

Research regards two different distribution network approaches: Intermediate tiers being used as a cross-dock facility and on the other hand, intermediate tiers are being completely bypassed. The first one uses the DLMS as a cross-docking facility, where already packed and fulfilled orders for individual HCs are delivered to and delivered from there to HCs or collected by HCs, which reduces the districts' administrative tasks. The facility is used to store and transport medicine and to collect data from the HC. The latter one is using only two tiers and delivery and order fulfilment is done direct from NLMS to HCs (USAID, 2011a).

The private sector, with a network of importers, wholesalers, sub-wholesalers and pharmacies is more complex and links international manufacturers with local private pharmacies and HCs. In Nigeria there are 292 licensed medical importers, whereas in the most OECD-countries 3-5 large wholesalers serve the whole market (Yadav et al., 2011). Private partners use either the public distribution network or private warehouses and can have several tiers between warehouses and HCs (Federal Ministry of Health, 2010b). In Nigeria the Churches Health Association of Nigeria (CHAN) Medi-pharm, which is a FBO, distributes drugs to 1920 HCs such as hospitals and dispensaries (Yadav et al., 2011). CHAN Medi-pharm distributes essential medicine to 12 Nigerian states covering 46 communities in rural areas and collect consumption data from HCs (CHAN Medi-Pharm, 2010). Some development partners e.g. NGOs or donors build their own parallel systems due to a weakness of governmental structures and lack of efficiency in the public supply system. Only 20-30% of procured medicines from partners are distributed through governmental structures. Thus, harmonization of vertical programs and governmental systems becomes vital (Federal Ministry of Health, 2010b and CHAN Medi-Pharm, 2010).

For example in Nigeria there is a complex and chaotic medicine supply chain system with registered and unregistered facilities, where the NLMS purchases essential medicine and distributes to DLMSs. The HCs are responsible for collecting or arranging deliveries from higher levels. Most DLMSs have their own distribution system (80%) and some even have a monthly scheduled delivery to HC level, which follows the push-system. However, for an effective delivery system the amount of vehicles is insufficient. Therefore distribution is outsourced to private companies, which sometimes face issues such as a lack of appropriate vehicles for cold supply chain, a lack of capacity and some store medical supplies to combine different deliveries and maximise profits. This could lead to late deliveries, shortages and loss of quality. Donor funded programs such as HIV/AIDS, TB and malaria drugs have separate and parallel distribution systems and dispensing mechanisms (Federal Ministry of Health, 2010a), which are financed by various health programs with several stakeholders and interests (USAID, 2008a).

The supply chain becomes complex because several hundred drugs need to be selected, purchased, distributed and tracked and each drug has unique supply chain limitations such as cold chains or short shelf lives. Appendix A lists characteristics such as storage and transportation requirements for essential medicines commodities (USAID, 2008a).

The medicine supply chain is a complex system with public and private organizations such as private distributors, governmental warehouses and NGOs with several tiers such as National Level Medical Stores and District Level Medical Stores. Procurement and distribution, which often work as separate functions with a poor, irregular communication and share of information, hinders a coordinated, coherent and efficient national procurement and distribution plan. Furthermore, due to a lack of efficiency, shortage of vehicles and poor condition of vehicles, many programs built their own supply chain systems within the private sector. The system becomes even more complex due to special supply chain requirements for each drug such as cold chains and short shelf lives, which makes the whole distribution network even more complex.

2.2. Inventory Management

2.2.1. Inventory management/warehouse infrastructure

An appropriate inventory control system, good and secure storage facilities, an appropriate quantification and selection process improves medicine availability and reduce spoilage. But what are the challenges (Foster, 1990)?

Appropriate inventory management at the various levels of the supply chain is crucial for effective distribution from the various warehouses. Often there are several tiers between NLMS and HCs, which all hold inventory and handle orders from lower levels. This results in high stock levels, involves significant labour to process orders and leads to high inventory costs and numerous logistics tasks for health workers (HW) (USAID, 2011a). Therefore funding constraints need to be balanced with the tiers of the distribution network (Yadav et.al, 2011). Employees are

usually HWs and not logistics professionals, which could increase failure regarding IM and T&D (USAID, 2011a).

In Nigeria poor planning and forecasting, insufficient information about consumption and current stock levels, funding and capacity constraints and a poor infrastructure are reasons for inappropriate stock levels (Transaid, 2010a). Public warehouse infrastructure in Nigeria consists of NLMS, DLMSs and HCs, whereas challenges increase further down the supply chain. In Nigeria there are eight NLMSs, which struggle with moisture, leaking ceilings, roofs, drains or taps, inappropriate cold storage capacity (Federal Ministry of Health, 2010c) and non-existent designated areas for reception, delivery and quarantined products. However, there are special areas for the storage of dangerous and narcotic medicine, products requiring cold storage, possibilities to secure products and stores are shaded from direct sunshine. Stock management is done manually with stock holding cards and follows the first-expired-first-out (FE-FO) strategy (Federal Ministry of Health, 2010a). Nigeria and Burkina Faso have created semi-autonomous medical stores, which positively influence agility and flexibility due to management expertise (Yadav et al., 2011). NLMSs in Nigeria received several improvements such as the use of Standard Operating Procedures (SOPs) for IM, the installation of a Logistics Management Information System (LMIS) and training for employees (Federal Ministry of Health, 2010c). According to the Ministry of Health, HCs are usually run with a good infrastructure regarding storage, ventilation and security. Although, stock cards, traceability of batches, defined minimum/maximum stock levels are only common at hospitals. Furthermore, most HCs don't have temperature charts to control cold chains. 67% of stock-outs occur due to funding constraints or due to management constraints e.g. FE-FO, errors in forecasts or modifications of Standard Treatment Guidelines (STG) (Federal Ministry of Health, 2010a and Habiyambere and Wertheimer, 1993).

Research in Ghana and Guatemala assessed inventory performance of more centralized or decentralized warehouse management models. The results show that the use of centralized guidelines and standardized processes such as SOPs and clear stock cards improved performance (Bossert et al., 2007).

> Medicine needs to be stored in warehouses under appropriate conditions regarding security, temperature, conditions and storage area. Furthermore, a correct inventory management is necessary to ensure adequate stock levels. Therefore strategies such as regular stock taking, inventory reconciliation, first-expired-first-out practices and traceability of batches are beneficial. Research outlines that more centralized warehouse management models with guidelines and standard operating procedures improved performance.

2.2.2. Challenges for order fulfilment

Order fulfilment is defined by the allocation and distribution of stock based on the order request/requirements. Order fulfilment could follow the push or pull strategy. The push strategy al-

locates stock to lower levels with centralized planning and forecasting. In a pull system each HC estimates required quantities and requests stock from higher levels e.g. DLMS. The choice of the system depends on the maturity of the supply chain, stock planning and forecasting capacities and available consumption data. Some countries use a combination, where DLMSs request quantities from NLMS, and DLMS allocates stock to HCs (Yadav et al., 2011).

Quantification could be based on minimum/maximum quantities, where HCs order medicine up to maximum levels, when drugs reach minimum levels (Yadav et al., 2011). There are other approaches for quantification such as the kit system, where products are packed in predetermined quantities and are distributed to HCs; the two-bin system consists of two bins with equal quantities, whereas a replacement bin is distributed when the first bin is empty; the Delivery-Team-Top-Up system (DTTU), which operates in Zimbabwe, uses a delivery team and mobile warehouse to top-up stock at HCs; and there is the meet-up and resupply system, where stakeholders have a regular meeting for resupply, training and quantification (Hasselberg and Byington, 2010a). For quantification it is necessary to recruit dedicated personnel, who train, supervise and check HWs regarding quantification such as in Kano State (USAID, 2011a). Stock-outs can occur on all levels. The public health system in Nigeria had an average stock-out time of 90 days for dispensaries and 47 days for national/district warehouses (Federal Ministry of Health, 2010c). Stock-outs at public HCs force patients to buy more expensive medicine in the private sector (Federal Ministry of Health, 2010a). Necessary stock levels can be reduced by eliminating tiers in the supply network, because every level holds safety stock and ties up financial resources. USAID outlines that by eliminating two tiers such as RLMS and DLMS total stock levels can be reduced. For example maximum stock level could decrease from 29 to 15 months, although it may involve increasing costs for transportation and adequate warehousing (USAID, 2012a).

DLMSs in Nigeria order on a quarterly basis and deliver medicines to hospitals. Primary and secondary HCs such as dispensaries or surgeries collect their orders at the DLMSs. Quantification for the majority of drugs is made unsystematically and manually by doctors, pharmacist or HWs (Federal Ministry of Health, 2010a). The Zimbabwe Informed Push is an approach, where NLMSs fill up stock at HCs according to average monthly consumption data, which is also used for procurement quantification (USAID, 2010a). Another example is Ethiopia, which launched the Rural Health Extension Program and places two paid health workers at each of the 15’000 rural HCs, which serve around 5’000 people with basic health services and medicines. HCs use stock cards, whereas HWs document monthly consumption data by reporting opening and closing stock levels. Actual consumption, minimum/maximum quantities and resupply is calculated by the higher level. The BRAC Community Health Volunteer Program in Uganda focuses on the quantities their volunteers buy from BRAC-offices and calculate consumption data by consolidating the purchases (Hasselberg and Byington, 2010b). Research in Zambia investigates two ordering models to improve medicine availability at clinics and reduce out-of-stock. Model A tests the impact of the introduction of a commodity planner at DLMS, who ensures incoming orders from HCs and orders in bulk at NLMS. Model B tests the impact when HCs order directly at

NLMSs, whereas DLMSs function as a transit facility. Both models could reduce stock-outs, though, model B proved to be more successful e.g. paediatric malaria drugs dropped from average 29 to 5 days out-of-stock. However, commodity planners still have to handle transportation, storage space and insufficient communication channels (The World Bank, 2010).

Order fulfilment is the allocation and distribution of stock to lower health centres, which could follow the push or pull strategy. Quantification of stock is challenging and sometimes based on minimum/maximum quantities. There are different approaches such as the kit system, two-bin system, Delivery-Team-Topping-Up system or meet-up system. Results of research in Zambia outline, that an approach, in which HCs order directly at NLMS and DLMSs are only used as a transit facility could reduce out-of-stock situations noteworthy.

2.2.3. Inventory management systems and forms

IM systems or forms are necessary to gather information such as consumption data to identify successes and efficiency constraints (Transaid, 2013a). Unfortunately information is often collected by expensive on-off instead of regular point-of-sale/dispensing monitoring (Yadav, 2010). Data collection consists of information about actual consumption, demand, stock levels, adjustments and losses and is necessary for resupply planning. Entirely paper-based approaches such as in Kano State in Nigeria are straightforward and don't require expensive software implementation. However, such systems are unable to calculate up-to-date consumption data. Furthermore, labour costs could be expensive because of the amount of data which needs to be surveyed on higher levels. Zambia and Tanzania use a mixed approach, which uses a paper-based approach at HCs and warehouse management systems (WMS) at NLMS with low initial costs, but benefits due to automatic quantification and consumption trend analysis. Full electronic information flow approaches have high initial costs due to customized software and hardware at the HCs, necessary internet connectivity and reliable energy sources, but can significantly improve information availability and quality, and allow visibility of real-time demand data from HCs. In general the information system used needs to balance requirements and available resources (USAID, 2011a).

Results of research by WHO outline, that most sub-Saharan countries are using LMIS to improve order fulfilment, to shorten lead times and to standardize reporting forms (Bossert et al., 2007). For an efficient use of LMISs, it is necessary that different medical programs standardize and harmonize their reporting requirements to decrease complexity (Yadav et al., 2011). Nigeria, which is a decentralized state (and States have a lot of autonomy), currently has no standardized and common LMIS in use. The NLMS keeps good records of receipt, issuance, expiration and stock availability (Federal Ministry of Health, 2010c). Some medical programs have installed separate WMSs for HIV programs. However, due to a lack of training, the software use does not prove to be satisfactory (Federal Ministry of Health, 2010a). Often there is a lack of monitoring and recording at HCs (Federal Ministry of Health, 2010c). However there are

examples for good practice such as a family folder system, which is used in Ethiopia on HC level and helps to keep record of statuses and the medicine received by patients. This information helps to forecast demands for vaccines or family planning products and makes it more predictable (John Snow, 2012). In Malawi a Government initiative uses Community-based distribution (CBD), where an agent supplies medicine to rural areas. This approach is used in other African countries such as Madagascar and Kenya as well. The HW tops-up their drug storage to maximum levels at the closest HC and reports stock on hand, adjustments and losses. The HC enters the data into software and determines specific information for each HW. Another approach is to use mobile technology to determine quantities and collect data for resupply such as the 'Asociación Pro-bienestar de la Familia de Guatemala (APROFAM)', which uses Palm Pilots for the management of inventory of HWs (Hasselberg and Byington, 2010a).

Information about consumption and stock levels are crucial to plan procurement, ordering and distribution. Therefore different sub-Saharan countries use different systems from paper-based approaches to fully electronic methods such as mobile technology. In general, up-to-date information is necessary, but the system needs to balance requirements and available resources.

2.3. Transport and Distribution

2.3.1. Supply Chain and Transportation strategies

Some of the transportation and distribution challenges include limited funds for vehicle purchase, maintenance, repairs, fuel and driver salaries (USAID, 2011a). In Ghana 13% of the stock value of the essential health commodities constitute for logistics costs. There are competing interests between low distribution costs and high service quality. If distribution frequency is high, transportation costs are high, but in a more reliable demand planning horizon with less stock-out situations (Yadav et al., 2011). Research shows that decentralized transportation systems in Guatemala results in a high performance (Bossert et al., 2007).

Last mile distribution is usually on a collection basis, meaning HCs pick up orders at warehouses via bicycles, public transport or vehicles, of which some are often used for several different purposes and bring the commodities back to the facilities. Collections often occur in an ad hoc manner and HCs need funds for transportation. Furthermore, collection of medicine by HCs could mean that HWs need to travel long distances and close the HC due to a lack of human resources (HR). Delivery by warehouse like the DTTU in Zimbabwe arranges direct deliveries from NLMS to HCs and collect information and consumption data from the HC when the top-up team is on-site for delivery of drugs. This model has high initial costs and is resource intensive. The frequency of distribution depends on the distance from the NLMS and the storage capacity of the HC. This approach decreases administrative tiers and stock levels on the entire supply chain, but often increases transportation costs. But the DTTU's running costs are similar to models used before in Zimbabwe, whereas stock-outs decreased and logistics performance

benefited. Outsourced delivery can be very effective but needs to be strictly managed and controlled (USAID, 2008b). Research in Nigeria outlines savings from 12-19% for outsourcing. However, structural or political barriers can exist such as the capability of 3PLs, client communication or conflicts (Transaid, 2010b). For example in Gambia the government outsourced their distribution to a NGO, which maintains a vehicle fleet and charges the government on a cost per kilometre basis. Private organizations often distribute with mini-vans, public transport or via collection (Yadav et al., 2011). It is important to schedule deliveries to avoid exceeding delivery deadlines due to a shortage and poor condition of vehicles or high costs of transport (Federal Ministry of Health, 2010a). In general distribution systems need to balance high initial investments, capacity of HWs, reliability and stock-outs to optimize distribution performance (USAID, 2011a).

There may be opportunities to reduce the number of supply chains by combining different commodities with similar distribution characteristics which may reduce overall costs for T&D. But, supply chain entities are fragmented and competing and thus, collaboration is difficult (WHO, 2006). Vertical supply chains have advantages for ad hoc and irregular drug deliveries and for a lack of capacity within the public supply chains. On the other side vertical approaches duplicate the need for specific services, which could increase total costs (USAID, 2008a). Another approach is to bundle consumer goods and medicine for last mile delivery (VillageReach, 2013a), but there are differences between consumer goods and medicine due to strong regulations in a small market and high necessity of traceability and security for health commodities (Yadav, 2010).

Transportation of medicine to HC needs to balance high initial investments, capacity of health workers, reliability and stock-out situations. Therefore there are used different approaches for distribution such as collection, delivery, outsourcing or public-private partnerships. Transportation cost can account for 10-20% of the stock value and thus, distribution systems need to be optimized.

2.3.2. Last mile distribution challenges

The last mile challenge is to deliver small quantities to several HCs and includes physical distribution of medicine and the collection of data. The last mile could be the link between HWs and HCs, especially as HCs are often located in rural areas, which are difficult to access and have poor communication technology. Figure 5 shows, the main activities for the last mile distribution: Transportation means delivery or collection; High-quality logistics data needs to be captured at HCs such as stock levels, consumption and adjustments; Order fulfilment could follow a pull or push strategy. This process could be facilitated by the use of a LMIS with standardized process forms and electronic communication technology. Challenges for last mile distribution are a lack of human resource (HR) capacity, low salaries, a lack of capital to cover transportation costs and limited electricity and communication infrastructure (USAID, 2011a).

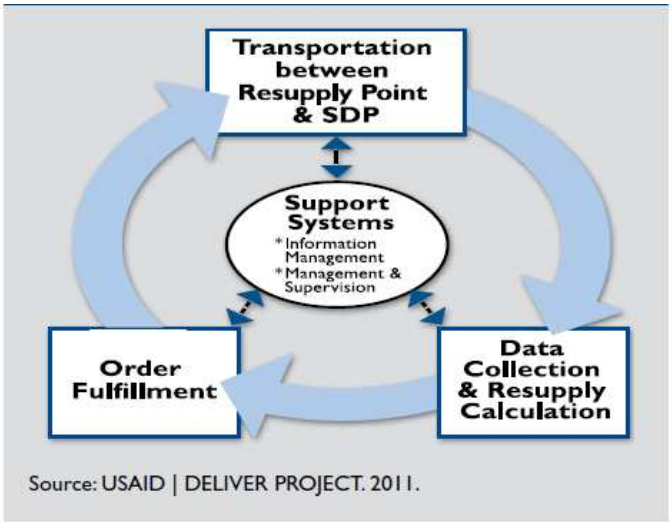


Figure 5: The logistics cycle at the last mile, USAID, 2011a

VillageReach summarizes challenges and recommends possibilities of in-house vehicle fleets, which struggle with high costs and low utilization, but ensure full control over the supply chain and outsourced delivery, which are expensive and offer a professional service, but have limited reach outside larger commercial areas. VillageReach suggests improving the existing system by a close collaboration with local vehicle owner-operators (Nakagawa and Beale, 2009).

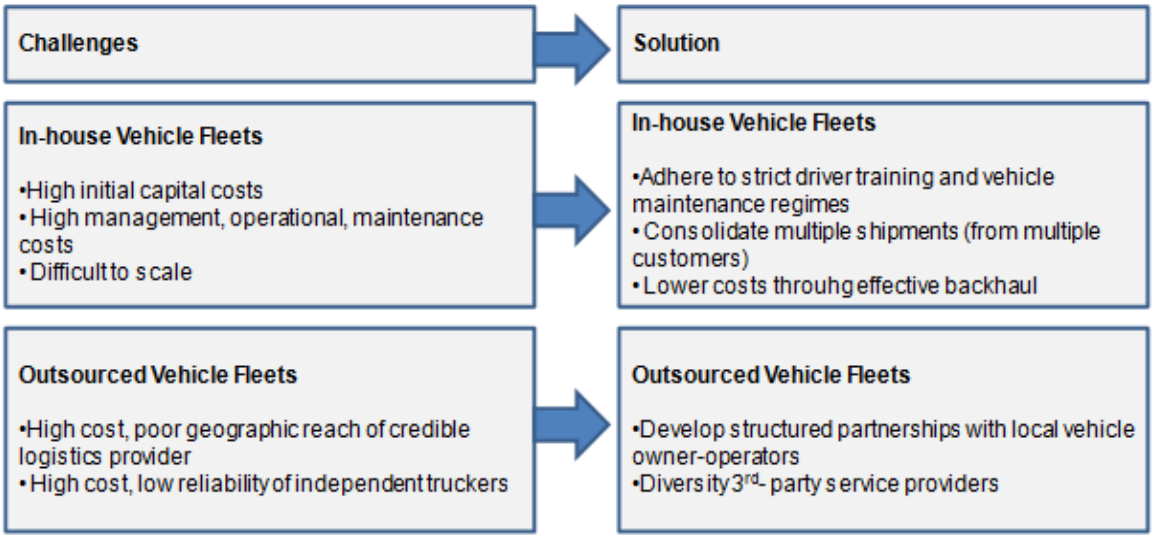


Figure 6: Transport possibilities in remote areas, Nakagawa and Beale, 2009

Research in Kano State in Nigeria suggests different transport strategies related to different commodities and distances for the last mile distribution. Facilities within 30 km are suitable for an ad hoc collection, whereas facilities which are farther away should be serviced by scheduled deliveries from warehouses for low volume commodities and manufacturer delivery for high volume commodities (USAID, 2010b).

Potential Transportation Stategy Configuration for Kano State		
Facilities / Products	< 30 km from drug management agency	> 30 km from drug management agency
High Volume/ Low Variance	Ad hoc Pickup	Supplier Managed Invoice
High Volume/ High Variance		
Low Volume		Scheduled Delivery

Table 2: Potential transportation strategy, Kano State, USAID, 2010b

Different countries face and try to solve these problems with different approaches and models. One approach is to use integrated community case management (iCCM) for rural areas, which is a strategy to train, support, and supply HWs to provide diagnostics and treatments to people with limited access to HCs (Marsh, 2012). The difficulty for this approach is to balance incentives for services and transport of HWs, training and supervision of HWs and collection of consumption data. The Living Goods project in Uganda is a door-to-door health education approach, where HWs provide health services to patients for childhood diarrhoea, malnutrition, and malaria and earn a living by selling drugs to patients (Yadav, 2013). In some rural areas the road quality is poor and the travel distance to the nearest HC is long, which makes travel expenses high. For example in Ghana over 20% cover over 48 kilometres to travel to the nearest hospital, which could hinder rural people from going to HCs and thus, encourages them to use traditional medicine or self-medication (Buor, 2003). Remote communities also face problems with accessing health care services due to limited and irregular supplies of vaccines and medical equipment to HCs, which results in lower confidence and use of the health care system (Nakagawa and Beale, 2009).

There are several challenges for the final delivery to HCs such as poor road and vehicle infrastructure, long travel distances and shortage of funding. Last mile delivery deals with transportation, data collection and order fulfilment. There are used several approaches such as mobile warehouses, collection, scheduled delivery or manufacturer-managed transportation. The challenge is to deliver small quantities to several customers and balance incentives, ability of HWs, medicine availability at HCs and collection of consumption data.

2.4. Monitoring and Training

2.4.1. KPI's to measure a good performance

WHO outlines that there are weak mechanisms for monitoring and evaluation (M&E) of medicine availability at HCs. Therefore WHO are committed in offering financial and technical assistance in order to develop M&E tools, to share and document good practice and to implement M&E-systems. Performance indicators and tools shall be developed, which monitor perform-

ance of the whole supply chain and as a result availability of medicines at HCs (WHO, 2006). Performance measurement for IM and T&D are necessary and could be monitored internally and externally. Internal performance measurements could take into account productivity, timeliness, use of resources and safety, inventory accuracy and inventory control whereas external measurements could cover delivery performance to customers e.g. accurate order fulfilment, length of lead time and stock availability. Distribution indicators should monitor frequency, reliability and condition of transport vehicles (USAID, 2011c).

USAID (2010c) designed a transport assessment tool with a questionnaire considering administration, operations management, financial management, fleet management and monitoring, health & safety and human resources and policy and policy development. This tool can be used as an assessment tool to conduct a transport system assessment (USAID, 2010c). The USAID – Deliver Project is establishing a regional office, which will support Western and Central African countries with knowledge to collect, compile and submit consumption data of family planning commodities, which contributes to the Procurement Planning and Monitoring Report (PPMR). PPMR matches country stock levels and shipment data and thus, mitigate stock-outs for family planning commodities. USAID reviews stock data on regional levels and uses results of indicators to identify the reasons for stock-outs (USAID, 2011b). Logistics professionals from Kano State conduct site visits to assess stock management and resupply quantities. But visits are often ad hoc and infrequent, which results in an overload of tasks per visit. This monitoring model uses existing administrative structures, whereas the family-planning program in Nigeria uses resupply meetings and combines commodity transportation, data collection, and resupply process supervision into a single regular meeting (USAID, 2011a).

Information and reliable data is necessary to measure performance and determine KPIs. Therefore some countries use site visits or meetings. However, only a few countries have defined indicators and performance measurements.

2.4.2. Necessary Knowledge Transfer and Training

It is necessary to invest in human skills and physical assets for an efficient medicine supply chain (Yadav, 2010). In a framework to improve procurement and supply chain management systems in African countries set up by WHO, eight necessary training for IM and T&D are suggested. These training cover technical support for establishing and adapting information systems; development of plans for drug distribution; effective management support & supervision for transport, equipment, buildings, office space and supplies; maintenance and assistance; development of model guidelines/SOPs for effective and integrated distribution systems; as well as conducting regional training courses regarding medicine storage requirements (WHO, 2006). Transaid suggests training and technical assistance for establishing fleet management and transportation policies (Transaid, 2008). Because of poor road conditions, long travel times and small budgets it is important to repair and maintain vehicle fleets and specify procedures and documentation requirements (Transaid, 2013b). There are several training providers and asso-

ciations such as i+solution, People that Deliver, International Association of Public Health Logisticians and Reproductive Health Supplies Coalition. Learning and Professional Training Opportunities (LAPTOP) is a shared web data base, which summarizes and lists around 215 available training courses in supply chain management aimed at governments and organizations (RH Supplies, 2013). Another reason for inefficient use of drugs is due to over-prescription or non-compliance by patients. Therefore, prescribers of medicine should be trained in STG and patients better informed about usage to avoid wastage of drugs (Foster, 1990).

Knowledge transfer and training is important to build up an efficient medicine supply chain.

2.5. Supply Chain Challenges

A workshop by WHO (2006) outlines the difficulties of the medicine supply of African countries; the main challenges being poor information, communication and consumption data, inadequate storage facilities and temperature control systems and a lack of quality assurance procedures. The workshop designed a regional framework to improve procurement and supply management systems for essential medicine in African regions and outlines challenges, goals and tasks for quantification and forecasting and storage and distribution.

This framework lists challenges for

- selection and quantification such as unknown demand;
- procurement such as a lack of transparent procurement procedures;
- storage such as inadequate storage facilities and capacity or lack of guidelines for SOPs and a lack of knowledge for good storage procedures;
- distribution such as a lack of appropriate planning, monitoring and evaluation and inadequate budget allocation;
- quality assurance such as medicine supply chain control;
- rational use such as inappropriate prescribing and dispensing.

3. Materials and Methods

3.1 Research Design

This survey research is based on a cross-sectional design and collects quantitative and qualitative data by semi-structured interviews. The project focuses on the challenges of medical supply chains in sub-Saharan Africa. The research tries to capture examples and the thoughts of experts. Therefore, the research needs multiple sources of evidence and qualitative and quantitative methods are used to generate a wide and detailed examination of the reasons behind a challenging supply of medicines in sub-Saharan Africa (Bryman and Bell, 2011, p.45 pp.).

3.2 Data Collection

Primary and secondary sources are used to collect data. Challenges and background information are researched with published literature which takes into consideration, peer-reviewed articles, case studies and project reports. Secondary data is used to analyse and evaluate the challenges of essential medicine supply chains in sub-Saharan Africa. The challenges are summarized and listed in Chapter 2: Literature Review. A comprehensive list of the literature can be found in the bibliography. One obstacle of the literature is that some interviewees worked in organizations, which are referenced.

As a qualitative method, primary information is collected by semi-structured interviews with supply chain experts of NGOs, associations, universities and private companies amongst others Health Partners International, Agence de Médecine Préventive, Transaid, Gates Foundation, Uganda National Medical Stores, Village Reach, John Snow DELIVER Project, Riders for Health and UNICEF.

Issues, which are discussed with interview partners focus on the reasons behind challenges, examples and scale of agreement regarding the medicine availability due to inventory management and transport and distribution. 35 experts were contacted in July 2013 and in total 20 interviews were conducted via Skype. The full list of interviewees is shown in appendix B. The semi-structured interviews took between 40 - 81 minutes and in total there were 16.5 hours interview material audio recorded. The interviews followed a questionnaire, which is attached in appendix C and was discussed during the interview. The questions cover the topics of warehouse infrastructure, stock levels, stock-outs, consumption data, delivery scheduling, transportation systems, transport infrastructure, vehicle maintenance, guidelines, performance indicators, training and vertical programs. Interviews were audio recorded and summaries are attached in appendix D. Interviews are anonymous. Furthermore, the interviewees could online access the questionnaire and indicate online the scale of agreement or scale of challenge per question on a scale from 0-100%.

3.3 Data Analysis and Discussion

First of all the questionnaire was set up with wide and general questions to capture expertise of medical supply chain experts in sub-Saharan Africa. External reliability and external validity is difficult to achieve, because findings can hardly be generalized due to the differences between sub-Saharan countries. However, results show a direction of challenges and possible approaches to improve the health system (Bryman and Bell, 2011, p.395 pp.).

The interviews were categorized according to a qualitative interview analysis, which involved an iterative process in order to emerge themes. The interviews were coded in terms of certain subjects and themes, namely challenges along the supply chain for each question (Bryman and Bell, 2011, p.297 pp.). The frequency of certain subjects and themes were counted and categorized. The percentages in parenthesis indicate the number of interviewees, who outlined this aspect. For each questionnaire question an area chart shows scale of agreement or scale of challenge, which presents the number of interviewees agreeing, to a certain percentage of agreement. The scale of agreement could be extracted from the online questionnaire. Furthermore, main challenges were identified and frequencies counted according to a content analysis in terms of subjects and counted only once for each question and per interviewee. The main challenges were mentioned across all 12 questions from all 20 interviewees.

Subsequent, research questions, literature, questionnaire questions, findings from interviews and recommendations were connected to each other and are visualized in tables. Each research question is answered by literature, findings from interviews and recommendations. Finally good practice examples were extracted from interviews and literature, and future research identified.

3.4 Ethics

In this research the privacy of interview partners and informed consent with associations and in particular with Transaid is ensured.

4 Findings and Analysis of semi-structured interviews

4.1 Findings per Questionnaire Question

First of all the questionnaire was set up with wide and general questions to capture expertise, examples and thoughts of experts of medical supply chains in sub-Saharan Africa. The findings can hardly be generalized, because of the differences between sub-Saharan countries, but show a direction of challenges and possible approaches to improve the health system. The interviews were categorized according to a qualitative interview analysis. The percentages in parenthesis indicate the number of interviewees, who outline this aspect. If 5 out of 20 interviewees see a particular aspect as challenging, 25% is indicated in parenthesis. The area chart shows how many interviewees agree with a statement (y-axis) to a certain scale of agreement in percent, where 10 equals 100% (x-axis).

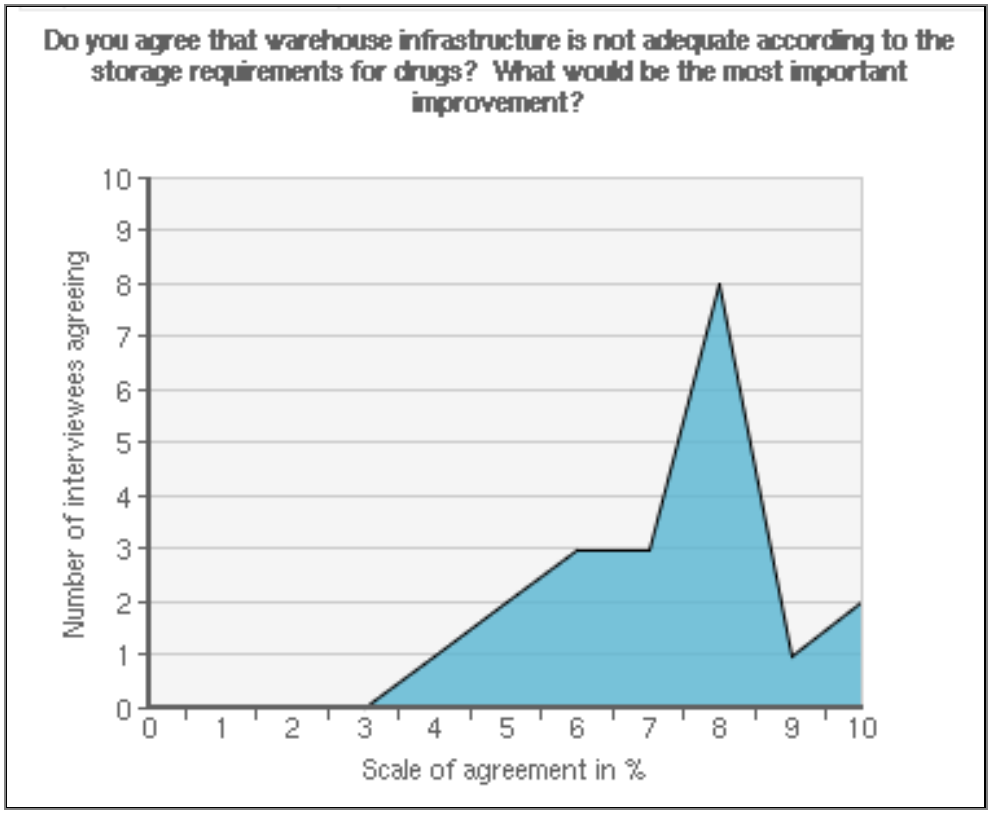


Figure 7: Scale of agreement for questionnaire question 2

An average scale of agreement for inadequate warehouse infrastructure is 73%. The first general finding is that insufficiency of warehouse infrastructure increases further down the supply chain and that there are huge variances between the levels. In recent years NGOs and the public health sector focused on warehouse infrastructure at national levels and thus, resolved many

challenges. ***The remaining challenges can be separated into two categories: physical infrastructure and management.*** Physical infrastructure implies storage capacity (45%), which is as seen challenging from 9 out of 20 interviewees. Furthermore, physical infrastructure includes temperature control (45%) and racking possibilities (25%). Interviewee #12 expresses that, the NLMS in Mozambique has 1/3 of the required capacity. Challenges regarding the management include a lack of expertise of human resources (HR) (30%), insufficient operational processes (30%) e.g. FE-FO and use of warehouse information (20%) such as stock availability for management-decision. Interviewees #11 and #13 outline that it is important to have a well-functioning design of warehouse management processes with clear responsibilities. On the other side interviewee #2 states that the NLMS in Zambia is well racked and organized, has good cold chain storage and mechanical handling equipment.

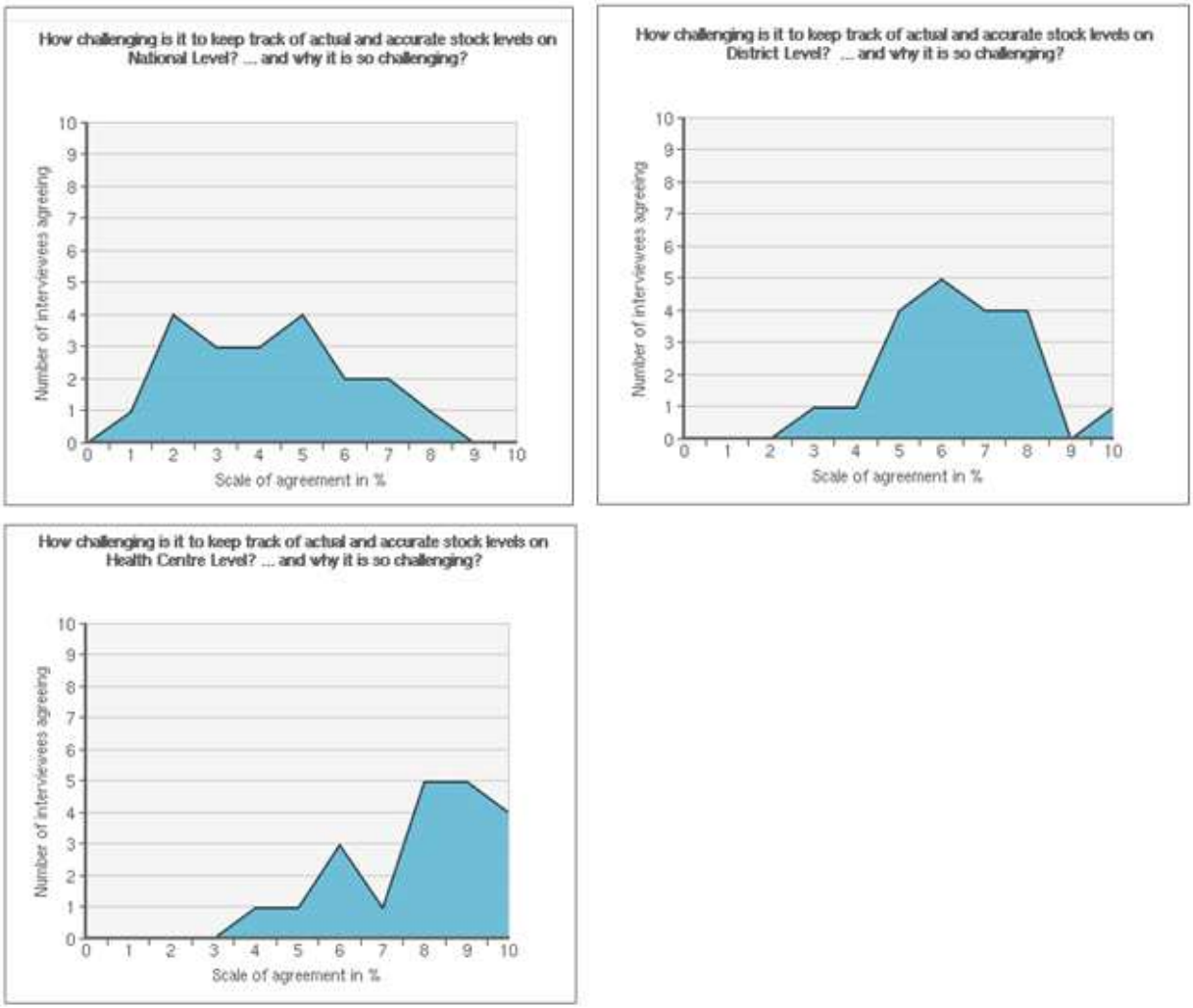


Figure 8: Scale of agreement for questionnaire question 3

The average scale of difficulty of keeping track of actual and accurate stock levels on a national level is 42%, on a district level is 64% and on a health centre level is 80%. Challenges increase along the supply chain. ***The main challenges regarding tracking accurate stock levels***

cover data transparency, systems and management processes and HR capacity. Data transparency indicates the need for visibility of accurate real time data (60%). Interviewee #17 outlines difficulties to convince management about importance of regular reporting. Furthermore, there is a lack of human resource capacity (55%) and a poor supervision for HWs. Lower levels are lacking in electronic systems (40%) and warehouse management processes (25%) which are used to track data accurately and report on a timely basis. Interviewee #12 states that it is difficult to keep track of accurate stock levels in Mozambique's NLMS. Performance is around 80%, but there are no quantified reasons for inaccuracy, which leaves the NLMS with reasons such as mismanagement or suppliers responsibility. Interviewee #10 states that there are well-functioning paper tools and electronic tools for tracking stock levels and that it depends more on recording behaviour and understanding reasons of reporting, rather than on available tools. Additionally, interviewee #16 outlines the need to train staff and management to follow processes, because a WMS or paper system only works well if staff follows defined business processes. Another challenge is the use of data for management-decisions (15%), because staff could become demoralized and cease to report accurate stock levels if there is no improvement to these individual stock levels, outlined by interviewee #13.

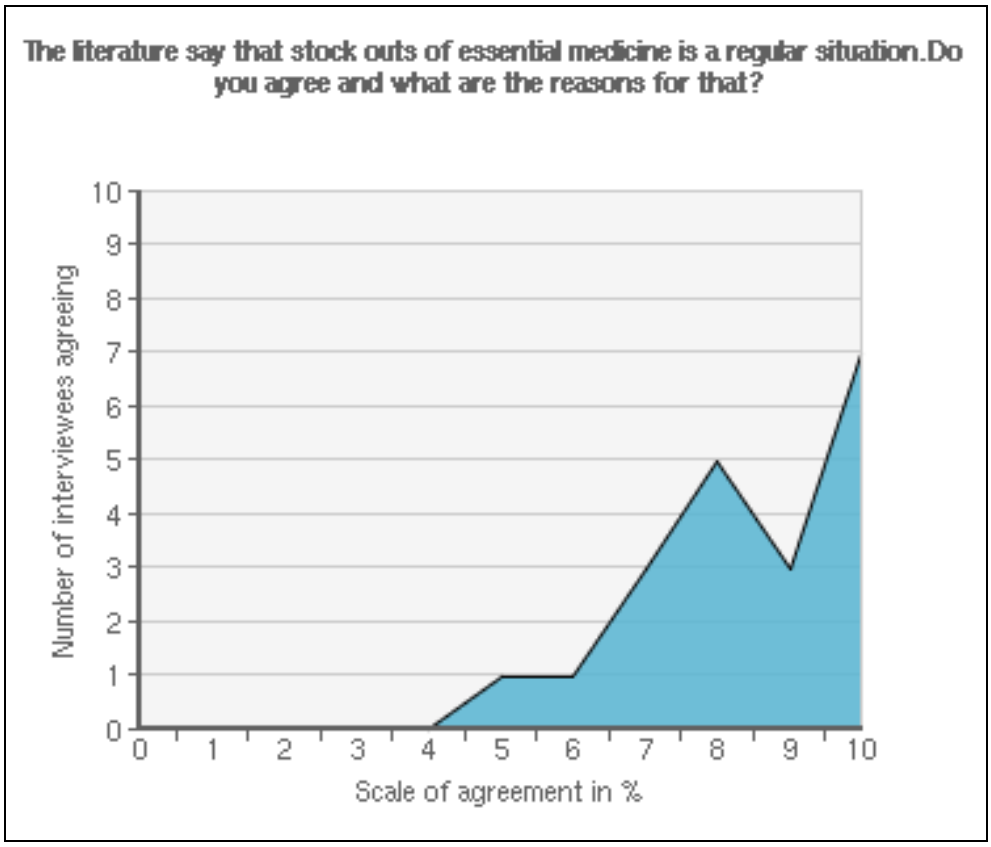


Figure 9: Scale of agreement for questionnaire question 4

The average scale of agreement is 85% that stock- outs occur regularly. This general question about stock-outs outlines four major reasons. ***The four main reasons provided by the interviewees are poor forecasting and procurement (65%), lack of funding (55%), lack of***

communication and poor ordering data (50%) and poor supply chains and distribution (35%). The extent of these challenges and contribution depend highly on the country specific health system. Interviewee #6 states that 50-70% of medicines from the essential medicine list (EML) are not available and some medicines were out-of-stock for 1.5 years in Tanzania. There is a lack of a well-functioning ordering system with poor quantification of demand, which can be related to the bullwhip effect and the use of issue data. The bullwhip effect is caused by dysfunctional ordering behaviour of HCs. Another difficulty is the use of issue data for forecasting, which doesn't consider unmet demands, such as the purchases of a substitute or HCs, which could not resupply due to funding constraints, outlined by interviewee #8 and #9. Funding constraints or inadequate release of financial resources increases stock-outs even more. Interviewee #12 states that in Mozambique only around 45% of funds which are needed, are available. However, interviewee #7 and #10 see challenges more about inadequate management rather than physical barriers e.g. lack of policies and management capability. Although, interviewee #10 experienced that motivated HWs resupply despite all challenges. Therefore interviewee #15 suggests capturing knowledge about ordering and delivery systems and creating a broader intelligence of working approaches. In summary the reasons are linked and it is important to analyze the whole supply chain to improve stock levels.

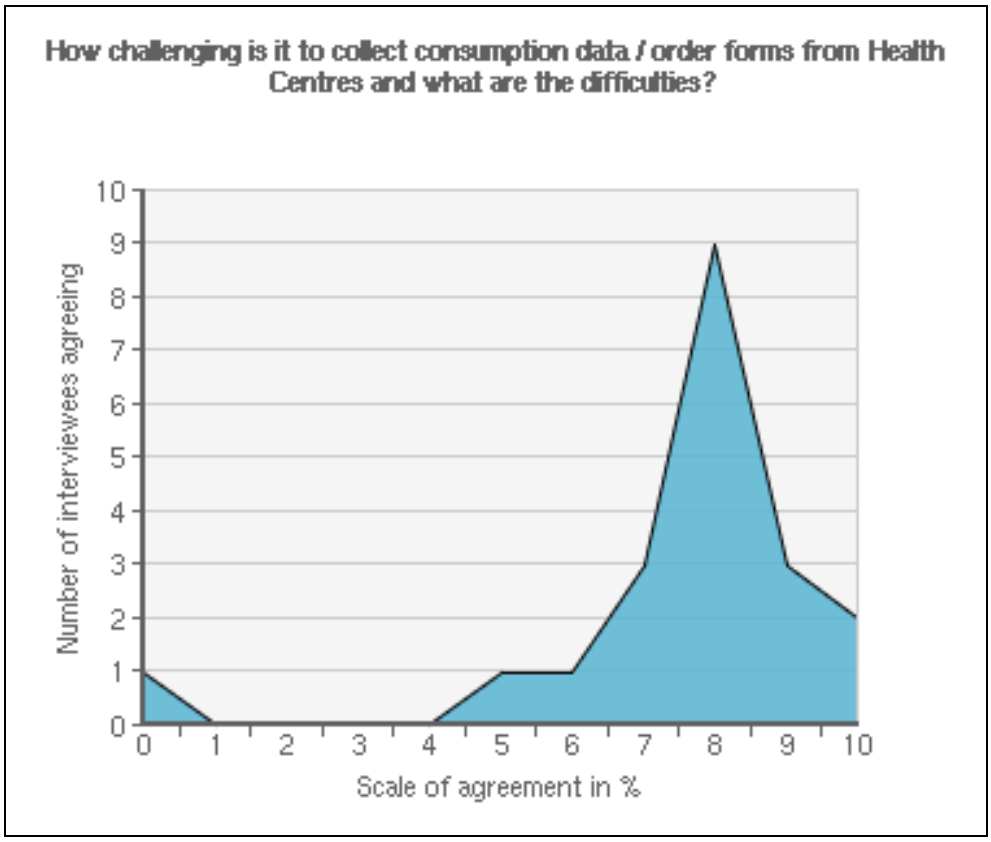


Figure 10: Scale of agreement for questionnaire question 5

The average scale shows a 76% difficulty in the collection of consumption data from HCs. ***Challenges regarding the collection of consumption data are related to weak transportation and technology, lack of human resources and commitment and poor quality of data.*** There is an overwhelming amount of work (50%) for HWs due to many responsibilities such as health services and IM. Furthermore, HWs need to fill out different requisitions forms from several programs due to a lack of standardization, outlined by interviewee #8. There is an inconsistent reporting quality of data (50%) regarding accuracy and timeliness. Quality of data becomes worse due to a lack of training for data reporting and a high staff turnover. It could be demoralizing for HWs to report data, if information isn't used (45%). HC sends data via a paper form to higher levels, where it is challenging to enter such a big amount of data into WMSs (15%). Interviewee #3 illustrates the challenge of collecting, aggregating and processing data from e.g. 15 districts with each 100-200 HCs. Besides, NLMSs receive rather issue data instead of real consumption data (30%), which makes forecasting difficult. Additionally, through ad hoc and irregular order behaviour of HCs, the need of high safety stocks increases. Therefore interviewee #1 and #4 outline the potential of technology, which could be applied to improve data quality and forecasting (45%) e.g. mobile signals could overcome distances. However, it is necessary to integrate new technology approaches into regular tasks.

Interviewee #17 outlines an example of one district in Tanzania, which improved both the quality and punctuality of their data reports from 60% to 100% in a short period of time by focusing on the topic, providing support for HWs and setting up incentives in order to attain the high quality of data reporting.

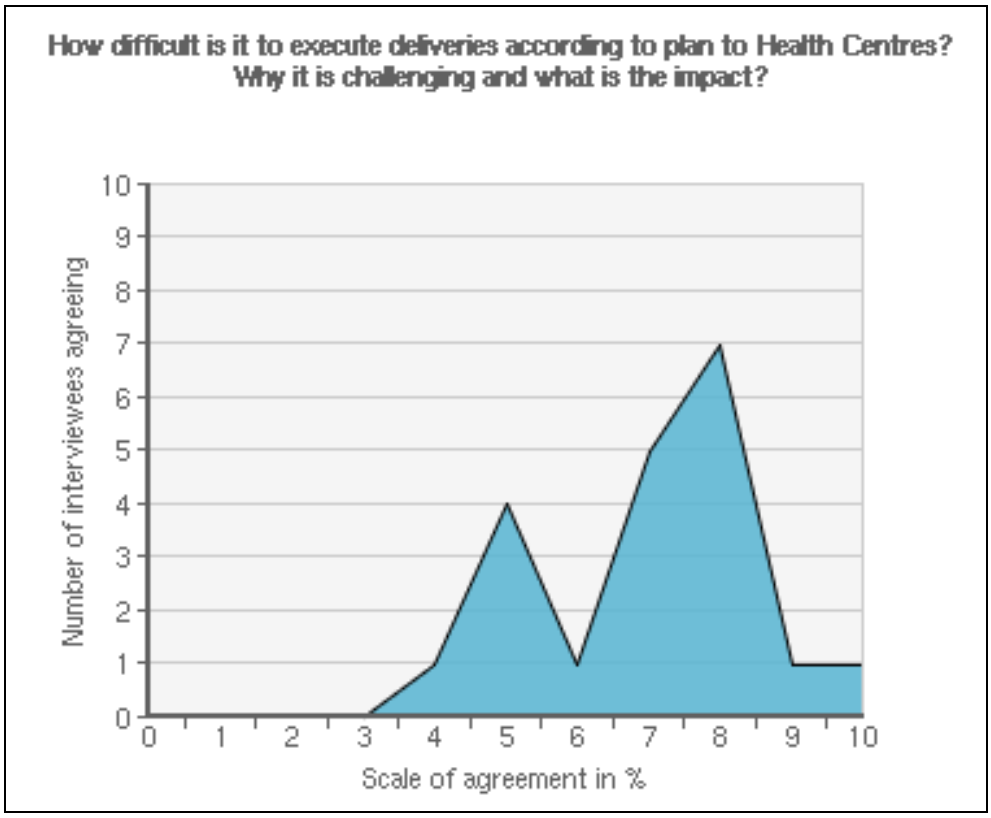


Figure 11: Scale of agreement for questionnaire question 6

The execution of deliveries to HCs which run according to plan is scaled at an average 70% difficulty rate. **The challenges faced in order to maintain on-schedule distribution, are delivery scheduling constraints *(70%), external conditions (45%), availability of vehicle fleets (40%) and financial budgeting (40%).*** Vehicle scheduling includes setting up delivery plans, which are adjustable, but improves certainty of supply chains and increase reliability, outlined by interviewee #16 and #20. It is helpful to have a transportation planning software and to plan deliveries decentralized to achieve optimized and efficient schedules. Delivery scheduling needs expertise of managers in order to plan realistic deliveries, considering vehicle resources and road conditions. An adequate vehicle fleet with appropriate vehicles for difficult conditions, which can fulfil transportation requirements such as cold chains, needs to be available. Delivery schedules need to consider external conditions e.g. rainy season or outbreaks of epidemic diseases. Furthermore, financial resources and budgets need to be planned and allocated in advance with earmarked line items for fuel, driver salaries and maintenance. It is important to have a holistic perspective of the supply chain with precise budgeting for total costs of transportation. Interviewee #1 outlines that Madagascar has a well performing mix of six weekly delivery and

collection from resupply points, whereas it is crucial to have the commitment of partners. In summary interviewee #10 expresses that a distribution system functions as long as it is reliable.

Question 7:
Research suggests different transportation systems such as collection, delivery-by-warehouse or outsourcing.
What are your thoughts about the different options?

Collection is the natural opposite of delivery and makes sense for small volumes, emergency resupplies or in low population densities. It could be an ad hoc default option if delivery is not reliable. In this scenario HCs are able to collect medicine to prevent stock outs (25%), and if needed are able to contact their supervisors during collection. But a successful collection system needs funds for transportation and planning (35%). On the other side HCs have the lowest level of capacity and infrastructure e.g. lack of bulky transportation possibilities and cold chains for vaccine or the necessity to close HCs due to a lack of human resources (35%), stated by interviewee #8 and #11. Disadvantages are the introduction of varied ability and the complex organization involved in the collection system (20%). Interviewee #3 highlights huge difference of quality if one DLMS relies on 100 people for collection.

For successful ***distribution*** it is necessary to have available funds (45%), a well maintained and managed vehicle fleet (30%) and the ability to manage the flow of information for a reliable and secure delivery. However, distribution is not core ability in the public health system and requires a lot of time and resources (10%). Thus, warehouse delivery is only an option if outsourcing is not possible (5%). Furthermore, warehouse delivery could be an option for decreasing the risk of delivery failures, for using deliveries as emergency ad hoc distribution or if economies of scale can be achieved (10%). Interviewee #20 highlights that OECD-countries have outsourced medical supply chains to make distribution more reliable and countries should only build up a distribution system if outsourcing is not available.

Outsourcing is a good option because 3PLs have core abilities in distribution (40%) and can leverage costs and operate more cost effectively (15%). Outsourcing could take the pressure of transportation from the health system (10%). But interviewee #2 and #7 outline that, NLMSs need to understand own costs for in-house transportation processes to achieve optimal results with an outsourcing partner. Additionally, the public health system needs professional staff to manage contracts regarding quality and to build up sustainable and pro-active relationships with 3PLs (30%), as stated by interviewee #14. Moreover, it is difficult to find appropriate 3PLs in developing countries (55%), regarding paper-work, delivery and storage requirements. Besides, 3PLs might reject contracts, because the public health sector is a difficult customer due to late payments, outlined by interviewee #10 and #16. Likewise, there is a negative perception and differing motivations fuelling the private and public sector, which makes outsourcing politically difficult (10%), stated by interviewee #18. Therefore interviewee #10 suggests outsourcing models with social businesses and expresses that the MOH should still have a connection to

the supply chain to gather information, consumption data and provide supervision at the HCs. Uganda uses a well-functioning outsourcing approach and designed a reliable distribution system with strict policies regarding quality and costs. A contract manager is responsible and the risk of delivery failure is decreased, as several 3PLs across the country are used.

Interviewee #6 and #11 outline that every system can function well if country specific situations are considered and there is a good transport management system with strong political involvement, clear responsibilities, tasks and roles, good supervision systems and adequate budgeting. The major improvement is setting up transport policies and transport management systems.

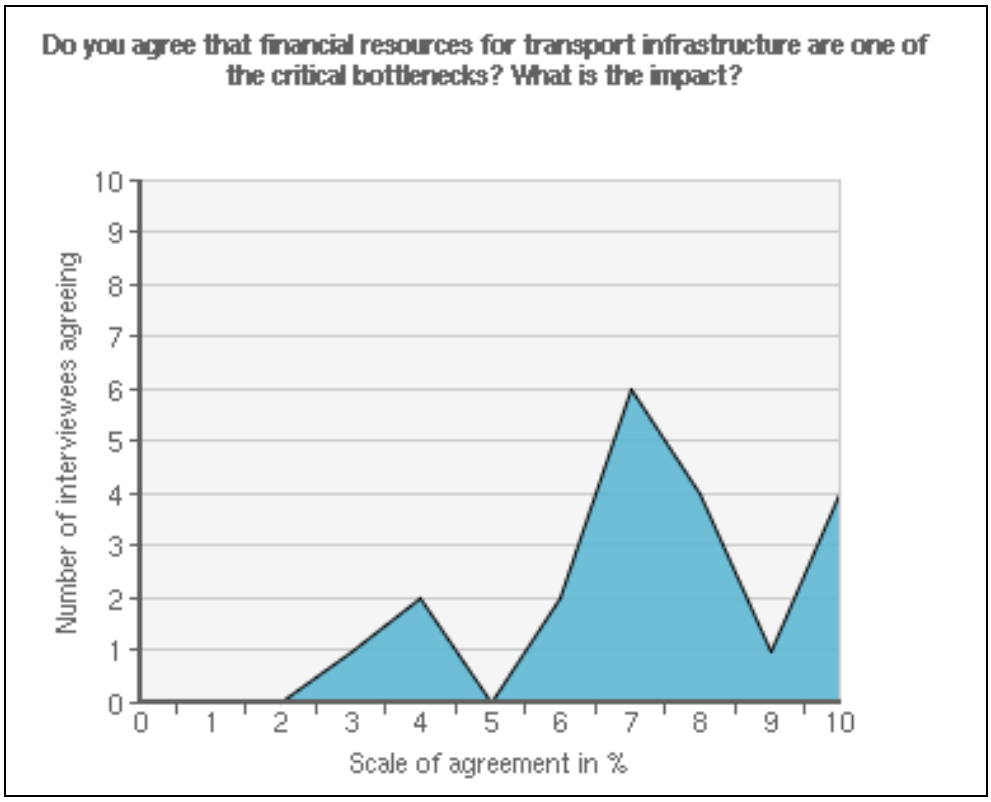


Figure 12: Scale of agreement for questionnaire question 8

73% is the average scale of agreement that financial resources for transport infrastructure are a critical bottleneck. ***Most of the interviewees agreed with this statement and mention inadequate budgeting and lack of expertise concerning maintenance as reasons.*** There is a lack of accurate budgeting for transportation (65%) such as the allocation of funds for fuel, supervision or maintenance. For example in Nigeria, which is a decentralized system, States need to release financial resources as well, which makes delivery more challenging, stated by interviewee #18. Furthermore, there is a poor understanding of total costs for transportation, especially for last mile distribution and thus, budgeting is difficult, outlined by interviewee #5 and #9. Interviewee #7 outlines that a truck could cost $50'000, but maintenance during vehicle life could sum up to $200'000, which is not budgeted. Additionally, interviewee #4 mentions that, there is a general shortage of financial resources (60%) for a whole range of activities due to a flow of responsibilities to DLMSs, but a lesser flow of financial resources.

On the other side there is a lack of vehicle maintenance (40%), a lack of skills to repair broken down vehicles (35%), poor fleet management and lack of HR capacity (25%) and sometimes spare parts are not available (15%). Interviewee #10 has an example, where a brand new vehicle broke down due to a small part, but instead of repairing the vehicle, the facility used the vehicle for spare parts and lost the brand new vehicle.

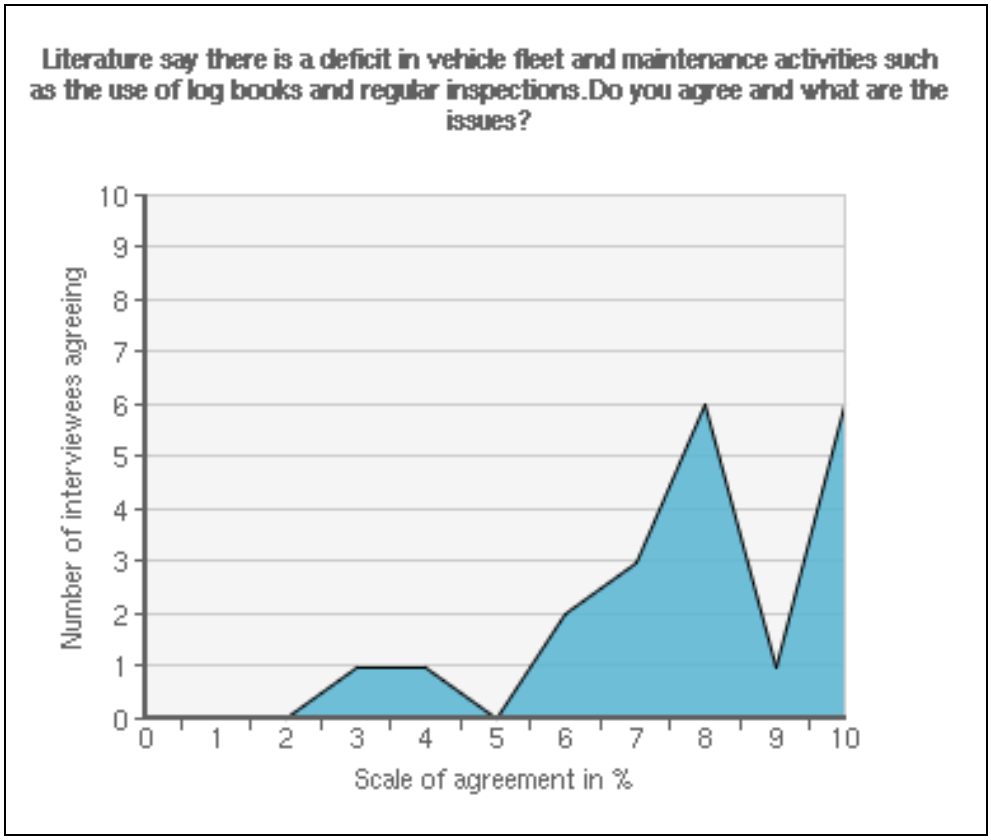


Figure 13: Scale of agreement for questionnaire question 9

The average scale of agreement is 79% that there is a deficit in vehicle fleet and maintenance activities. ***The interviews express that there are physical constraints and management constraints regarding vehicle fleet and maintenance activities.*** Physical constraints include unavailable spare parts, a lack of human resources with maintenance skills (50%) and an appropriate vehicle fleet (45%). Interviewee #1 experienced how employees performed a quick look around vehicles to check obvious issues, instead of conducting appropriate maintenance such as oil checks and replacement of key components. The reason for insufficient maintenance is a combination of training issues and poor understanding of the importance of preventive maintenance (45%). This understanding needs to be on management level, as well as on staff level. Furthermore, there is a lack of financial resources for maintenance activities (45%) and the bureaucratic challenges that are faced in order for such funds to be released. Interviewee #9 mentions, in Benin HCs need to inform DLMSs to share costs for curative repairs and replacements, but preventive maintenance needs to be financed by HCs. On the other side there are management constraints such as a poor communication between management and

staff to report necessary maintenance activities. It is important to define roles and responsibilities and set up a good maintenance program, as another challenge is the lack of accountability and responsibility for vehicle maintenance (25%). Additionally, there are no incentives to create transparency (15%) e.g. the utilization of logbooks, where data is collected on the use of transportation resources, such as driven kilometre. In most cases, however, such data is neither analysed nor is action taken (30%). Uganda's National Medical Store has a well defined vehicle fleet system and transportation policy, which monitors costs per vehicle and costs per kilometre, maintenance activities, and fuel consumption and requires pre- and post-trip checks.

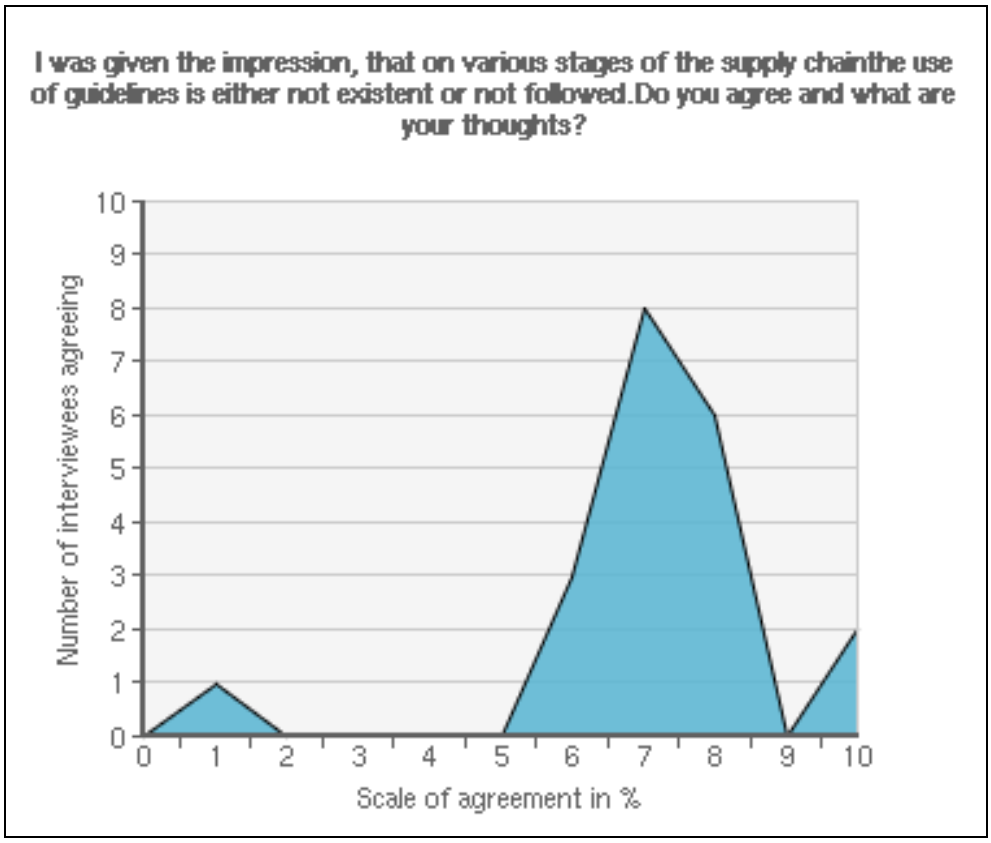


Figure 14: Scale of agreement for questionnaire question 10

There is a 72% average scale of agreement that the use of guidelines is either non-existent or not followed. Guidelines often do exist (50%), but they are not always adhered to (45%). ***The main challenge is to have relevant guidelines and to communicate these properly.*** Interviewee #13 outlines the importance of clearly defined procedures, tasks and responsibilities, because guidelines act as a reference for employees to know what they are supposed to do (15%). This is especially important e.g. in Mozambique, where in only 2 years in logistics, there is the very high staff turnover of 76%, mentioned by interviewee #10. Furthermore, interviewee #16 outlines that it is necessary to have the right mindset about the importance of standardization (35%) and to see the benefits. Therefore guidelines should be adapted for each level and each job (45%) and staff should be engaged to develop SOPs (20%). Additionally, it is necessary to simplify guidelines e.g. design pocket guidelines for a constant communication of SOPs,

outlined by interviewee #18. For an appropriate use of guidelines it is necessary to set up a regular monitoring system such as in Uganda where guidelines are displayed at work stations and published on posters, as mentioned by interviewee #19. Furthermore, guidelines need to be routinely re-enforced. On the other hand, sometimes there is a lack of financial resources (45%), which hinders adherence to SOPs e.g. there is no refrigerator vehicle available for a vaccine distribution, which results in a lack of motivation (50%) to follow guidelines, as stated by interviewee #12. Besides, there is a lack of training and HR capacity regarding the implementation and communication of guidelines (50%). In general it would be important to explore knowledge about IM and T&D for developing countries due to different organizational cultures and approaches to achieve a high relevance of guidelines.

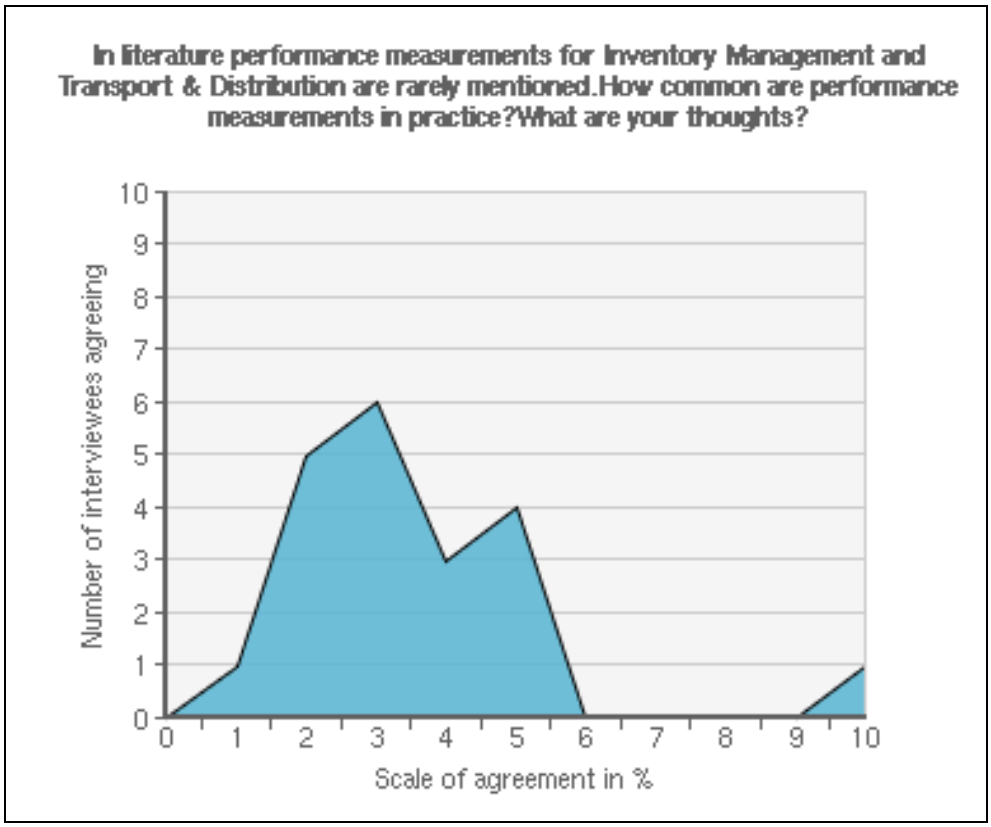


Figure 15: Scale of agreement for questionnaire question 11

The average scale of agreement is 36% that performance measurements are commonly used. ***The main challenges faced, are the routine collection and use of data and the lack of expertise and ability.*** The interviewees agree that performance measurements are not frequently used (55%), because of a lack of expertise and the capacity to measure and analyze data (15%). It is necessary to balance the work load and outcome of indicators (25%). Therefore, it is important to design the correct indicators, which are measureable, understandable and adjusted to suit the system, as highlighted by interviewee #13. Furthermore, it is necessary to have a regular, punctual and high quality data collection (40%). It is even more important to analyze and use the results of performance indicators for decision-making such as allocating budgets for

problems based on such results (40%), as stated by interviewee #17. Therefore process performance measurements should be designed, for example, running costs per kilometre, fuel consumption, available vehicle days, punctuality of orders, order fulfilment rates and stock-out rates, as suggested by interviewees # 7, #13 and #17. Interviewee #19 outlines Uganda's routine performance measurements, because the NLMS uses performance dash boards and employees fill out contributions for each day. The NLMS sets targets and measures these against actual performances. These results are published, e.g. for order fulfilment rate, and thus, employees are simultaneously motivated. However, some sub-Saharan countries have a low level of organizational transparency and there is neither accountability nor incentives to implement performance measurements (15%). But in general, performance measurements are very necessary, because transportation is a huge cost factor and it is crucial to deliver life saving drugs and thus, there is the obligation to make it more effective and as efficient as possible by monitoring performances and identifying bottlenecks, as outlined by interviewee #2.

Question 12:
There are a lot of trainings for Inventory Management and Transport & Distribution available and it is a critical topic, because the impact can't be measured.
What are your thoughts?

The two most important aspects are to provide on-site monitoring, supervision and follow-up training to make knowledge more sustainable by on-going performance measurements and support (45%) and to make training information applicable and adapt it to real world challenges (35%) in the specific work environment. Interviewee #8 outlines that recently a lot of donors are dissatisfied with the effectiveness of training and are looking for ways to upscale skills of people in innovative ways e.g. supervision or rotation. Training is only successful if the right instructors train the right audience (30%) e.g. interviewee #9 invites directors, supervisors and hands on staff to training seminars, and does follow ups and visits to check implementation difficulties. In order to provide applicable training, the whole organization should be involved with the aim of gaining a more structured change management approach (30%), as in-depth training for a few employees doesn't ensure changes, due to the same institutional cultures and dis-enablers. The management should be in support for improvements/changes and action should be taken (20%). It is necessary that tools and enablers for improvements are available and management strategies are adapted to training, mentioned by interviewee #18. Interviewee #2 outlines that if drivers make pre-drive checks, but can't repair defects, it will undermine the whole 'safe' training process. Additionally, it is necessary to train both procedures and background knowledge and to underline the impacts on the distribution network (20%), such as the connection between individual tasks and higher level responsibilities, as expressed by interviewee #13. On the other side interviewee #20 outlines that training in NLMSs and DLMSs are more important than on HC level, because most products need sophisticated knowledge and HC employees have different tasks and shouldn't be responsible for IM and T&D. In general, there is a lack of logistics and supply chain professionals, as stated by in-

terviewee #11 and transport planning, asset management, quantification and forecasting are seen as important training.

Question 13:
Research suggests that vertical programs are common due to the following reasons:
- **Smaller group of stakeholders within program**
- **Substantially lesser level of program coordination, collaboration, and political will necessary**
- **Lesser supply chain requirements for one commodity of drugs**
- **Financing method and source is separate**
- **Functions, which need to be managed centrally are overwhelming the systems in use**

What are your thoughts?

Important aspects of vertical programs are that there is a transfer of knowledge and capacity from such networks towards public health supply chains (40%) and that, integration **possibilities according to supply requirements (45%) are explored.** Interviewees demand more integration by segmenting commodities considering storage requirement, predictability, manufacturing facility and distribution cycles to redesign distribution networks according to optimal supply chains rather than according to funding methods. It is a huge challenge to integrate and collaborate due to specific procedures and equipment (30%), but it is worth the effort, as outlined by Interviewee #10. Interviewee #8 states an example in Sudan, where Global Fund trucks deliver medicines for 3-4 programs to RLMSs to leverage vehicle fleets utilization. However, interviewee #20 estimates an optimization potential of only 25%, due to continuous development. Interviewee #7 outlines that cost-savings are minimal regarding low utilization of trucks, but that it is more important to strengthen and improve deliveries and health systems. Interviewees have a different view about vertical programs and mention financing source (40%), weaknesses in public supply chains (20%) and global politics (10%) as reasons for establishing vertical programs. Interviewee #14 outlines that, HIV is a better campaign for global politics, than general strengthening e.g. PEPFAR by the US government. Some interviewees state that complex product requirements for HIV, TB or malaria, need more funds, more commitment and more expertise and receive this from vertical programs (15%). Although, interviewee #8 highlights that, funds from external donors can be used in vertical supply chains or in public supply chains, which is, however, dependent on its maturity. It is important that NLMSs have transparency across different programs and that programs are under surveillance of NLMSs. In Tanzania for example all programs are managed by the NLMS, which enables the use of a standardized, common LMIS and improves transparency. Interviewee #10 appreciates vertical programs because it is more reliable and effective and thus, has a higher impact. On the other side interviewee #9 is against vertical programs because it creates parallel systems with own distribution plans but same delivery locations. Interviewee #15 believes if funds of all vertical programs are consolidated, it would be possible to create a stronger single system and could

improve economies of scale. For a successful integration, the capacity of NLMSs needs to be built up into a pro-active holistic system. There are good examples such as Riders for Health, which distribute supplies for different programs on an emergency basis between DLMSs and rural HCs and collect data. But there are lots of challenges with this collaboration due to different funding mechanisms, as stated by interviewee #5. Interviewee #13 mentions another example in Liberia, where coordination is achieved by regular meetings of a supply chain technical working group.

4.2 Main Challenges for Medical Supply Chains

The research outlines main challenges, which were mentioned across all 12 questions from all 20 interviewees. The following table shows the frequency of challenges. Challenges were categorized according to a qualitative interview analysis and counted only once for each question and per interviewee.

Frequency of Main Challenges	
Human resource capacity and skills	78
General management and management of processes	72
Transparency and communication between levels	51
Budget planning	40
Physical capabilities and resources	36
Use of data for management decisions	25
Commitment and motivation	19
Accountability	12

Table 3: Frequency of main challenges

The table outlines that human resource capacity and process management are the most critical factors for a well-functioning IM and T&D. There is a lack of HR capacity to take care of all responsibilities. Interviewee #12 mentions research which shows that warehouse staff, including warehouse managers would do fulltime supervision in order to fulfil all their supervision responsibilities. Furthermore, there is a lack of skills and expertise. Focus should be on on-site training and supervision and should be applicable into practice. General management and management of processes are poor, which results in inefficiency and waste of resources due to unclear tasks and responsibilities e.g. vehicles maintenance. Processes are poorly displayed and enforced. Additional challenges are a lack of transparency and communication possibilities and inadequate budget planning and allocation of financial resources e.g. for transportation. These challenges include difficulties to communicate high quality and punctual data to higher levels and to transfer data into a WMS to achieve real-time consumption data at NLMSs. Understanding total costs would improve distribution because of realistic allocated budgets for particular supply chain steps. Afterwards interviewees highlight physical capabilities and resources of the health system such as tools, vehicles and warehouse infrastructure. The use of data for man-

agement decisions, commitment and motivation of staff and a lack of accountability is mentioned less. It could demoralize HWs and hinder the report of accurate and punctual data e.g. stock levels, if data is not used for decision-making and thus, HC stock levels don't improve. Besides, inaccurate data could worsen forecasting due to the bullwhip effect and additionally, there is a lack of responsibility and accountability within the public supply chain system.

The findings from the interviews highlight that the difficulties of the medical supply chain are more related to poor process management and leadership and human resource capacity, rather than to physical infrastructure.

5 Discussion and Recommendations regarding Medicine Availability

5.1. Recommendations according to Research Questions

As shown in the analysis, there are several main challenges for IM and T&D and thus, the following thoughts outline some areas along the supply chain for improvements. The interviewees highlight that management skills with defined responsibilities and roles and communication possibilities between different levels are the most important aspects to focus on rather than infrastructure and resources. With clear responsibilities and communication technologies, it is easier for employees to respond efficiently to the distribution network.

Due to a comprehensive literature review and the analysis of 20 semi-structured interviews with experts of medical supply chains in developing countries, the following section outlines recommendations and discusses challenges of IM and T&D and connects research question, literature, questionnaire question, findings and recommendations and presents it in a table relative to each research question. The tables are used to create clarity and give an overview about the main aspects.

Research Question	1. What are the reasons for stock-outs at health centres?
Literature	See Chapter 1.1.1. + 1.2.1.: • Complex system with public and private organizations • Procurement and distribution are separate functions with a poor, irregular communication and share of information, which hinders coordinated and efficient procurement and distribution plan • Waste of drugs due to inadequate storage, poor planning and forecasting • Funding constraints and insufficient data regarding demand
Questionnaire	Question 4
Findings from Interviews	• Four main reasons: poor forecasting and procurement, lack of communication and poor ordering data , poor supply chains and distribution and a lack of funding . • The extent of these challenges and contribution depends highly on the country specific health system.
Summary and Recommendation:	• Strengthen policies and SOPs regarding IM and T&D and define clear roles and responsibilities to strengthen health system sustainable • Enable responsible employees to fulfil tasks with necessary knowledge and physical resources • Strengthen communication possibilities of HWs e.g. mobile technology • Plan budgets appropriate and identify future financial constraints • Create a culture of transparency because only identified constraints can be tackled

Table 4: Findings and recommendation for research question 1

For research question one the most important aspects are to define strict policies with clear roles and responsibilities and to enable responsible employees by providing knowledge, communication possibilities and physical resources and to create transparency in order to identify future bottlenecks and thus, prevent stock-outs.

Research Question	2. Why is inventory management challenging and are there physical warehouse infrastructure constraints?
Literature	See Chapter 1.2.1. + 1.2.2: • Need appropriate conditions regarding security, temperature, state and storage areas. • Lack of funding and lack of management procedures (FE-FO, forecasting) • Tiers in supply chains tie up financial resources • Necessary funding for HC to resupply and pay for medicine • HCs face constraints regarding communication, storage, transportation and funds for resupply
Questionnaire	Question 2 + Question 3
Findings from Interviews	• Physical infrastructure implies storage capacity, temperature control and raking possibilities • Management constraints include lack of expertise of HR, appropriate operational processes and use of warehouse data for management-decisions • Tracking accurate stock levels throughout the network is challenging due to a lack of data transparency, systems and management processes and HR-capacity
Summary and Recommendation:	• Strengthen policies and SOPs regarding warehouse management processes and define clear roles, responsibilities and accountability; encourage following SOPs • Consider impact of purchase and delivery frequency regarding reduced stock levels and capacity requirements • Consider increasing efficiency and reduced costs for infrastructure and support by eliminating tiers in distribution network • Use of new technologies such as barcodes to integrate stock management activities automatically into the LMIS and tackle challenges regarding goods in transit and real time tracking; facilitate work for employees • Provide supervision for HWs to increase understanding, importance and impact of recording • Further research about VMI within public health systems • Future research to explore and build up understanding of costs regarding warehousing and e.g.. impacts of delivery frequency

Table 5: Findings and recommendation for research question 2

For research question two it is suggested that communication and tracking possibilities could be improved with the use of new technologies, that human resource capacity and capability can be strengthened with training and supervision and that knowledge about new approaches such as VMI and about costs should be increased, such as the impact of delivery frequency and thus, improving inventory management.

Research Question	3. What are the reasons for inaccurate orders from health centres and what are the challenges involved in collecting consumption data?
Literature	Chapter 1.2.2. + 1.2.3. + 1.3.2.: • Lack of HR expertise at HCs for quantification, limited on-going supervision and support, different reporting requirements for commodities • No real-time data available; usually issue data instead of consumption data from order forms or expensive on-off monitoring instead of regular point of sale/dispensing enquiries • HC is often located in a rural area with access constraints and poor communication technology • Lack of electronic communication technology, standardized process forms and skilled staff for the use of LMIS, which enable and facilitate capturing quality data from the point of consumption
Questionnaire	Question 5
Findings from Interviews	• Main challenges for consumption data collection include transportation and technology; a lack of HR capacity and commitment; quality of data and use of available data for decision-making
Summary and Recommendation:	• Incentives to create transparency and focus regular monitoring within management and front-end staff, that data can be used for informed decision-making • Explain background information to HWs and provide HWs with supervision and pocket guidelines, (preferable with icons than with text) • Dedicated employees should be responsible for quantification, because HW's are not the appropriate person to calculate resupply quantities • HCs should only report actual stock levels, preferable on an electronic way, which feeds into regular LMIS and is easy to use e.g. automatic transfer of actual consumption data immediately when used • ´New technologies such as mobile technology, barcode scanner or RFID could be used for communication and data transfer • Electricity constraints can be tackled by phones with solar phone charger or maybe in future with solar energy phones (prototype available) • Future research about well-functioning ordering approaches to build up broader intelligence

Table 6: Findings and recommendation for research question 3

For an efficient collection of consumption data in research question three it is recommended to focus on regular monitoring and training for staff, to hire dedicated employees for quantification and forecasting and use new technologies such as mobile phones and solar electricity to enhance efficient communication, real time tracking and data transfer. Future research should build up a broader intelligence about well-functioning ordering approaches.

Research Question	4. What transportation systems are in use and what are the challenges?
Literature	Chapter 1.1.1. + 1.3.1. + 1.3.2.: • Weakness of governmental distribution network and lack of efficiency • Private companies face lack of appropriate vehicles and capacity • Collection could face long travel distances, lack of HR; lack of funds for transport • Structural or political barriers about outsourcing e.g. capability of 3PL,communication to HCs, potential conflicts, costs, limited reach for rural areas and market restrictions • Supply chain entities are fragmented and competing and thus, collaboration difficult
Questionnaire	Question 7 + Question 13
Findings from Interviews	• Major improvement is to set up transport policies and transport management systems • Collection: HC needs funds for transportation, introduction of a high variability and complexity • HC have the lowest level of capacity and infrastructure e.g. lack of bulky transportation possibilities, weak transportation packaging • Distribution is not a core competence in the health sector • Necessary to have a well maintained and managed vehicle fleet and ties up time and resources • Outsourcing parties can leverage costs, operate more cost effective and more efficient • Political constraints and difficulties to find appropriate 3PLs and have appropriate contract management • Main reasons for vertical programs: funding source, dysfunctional public distribution network, global politics • More available funding, more commitment and more expertise for more complex product groups within vertical programs • It is important that the NLMS has transparency across all the different programs • Transfer of knowledge and capacity from vertical programs towards public supply chains, but integration and collaboration is challenging due to specific procedures, and specific equipment • It is necessary to segment commodities according to requirements and analyze and identify integration possibilities such as storage requirement, predictability, production location or distribution cycles to redesign supply chains according to optimal supply chain rather than according to funding source
Summary and Recommendation:	• Considering country specific political systems and situations and thus, set up a strict distribution network • Well-functioning transport management systems need strong political involvement, clear responsibilities and roles, good supervision systems and adequate budgeting by considering total costs of transportation • Therefore the whole logistics systems should be redesigned for an optimized way in a pro-active holistic system • Management should be centralized and should be under surveillance of MOH or NLMS, which enables the use of a standardized, common LMIS and improves transparency

Table 7: Findings and recommendation for research question 4

A well-functioning transportation system depends on country specific situations and political structures, therefore it is suggested to set up a strict distribution network and transport management system with strong political involvement, clear responsibilities and roles, good supervision systems and adequate budgeting by considering total costs of transportation.

Research Question	5. What are the challenges regarding delivery from warehouses to health centres?
Literature	Chapter 1.1.1 + 1.3.1. + 1.3.2.: • For an effective delivery system the amount of vehicles is insufficient due to limited funds for vehicle purchase, maintenance and repair, fuel and driver salaries. • Vehicle is used for different purposes and in-house vehicle fleets struggle with high costs and low utilization • Orders occur ad-hoc; lack of predetermined delivery schedules • Last mile distribution faces challenges such as staff shortages and low salaries; limited capital to cover distribution operating costs and limited transportation, power, and communication infrastructure
Questionnaire	Question 6 + Question 8
Findings from Interviews	• Main challenges regarding delivery according to plan are availability of a vehicle fleet, capacity for delivery scheduling, financial budgeting and external conditions • Lack of planning and budgeting for transportation such as the allocation of funds for fuel or maintenance
Summary and Recommendation:	• Focus on a holistic perspective of the supply chain with early and precise budgeting and to raise the awareness of total costs for transportation, especially for the last mile distribution • Countries need to set up a transport management system and transport policy with clear roles, responsibilities and accountability • Budgets with realistic earmarked line items for fuel, drivers salaries and maintenance and thus, have the possibility to identify future funding constraints for transportation • Planning delivery decentralized to achieve optimized and efficient schedules with the possibility to adjust it • Future research should analyze inventory policies and resupply possibilities

Table 8: Findings and recommendation for research question 5

Research question five regards the challenges of distribution from warehouses, where it is recommended that the planning of deliveries is decentralized, taking into consideration, transportation resources, the planning of budgets with earmarked line items in advance, considering total costs and the setting up of a strict transport policy to ensure a reliable transportation.

Research Question	6. Why is it challenging to keep and maintain a vehicle fleet?
Literature	Chapter 1.3.1 +1.4.2.: • A lack of maintenance know-how leads to a shorter vehicle life cycle and wear and tear-damage • Small health care budgets and high costs make the need for an efficient transport management obvious
Questionnaire	Question 8 + Question 9
Findings from Interviews	• Physical constrains include available spare parts and a lack of HR with the required skills and expertise for maintenance • Lack of financial resources for maintenance activities • Management constraints involve a lack of regular maintenance due to cultural issues to be aware of the benefits of preventive maintenance and no incentives to create transparency • Data e.g. from log books is neither analyzed nor action is taken • Poor communication between management and staff to report maintenance necessity
Summary and Recommendation:	• More focus on transportation and vehicle maintenance, which is necessary to use vehicles more efficient and reach patients • Train and raise awareness of importance of a good preventive maintenance activities on management level, as well as on staff level and allocate financial resources • Implement easy processes to clarify communication such as letter box for maintenance requests • Define vehicle fleet system and transportation policy, which monitors indicators, publishes and compares results to targets • Coordination between procurement and transportation manager to identify suitable vehicles for surrounding with available spare parts and skills for maintenance

Table 9: Findings and recommendation for research question 6

For a well- maintained vehicle fleet in research question six it is suggested to raise awareness of importance about good preventive maintenance, implement a clear communication possibility for requesting maintenance activities, set up a transportation policy and define a training and monitoring system to build up maintenance expertise.

Research Question	7. Why is the use of Standard Operating Procedures (SOP's) and performance measurements so challenging?
Literature	Chapter 1.4.1. + 1.4.2.: • Supervisors are supposed to assess stock management and resupply calculation, but visits are often ad-hoc and too infrequent. • Operation management should specify in a policy the day-to-day use of resources such as vehicles and identify responsibilities
Questionnaire	Question 10 + Question 11
Findings from Interviews	• Guidelines often exist, but guidelines are not always followed • It is necessary to have relevant guidelines as a reference for staff to know what they are supposed to do • Management doesn't enforce adherence of guidelines, there are no incentives or accountability • Lack of expertise and training regarding the implementation and communication of guidelines to measure and analyze data because employees are health professionals • Lack of capacity of human resources or financial resources • Monitoring performance of transportation and distribution is crucial to know where difficulties along the supply chain are and thus, address it • The interviewees agree that performance measurements are not frequently used • Necessary to balance the work load and outcome of indicators • Important to design right indicators, which are measureable and understandable • It is necessary to have a routine, timely and high-quality data collection • Analyze and use results of indicators for decision-making and thus, change and improve the health system
Summary and Recommendation:	• Raise awareness about importance of guidelines and standardization; management needs to be a model and encourage employees • Explain reasons of guidelines and performance indicators and impact regarding the whole supply chain • Focus on process performance measurements to have a feedback regarding the single steps • Display results and compare them to targets, set incentives to achieve targets • Guidelines should be adapted for each level and each job in the supply chain and displayed • Simplify guidelines e.g. design pocket guidelines and posters for work stations with icons for a constant communication of SOPs • Define responsibilities and tasks and set up a regular monitoring and supervision system • Set up a good supervision system e.g. with feedback loops between HWs, DLMS and NLMS to enhance transparency •Future research about the right incentives and approaches for changes e.g. Financial incentives such as bonuses or personal incentives to develop a sense of ownership such as 'Best Employee of the months' • Future research to build up knowledge about IM and T&D in the context for developing countries due to different cultures and approaches to achieve a high relevance of guidelines

Table 10: Findings and recommendation for research question 7

For the use of SOPs and performance indicators in research question seven it is recommended to focus on the importance of guidelines, standardization and performance measurements, to simplify guidelines and to set up a regular monitoring and supervision system, in order to re-enforce adherence to SOPs and create accountability with defined tasks and responsibilities. Furthermore, future research should focus on financial and personal incentives within public health systems.

Research Question	8. What form of knowledge transfer and training would be helpful?
Literature	Challenges about trainings aren't mentioned in reviewed literature
Questionnaire	Question 12
Findings from Interviews	• First of all there is a need for logistics and supply chain professionals • Background information such as the connection between own tasks and responsibilities to tasks of higher levels and reasons and impacts on the whole supply chain system • On-site monitoring, supervision and follow-up training to make knowledge more sustainable • Make training information applicable to own work environment • Tools and enablers for improvements need to be available and management strategies needs to be adapted to the training content • Trainings are only successful if the right instructors train the right audience
Summary and Recommendation:	• Whole organization should be involved to have a more structured change management approach • Important to raise awareness about best practice, tools, approaches and the different in-country supply chain network • Set up training in rotation between theoretical knowledge and practical knowledge with on-site monitoring and supervision • Introduce 'Continuous Improvement Process' (CIP) into day-to-day work and set up a communication possibility between front-end staff and management e.g. Letter box • Set up training requirements and plans with check boxes for each position within health system and train people accordingly to enhance transparency about received and necessary trainings

Table 11: Findings and recommendation for research question 8

For research question eight concerning necessary training, it is suggested that it is vitally important that innovative ways of making training applicable for the individual work environment are built up and that this involves the whole organization. For example, training in rotation between practical terms and theoretical terms, implementing training plans per position, introduce 'Continuous Improvement Processes' (CIP) and the providing of easy access information with pocket guidelines and posters.

In general stakeholder should focus on well-functioning transport management systems and inventory management policies, with strong political involvement, clear responsibilities and roles, good supervision systems and training and adequate budgeting to enhance the health system.

5.2. Good Practice Examples and Thoughts

The following examples of good practise throughout Africa should give all stakeholders food for thought to improve particular steps along the medical supply chains and bring evidence that well-functioning approaches exist and are in use.

There are many good examples of NLMSs such as in Botswana and Zambia, both of which are outsourced to Crown Agents. The NLMS in Botswana is a well organized warehouse regarding physical, informational and management processes, which was able to gain the ISO-certification for quality management, as stated by interviewee #14. These examples show that clear management processes and expertise positively influenced warehouse infrastructure. Interviewee #8 suggests changes in the practice of annual purchases and deliveries due to a lack of storage

capacity, because a more frequent delivery and purchase practice could decrease safety stock levels, storage capacity and waste of medicine due to expired products. Furthermore, interviewee #17 states that by eliminating a tier in supply chains, efficiency could increase, costs for infrastructure, support and staff could decrease, but this is difficult due to political reasons.

Interviewee #1 outlines a basic and straightforward approach for orders, which functions well in Madagascar where medium remote HCs make a phone call one week before delivery and report stock levels. Stock levels are compared to previous deliveries, consumption is calculated and thus, the order generated and delivered. The National Medical Store in Uganda works with a WMS, which manages stock, orders, incoming dates, expiry dates, location of stock and deliveries. However, everything is still manual and there are some challenges regarding goods in transit due to a lack of real time tracking, as mentioned by interviewee #19. There are great examples of new technologies, which help to keep accurate stock levels and support communication between levels. Interviewee #10 states SMS as another straightforward and easy order system, which is in use for vaccines. For essential medicines it is more challenging due to the number of products. And interviewee #5 agrees that even with smart phones it wouldn't be that easy to keep track of such a big stock with so many commodities. Nevertheless, the Community Stock (cStock) in Malawi uses mobile phone technology to improve stock management processes, outlined by interviewee #2. HWs send stock levels via SMS, data becomes available in a visible data base and thus, consumption data flows upwards in the supply chain. Furthermore, there is more confidence for HWs, because, HWs receive a text, which confirms that stock is available for resupply. The Dedicated Logistics System in Mozambique is a vendor managed vaccine distribution approach, which collects data during the monthly delivery at HCs and uploads data into the cloud via an open-source eLMIS application (VillageReach, 2013b). Likewise, the Rapid SMS approach for maternal and neonatal child health care in Nigeria uses SMS to send demand data to a central dash board and order a resupply. The same approach is used for bed nets in Nigeria, which is helpful, but it isn’t integrated into the regular stock management system and thus, the order bypass the LMIS and doesn’t strengthen the health system, as stated by interviewee #18. Ideally, the use of bar codes and a connected LMIS to automatically integrate stock withdrawals into the system would be most effective. There are many innovative solutions available, which can improve real-time and two-way communication (UNICEF, 2012), but there is often a lack of coordination, as stated by interviewee #18. Coordination would improve visibility within the whole health system and ease reporting of data due to a standardized and common approach (VillageReach, 2012).

Vendor Managed Inventory (VMI) is a concept, which could be used in the public health sector with a broadened definition. "Vendor" is an external party, which takes over a consignment warehouse for multiple suppliers or provides some additional services. VMI-systems could have benefits regarding a reduction of inventory, a decrease of distribution costs and an increase in commodity availability. VMI has particular advantages because inefficiencies could be tackled. However, for a VMI approach a health system needs a functioning LMIS, the health commodity needs reliable funds and high demand predictability, the third party must be capable and stake-

holders need to have the mindset and openness for information sharing and transparency in regard to their partners (USAID, 2012b and Watson et al., 2012). Interviewee #14 outlines good examples for VMI such as in Nigeria and Malawi, where the laboratory system is managed externally. In South Africa, a third party acts as a VMI provider between multiple HIV suppliers and the health system. In Tanzania a third party is responsible for inventory replenishment by technical assistance e.g. by setting up processes, providing reminders and building up capacity.

Another part of the supply chain is T&D. A good example of a well managed delivery is outlined by interviewee #5, where Riders for Health makes the last mile deliveries for HIV/ARV commodities in Nigeria via a truck in a two monthly cycle. Interviewees #16 and #17 both mention an example of Tanzania, which is scaling up region by region to deliver direct from NLMS to the 5000-6000 HCs. Another approach is the DTTU in Zimbabwe, which combines first mile data collection and last mile distribution. Due to this, product availability increased to 95% because transport, supervision and information were all connected. Interviewee #17 states that creating a single supply chain with punctual and accurate data collection from dedicated personnel generated savings, because there is less training necessary for HWs.

Interviewee #1 outlines an approach for collection in Madagascar where small businesses sell drugs to HWs from small resupply points close to the communities. One requirement is that HC are open during collection. Interviewee #7 outlines the Drug Revolving Fund in Nigeria in Kano State, where HCs have funds for transportation, because of a mark up on the selling price. HCs submit order forms and collect drugs at DLMSs (MIT Zaragoza, 2010). For collection it is important to create mobility amongst HW's. Interviewee #4 outlines that in Madagascar Transaid improves the mobility of HWs for transportation with bicycles, which has a positive impact on stock levels due to replenishment possibilities.

There are possibilities around outsourcing to 3PLs to build up capabilities such as in Zambia and Uganda, where good 3PLs in the private sector are available, as mentioned by interviewee #2 and #19. Interviewee #14 highlights another good example in South Africa where a private sector organization is responsible for HIV delivery to HC level and has excellent operational processes. Interviewee #12 states examples for outsourcing such as the Clinton Health Access Initiative, who is doing a project with Coca-Cola, and who provide their vehicle fleet to deliver medicine from RLMSs to DLMSs. Furthermore, there is a performance based agreement with the World Bank, where it creates an earmarked budget for distribution and supervision for RLMSs and makes performance based payments for implementing distribution and supervision plans. In addition, interviewee #6 mentions a good example in the private sector such as in Arusha in Tanzania, where there is a large concentration of retail pharmacies, which transport medicines to all parts of the country and organize their distribution as a good network, by using public transport and their own vehicles.

Other good approaches for medicine delivery are innovative public-private partnerships, because they bring a level of professionalism and capability. An example stated by interviewee #4 is the emergency transport scheme in Nigeria, where commercial transport workers volunteer to carry pregnant women to hospitals in medical emergencies. This innovative approach was set

up between Transaid and the National Union of Transport Workers. Another public private partnership between Coca-Cola and the MOH in Tanzania became known as the Last Mile for Medicines partnership, whereas Coca-Cola built up expertise in the public health sector regarding processes and tools, human resources and delivery to HCs. Therefore a close coordination is necessary to ensure translation of Coca-Cola tools and approaches into the operations of the NLMSs (Wong, 2012).
Additionally, there are situations where inventive approaches need to be considered, e.g.in extreme environmental conditions. Interviewee #2 mentions a trial with a hovercraft, which is designed to work during the rainy season in Madagascar and in order to make the use of it sustainable for medical supply, commercial opportunities are tested out. The private sector could influence the public health system by increasing efficiency and effectiveness of supply of products and by broadening the knowledge about best practices (Rockefeller Foundation, 2008). The difficulty is to scale up innovative public-private partnerships to other countries and conditions (Wong, 2012).

Complimentary processes such as guidelines, performance measurements and training is as important as physical infrastructure and management processes. Uganda's NLMS uses and follows inventory management and transport and distribution SOPs throughout the NLMS with regular reviews every three years or when required. Furthermore, employees are trained in the relevant guidelines and these are displayed at work stations, published on posters and performance dash boards are in use, as outlined by interviewee #19. Interviewee #9 expresses the use of guidelines within immunization in Benin, because there are clear SOPs regarding storage requirements and temperatures per vaccine and SOPs for each type of refrigerator if it breaks down. Interviewee #12 outlines the monitoring plan in Mozambique, which has 27 indicators of stock accuracy, performance of provinces and their ordering/fulfilment behaviour, as well as information about the punctuality and quality of reports.

In regard to training, interviewee #8 outlines the focus on orientation, on-the job training and ongoing performance measurements with incentives. Interviewee #10 states the Malawi pharmacist training as a good example, where 60 pupils study for two months and rotate between theoretical terms and practical terms as interns in HCs. The training includes supervision and follow-up training as well as basic knowledge about logistics and the impact of activities. Interviewee #12 highlights plans for a new approach in Mozambique, where training in supply chain management as a university course degree is offered. Likewise, the MOH plans to develop a job for supply chain professionals within the MOH, because 75% of pharmacists work in logistics instead of health services. Therefore, it is necessary to build up professional logisticians in developing countries with innovative approaches.

There are several good practice examples for inventory management such as VMI, for communication possibilities such as mobile phones, for transportation possibilities such as delivery, outsourcing or public-private partnerships, for the use of guidelines and performance measurements and for innovative training approaches, but it is still a relatively underdeveloped area.

5.3. Discussion of Findings and Recommendations

The analysis and recommendations outline that there is a difference between the literature and the semi-structured interviews from experts of the medical supply chain. The challenges within the literature focus on constraints in infrastructure such as storage space, rather than the findings of the interviews, which highlight a lack of human resource capacity and skills, management constraints and poor process management and poor transparency and communication between levels. This is an important point for policy makers and donors to decide in which area financial resources and knowledge should be focused, which implies the question of whether there is perhaps an incorrect focus. If the focus is set on processes, leadership and management skills or software implementations, why are there only a few well-functioning examples and why is best-practice knowledge and good examples not widely spread? Is it due to the nature of complex medical supply chains with their several thousand health facilities? On the other side private companies have a reliable distribution network such as Coca-Cola, so why is it so challenging for the public health sector? The role of the private sector is not as easily identifiable as it seems at first, due to the differences in transportation requirements and experts are cautious about outsourcing. It should be possible to outsource delivery even to rural areas as it is possible for Coca-Cola to deliver their products to such areas and thus, innovative solutions such as the ColaLife project is a good example and should be focused on. However, commercial supply chains are different from medical supply chains due to access constraints, security constraints, traceability and the value of products and often its run by governmental monopolies, which hinder small-scale business model innovations (Yadav, 2013). Uganda outsources their deliveries successfully. But why are there not more examples of successful outsourcing and why is knowledge so poorly shared? The problem within the medicine sector is the unpredictability of demand and a lack of market research (Yadav, 2013). But why is it so difficult to predict demands and forecast quantities considering actual demand data, population and seasons for epidemic diseases and to be able to learn from previous periods? It is necessary to establish a more realistic planning. But where are the constraints for planning and organizational transparency? Is it because of a lack of uncertain processes such as emergency order points, human resource capacity and expertise such as dedicated personnel or poor communication possibilities? Is it possible to collect data during resupply? In practice there are more challenges than just the collection of consumption data. It is more about the use, adjustment and quality of data e.g. if reports are missing, it is necessary to calculate total estimated consumption or adjust consumption due to unmet demand (USAID, 2012a). And why is distribution challenging? Is it challenging

due to a lack of defined processes and management approaches such as the use of individual lead times, quality and quantity of available transport or appropriate planning considering total quantity, weight and volume, of supplies?

Furthermore, there is a lack of performance measurements and a lack of accountability. Is there a lack of accountability due to a lack of high-quality data, lack of defined processes, not enough capacity and management time or is it the physical distance to HCs regarding supervision? Interviewee #10 outlines that for a vaccine distribution program run by VillageReach, which is combined with the public sector, log books are used in only the vehicles owned by VillageReach, and are regularly updated and checked, in comparison to the other half of the vehicles which are owned by the government and do not emphasize or control the use of log books. The question is why there is a lack of accountability and whether is it changeable. And why are policies and SOPs rarely followed? Are SOPs rarely followed due to poor communication or due to a lack of training or inefficient training? And why is there a huge staff turnover within departments of the MOH? Do employees change departments due to political reasons? Is it possible to tackle a high staff turnover such as in Mozambique by connecting the profession as a HW or as a logistician with the job description and have job performance measurements with the correct incentives? If there are no performance measurements for employees, is there the possibility of training and controlling employees? Might it be a possibility to achieve a better performance with financial and personal incentives or does the public health system have too rigid a governmental structure regarding salaries and promotion There is evidence from OECD countries that the public sector do not perform as well as the private sector regarding performance based measurements due to these structures.

There are clearly many different options to improve a health system, but all need funding, political will for reformations, sufficient technological and organizational capacity to implement needed changes. Furthermore motivation and will of the employees who have to work with these changes is vital in order to reform and improve the health system (Rock Kopczak et al., 2011, p.235 pp.) Therefore, there should be a strong focus on minimizing negative impacts due to human resource capacity and skills, management and management processes, transparency and communication between levels, budget planning, physical capabilities and resources, commitment, motivation and accountability and the use of data for management decisions.

There are different thoughts and aspects, which need to be considered to design a strong IM and T&D network. As seen there are recommendations and good practice examples, but there is still a gap in many countries, thus the question remains why it is so difficult to improve medical supply chains. Therefore raised questions should be kept in mind, while analyzing a particular country with individual structures and situation and while designing an appropriate inventory management and transport and distribution network.

5.4. Future Research

Future research should build up knowledge about IM and T&D for countries in a developing condition, because such knowledge is relatively underdeveloped due to different organizational cultures and different approaches in sub-Saharan Africa, as stated by interviewee #4. It is important to investigate change management approaches and correct incentives such as financial or personal incentives for developing countries. Public-private partnerships and the engagement of private companies within the public health supply system need to be further explored and knowledge about possibilities and approaches shared e.g. for resupply and ordering, as stated by interviewee #16. For example, for a more efficient delivery, packaging of vaccines could be standardized or new cooling equipment developed, such as that which uses solar energy. Another topic for future research is the use of new innovative technologies such as solar powered mobile phones or chargers, mobile technology and identification technology such as bar codes and RFID. Interviewee #5 suggests that the most important thing to explore is to build up understanding of total costs such as warehousing and transportation for realistic allocation of financial resources. The way forward is to redesign supply chain systems and learn from countries, which have outsourced functions of the supply chain or optimized their distribution network (Zaffrana et al., 2013). Any approach with a close collaboration between different stakeholders will need to have its basis in information transparency, a willingness to work together in a sustainable way and the sharing of information to ensure success and strengthen the health system (Watson et al., 2012).

Future research should explore and build up understanding of costs and possible approaches, incentives and change management approaches regarding IM and T&D in the context of sub-Saharan Africa.

6 Conclusion

The major objective of this research is to identify challenges for reliable medicine supply chains with effective in-country distribution systems regarding the medicine availability due to inventory management and transport and distribution.

This research includes a literature review about the challenges of medical supply chains in sub-Saharan Africa and compares literature to findings of 20 semi-structured interviews with experts of medical supply chains. In total there were 16.5 hours of interview material audio recorded and analysed. This comprehensive research is the first to compare literature to findings from semi-structured interviews, to identify the main challenges, to outline good practice based on country specific examples and to recommend approaches to improve medicine availability based on supply chain challenges.

Literature identifies the difficulties of the medicine supply chains of African countries; whereas the main challenges are poor information, communication and consumption data, inadequate storage facilities and a lack of management procedures. The challenges include selection and quantification of demand, a lack of transparent procurement procedures, inadequate storage facilities and capacity, lack of guidelines for good storage procedures, a lack of appropriate planning, monitoring and evaluation and inadequate budget allocation.

The interviews outline that human resource capacity and process management are the most critical factors for a well-functioning IM and T&D. There is a lack of HR capacity and expertise to take care of all responsibilities. Training should focus on on-site training and supervision and should be applicable into practice. General management and management of processes are poor, which results in inefficiency and a waste of resources due to unclear tasks and responsibilities and processes are poorly displayed and enforced. Furthermore, there is a lack of transparency and communication possibilities such as the transfer of punctual data to higher levels. Inadequate budget planning and allocation of financial resources could be improved by a better understanding of total costs. Physical capabilities and resources of the health system were mentioned less. Likewise, the use of data for management decisions is poor and there is a lack of responsibility and accountability within the public supply chain system.

The research identifies recommendation based on a comprehensive literature review and findings from interviews with experts. In general, stakeholders should focus on well-functioning transport management systems and inventory management policies, with strong political involvement, clear responsibilities and roles, good supervision systems and adequate budgeting. Examples include aspects such as building up knowledge in innovative ways, providing easy access information, creating awareness about the importance of guidelines and standardization, designing appropriate process performance indicators, focusing on regular monitoring, hiring

dedicated employees for quantification and using new technologies to enhance efficient communication, real time tracking and data transfer.

There are clearly many different options to improve a health system, but in summary, a strong inventory management and transport and distribution approach needs appropriate tools, management skills and human resources with logistics expertise and capacity, all of which are challenging requirements considering the situation of developing countries.

There are open aspects and thoughts to discuss, why a strong IM and T&D network is so difficult to develop, because there are recommendation and good practice examples, but there is still a gap in many countries. So the question remains, why it is so challenging to ensure medicine availability at HCs. Therefore, particular countries need to be analyzed regarding individual structures and situation and an appropriate inventory management and transport and distribution network needs to be designed.

Future research is necessary to build up an understanding of total costs such as warehousing and transportation, of inventory policies for resupply and ordering approaches, of vehicle fleet and maintenance activities and of the use of new innovative technologies. Furthermore, change management approaches in developing countries and the correct financial and personal incentives, needs to be investigated.

There are always reasons such as organizational culture, funding constraints due to economic crises or lack of expertise to hinder changes, but never before has there been a better time to work together in order to strengthen the health systems in developing countries. Improving medicine availability is crucial in order to meet the targets of the eight Millennium Development Goals by 2015. There is international expertise within the health care community and beyond, who is able to tackle these challenges, transfer knowledge and implement sustainable redesigned supply chains and improve the health systems in developing countries. This in turn improves medicine availability for patients and thus, improves life in sub-Saharan Africa.

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Appendices

- Appendix A: List of essential medicine and transportation requirements
- Appendix B: List of interviewees
- Appendix C: Questionnaire

Appendix A: Essential Medicine List with Commodity Characteristics

Category	Commodity/Clinical Use	Characteristics
HIV/AIDS	**Chronic Treatment**	
	Antiretrovirals (ARVs)	• Requires long-term supply commitment, as cure does not yet exist • Requires > 90% adherence to ensure efficacy and reduce resistance • Requires complex clinical component for monitoring • Scale of needed financing substantial, despite price reductions • Potential social stigma associated with use • Substantial global financing sources available for procurement
Malaria	**Acute Treatment**	
	Artemisinin-based combination therapy (ACT)	• Unit costs reduced in last several years (~$U.S.1.00 landed cost in-country as tablets in blister packs per adult treatment (MMV 2005) • Fixed dose combination, which is effective against existing drug resistant strains • Have no negative pharmacological interactions, are well-tolerated, and show acceptable toxicity • Suitable for use in children and pregnant women • Short shelf life, resulting in the need for a short logistics pipeline • Substantial global financing sources available for procurement
Reproductive Health	**Chronic Treatment**	
	Contraceptives	• Ability of clients to choose among a variety of methods important for use and adherence • Limited range of available products • Wide range of couple-years of protection (CYP) costs between methods • Wide range of side effects among methods • Potential social and political stigma associated with use • Growing demand for modern contraception • Limited global financing available for procurement
Tuberculosis	**Semi-chronic Treatment**	
	Treatment Antibiotics	• Infection resistant to standard drug treatment (multidrug-resistant tuberculosis (MDR-TB) may result in need for multiple products • More effective medicines are coming through the research and development pipeline • Current treatment course of 6 months leads to low adherence and fosters development of drug resistance • Complex laboratory and monitoring component • Limited global financing sources available for procurement (Stop TB 2005)
Vaccines[5]	**Semi-chronic Treatment**	
		• Sensitivity to heat, humidity, and fluctuations in temperature require cold chain supply management • Packaging of newer vaccines (e.g., bulky, single dose) present challenges to existing storage and cold chain capacity in LDCs[6] • Predictable demand forecasting for routine immunizations • Substantial global financing (e.g., UNICEF, PAHO, GAVI) available for procurement • High cost effectiveness when comparing price and health impact • User fees may be barrier to uptake (i.e., routine immunization, preventative, not curative) (WHO 2001) • Limited private sector market in low-income countries • Limited number of producers

Table 12: Characterization of selected essential medicine, USAID, 2008a

Appendix B: List of Interviewees

- Caroline Barber, Head of Programmes, Transaid
- Chris Wright, Senior Technical Advisor, John Snow, Inc.
- David Sarley, Senior Program Officer, Gates Foundation
- Deepti Tanuku, Senior Program Officer, Johns Hopkins Program for International Education in Gynaecology and Obstetrics
- Gary Forster, Chief Executive Officer, Transaid
- Hamadou Dicko, Supply Chain & Community Health Advisor, Agence de Médecine Préventive
- Jeff Mecaskey, Partner, Health Partners International
- Jeffrey Turner, Visiting Lecturer and Independent Consultant, Institute for Transport Studies, University of Leeds
- Kameko Nichols, Partnership Director (Africa),Riders for Health
- Kevin Pilz, Health Commodity Advisor and Director of Planning and Cooperation, Central Medical Store, MOH Mozambique
- Leah Hasselback, Country Director in Mozambique, Village Reach
- Luke Rooney, Global Program Manager, Clinton Health Access Initiative
- Maeve Magner, Chief Executive Officer, RTT Trans Africa
- Musonda Kasonde, Capacity Development Specialist, Supply Division, UNICEF
- Noel Watson, Executive Director, OPSMend
- Norbert Kasingwe, Transport and Logistics Officer, National Medical Store, Uganda
- Olivia Reyes, Senior Associate, Rabin Martin
- Philippe Jaillard, Immunization logistics program leader, Agence de Médecine Préventive
- Prashant Yadav, Senior Research Fellow and Director of the Healthcare Research Initiative, William Davidson Institute at the University of Michigan
- Simon Weeks, Technical Assistant, Transaid

Appendix C: Questionnaire

Questionnaire: Inventory Management and Transport & Distribution of medicine supply chains in developing countries. Challenges and Reasons

Dear participant,

This questionnaire is designed to identify challenges of medicine supply chains regarding the medicine availability due to inventory management and transport and distribution.

I'm undertaking a literature review and qualitative assessment to highlight examples of challenges and best practises relating to the distribution of essential medicines and vaccines in sub-Saharan Africa. The research will also cover the role of inventory management in ensuring consistent availability of medicines at patient level.

The literature review is now 60% complete, and is, we believe, potentially the first time that so much material has been gathered on the subject of distribution. The next stage is to ensure that I have captured all of the relevant research on the subject, and secondly to interview key stakeholders with practical experience vis a vis medicine/vaccine supply chains in the sub-Saharan Africa context.

It is part of my master thesis at the University of Westminster and I'm working in a close collaboration with Transaid. Transaid is an international development charity, which identifies, implements and shares local transport solutions to improve access to basic services and economic opportunity for people in Africa and in developing countries.

The questions have three parts, which I would like to discuss in an oral interview / in a chat. The questionnaire acts as a guideline. If you can't answer a question, I would suggest we go forward to the next topic.

1. Scale of Agreement / Scale of Challenge
2. Reasons for situation / Impact on medicine availability / Your thoughts
3. Example of good practice

If you agree, I would like to audio record the interview.

Many thanks for your participation.
Best regards,
Anna Schöpperle

Organizational data:

1. **Could you please briefly summarize your background and experiences?**

Name:

Title:

Organization where you are currently working or worked for:

Country/Regions where you have experience:

Projects you worked for:

2. Do you agree that **warehouse infrastructure** is not adequate according to the storage requirements for drugs?
   What would be the most important improvement?

0% 100%

3. How challenging is it to **keep track** of actual and **accurate stock levels** on ...

   a.) National level?

0% 100%

   b.) District level?

0% 100%

   c.) Health Centre level?

0% 100%

... and **why is it challenging**?

4. The literature say that **stock outs** of essential medicine is a regular situation.
   Do you agree and **what are the reasons** for that?

0% 100%

5. How challenging is it to **collect consumption data/order forms** from Health Centres and **what are the difficulties?**

0% 100%

6. How difficult is it to **execute deliveries according to plan** to Health Centres? **Why** it is c**hallenging** and **what is the impact?**

0% 100%

7. Research suggests different **transportation systems** such as collection, delivery-by-warehouse or outsourcing.
   What are **your thoughts** about the different options?

8. Do you agree that **financial resources for transport infrastructure** are one of the critical bottlenecks and **what is the impact**?

0% 100%

9. Literature says there is a deficit in **vehicle fleet and maintenance activities** such as the use of log books and regular inspections. Do you **agree** and **what are the issues**?

0% 100%

10. I was given the impression that on various stages of the supply chain the **use of guidelines** is either not existent or not followed. Do you agree and **what are your thoughts?**

0% 100%

11. In literature **performance measurements** for Inventory Management and Transport & Distribution are rarely mentioned. **How common** are performance measurements in practice?
    What are your **thoughts**?

0% 100%

12. There are a lot of **trainings** for Inventory Management and Transport & Distribution available and it is a critical topic, because **the impact can't be measured**.
    What are **your thoughts**?

13. Research suggests that **vertical programs are common** due to the following reasons:
    - Smaller group of stakeholders
    - substantially lesser level of program coordination, collaboration, and political will necessary
    - lesser supply chain requirements for drugs
    - financing method
    - functions, which need to be managed centrally are overwhelming the systems in use

    What are **your thoughts**?

Thank you very much for your time and support!

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