

Lean thinking in medical commodities supply chains: applicability and success factors for Tanzanian health supply chains

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Abstract

Purpose – This paper aims to examine lean thinking in medical commodities supply chains by considering its applications and success factors. It determines the drivers and wastes of medical commodity supply chain, and the existing lean tools and practices together with their application in the supply chain processes. The paper also examined the challenges and success factors for effective lean application in the medical commodities supply chains.

Design/methodology/approach – The study used qualitative approaches, in-depth interviews and focus group discussions with key informants to form the basis for data collection. Through thematic analysis, the collected data were analyzed by developing themes reflecting the objectives of the study.

Findings – The main drivers for waste associated with the supply chain were demand management, supplier development, institutional framework and governance. The wastes were observed at the level of inventory, operation costs, transaction costs, delays in terms of service, commodity delivery time and quality. Digitalization, information technology and standardization were the tools for medical supply chain. Poor infrastructure, unreliable internet supply, environmental uncertainty and poor management support were challenges to realizing an effective supply chain.

Research limitations/implications – Although the qualitative approach used in the study provides detailed information, a quantitative study covers a larger sample for generalization.

Practical implications – Capacity building and professionalism should be given a priority because the philosophy of lean focuses on waste removal and continuous improvement, which highly depends on the quality of human resource (Brito *et al.*, 2020). Limited human resource capabilities in supply chain management will, therefore, result into poor operational efficiency, which are wasted. Moreover, systems interoperability is key waste minimization and, therefore, demands interventions.

Social implications – The government under the Ministry of Health and other key sector ministries such as local and regional governments should better understand the role of the waste drivers and adopt system-wide reforms to support improvements to remove waste in the medical supply chain. For example, the current institutional framework creates an administrative block and hence leads to wastes. This bureaucratic procedure should be removed to minimize wastes along the chain.

Originality/value – This study is among the first studies to determine applicability and implementation of lean in a resource-constrained context. The paper identifies contextual factors for lean implementation. This paper focused on a holistic view of the entire supply chains to enhance a well-functioning supply chain in delivering health commodities.

Keywords Lean thinking, Supply chains, Medical commodities, Waste, Lean tools and practices, Health supply chain

Paper type Research paper

Introduction

Globally, public health-care facilities are being forced to adopt different tools and techniques used in manufacturing industries to increase their supply chains (SCs) efficiency (Radnor *et al.*, 2012). In this case, lean thinking has become a pioneering approach to service operations improvements and, therefore, being adopted by the industry. In the current uncertain operations characterized by constrained and reduced spending,

lean thinking offers the potential to maintain service productivity, improve resource utilization and maintain service quality. Lean thinking has been promoted by many authors as

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the key process improvement philosophy (Gupta and Sharma, 2016; Radnor *et al.*, 2012) that adds value to the processes by removing waste within the chain (Sisson and Elshennawy, 2015). Despite the promising positive effects of lean in health-care SCs, adoption in health care is still at an infancy stage (Tortorella *et al.*, 2019). Many authors argue that the applicability and implementation of lean in health care is still clouded by uncertainty, including unpredictable demand for medicines and medical supplies (Young and McClean, 2009; Terra and Berssaneti, 2018; Tortorella *et al.*, 2019). Young and McClean (2009) showed that the focus in health sector has mainly been on resource efficiency instead of flow efficiency of integrated resources, which is among the cause of failures of lean in health care. For lean to be successful in health care, its scope of implementation should not be restricted at the resource boundaries but to the entire SCs (Guimaraes *et al.*, 2013). It has also been noted that there are very few empirical studies that explore the applicability and implementation of lean in health-care SCs (Olsson and Aronsson, 2015).

According to Supeekit *et al.* (2015), the health-care SC is a very complex process, which includes internal SC, such as clinical care processes and external SC that ranges from sourcing of suppliers to the distribution of medical materials. The reviewed lean supply chain (LSC) literature also indicated that most of the studies have focused on individual aspects of LSC and very few researchers have approached both upstream and downstream activities of the organization (Jasti and Kodali, 2015; Riet *et al.*, 2015). Given the growing complexity of health-care operations, lean practices cannot be handled only at a single organization and process (Gonçalves and Camotim, 2013; Young and McClean, 2009), instead more lean practices and strategies must also be implemented at the interorganizational level (supplier health facilities linkage).

Moreover, evidence showed limited comparative studies in public and private hospitals when assessing the application and implementation of lean practices (Kelle *et al.*, 2012). The importance of a comparative study on the supply of medical commodities in public and private health facilities is important due to the existing governance mechanisms. While public facilities are restricted to procure from the government agent known as medical stores department (MSD) or selected prime vendors (PVs), the private facilities are free to choose suppliers as they may wish. Therefore, this study focused on internal and external SC activities such as health facility-supplier linkage, stock management processes, distribution processes and order processing for medical commodities. The restricted scope is in line with existing literature, which emphasizes on hospital-internal logistics to enhance competitiveness (Rivard-Royer *et al.*, 2002; Landry and Philippe, 2004). Contextually, while the developed world is rich on literature, there is limited evidence on lean practices in developing countries, including Tanzania (Subramanian, 2020). Furthermore, developing countries have ineffective SCs due to complexities, uncertainty in financing, lack of accountability structures, long re-supply intervals, lack of SC planning data, lack of interest in financing operating costs, miss match between skills and system design and lack of incentives for SC staff (Yadav, 2015).

To cover the observed empirical and contextual gaps, the present study aims to explore the waste and their drivers and application of lean practices in the medical commodities SCs in

the Tanzanian health system, which includes both public and private health facilities. To meet the aforementioned objectives, this study, therefore, addresses the following research questions:

- RQ1. What are the drivers of waste in the medical commodities supply chain in public and private health facilities?
- RQ2. What are the wastes associated with the medical commodities supply chain in public and private health facilities?
- RQ3. What are the existing lean tools and practices applied in the medical commodities supply chain processes?
- RQ4. What are the contextual factors critical for effective lean application in the medical commodities supply chains?

Following this introduction, Section 2 details the literature review and Section 3 describes the methodology used in the study. Furthermore, findings and conclusion are presented in Sections 4 and 5, respectively.

Literature review

Medicine and health supplies

The health sector is a unique type of service industry which involves close interaction between customers and service providers. In the health sector, the primary process of operations is represented by the flows of patients and not goods, of which material flows are considered secondary (Thijssen *et al.*, 2016). Materials include medical and nonmedical items, which are kept as inventory within a health facility to support the provision of quality health services.

The health sector has been characterized by a high degree of uncertainty and complexity due to difficulties in demographic, epidemiological forecasts and advances in medical treatments which are uncertain (Soyiri and Reidpath, 2013). Medicine and laboratory commodity SCs in public and private hospitals are very complex because they deal with conflicting objectives and intractable constraints (Birkie *et al.*, 2017).

Also, medical products, medicines and equipment are not totally consistent; professionals in the industry are responsible for their selection, but their choice depends on the requirement of the end customers who are patients (Beliën and Forcé, 2012). In this case, the hospital operations, therefore, must deal with a complex distribution network composed of several storerooms and warehouses where different medicine and commodity supplies are stored following a variety of regulations (Rivard-Royer *et al.*, 2002). (Papalexí *et al.*, 2016) reported that the level of waste in medicine and commodity SC is very high, which leads to inefficiency in the delivery processes. Research suggests a number of initiatives that can be used to improve (remove waste) medicine and laboratory commodity SC such as lean thinking (Lee and Schniederjans, 2011).

Lean thinking and practices

The origin of “Lean thinking” concept can be traced back on the Japanese manufacturing shop floor and particularly in the

innovation of Toyota Motor Corporation (Antony et al., 2019). Faced with shortages and a lack of resources, Japanese car manufacturing companies responded by using lean to develop processes operating with a minimum level of waste (Harrison and Van Hoek, 2008; Holweg, 2007). Lean thinking is a process strategy which tries to provide a new methodology to think about how to organize human activities to deliver more added value to individuals while eliminating waste (Bharsakade et al., 2021). It is an improvement philosophy that focuses on improving processes by removing waste, increasing efficiency and providing a higher quality product or service (Papalexi et al., 2016; Young and McClean, 2009; Laureani and Antony, 2017). In this case, Antony et al. (2019) argue that the primary focus of lean philosophy has been to eliminate process waste, unevenness in operations and over-burden on resources. Lean principles from the manufacturing sector have been adopted into the pharmaceutical SC as the most effective mechanisms for eliminating waste within the SC, as almost half of the cost of pharmaceutical/medical commodities SC was considered hidden and unmanaged (Andelković et al., 2016). The focus on lean principles, therefore, has gained momentum over the past few years due to global competition and increasing operational costs (Simatupang and Basri, 2020).

In emphasizing the importance of lean supply chain management (SCM), Jasti and Kodali (2015) established eight pillars of lean SCM, which include elimination of waste, logistics management and continuous improvement. The literature has also identified several lean practices in the health-care setting, such as seamless and coordinated workflow cycle time reduction (Narayanamurthy et al., 2018). Other practices include issues like self-directed and flexible work teams, patient focus, patient flow and standardized work (Narayanamurthy et al., 2018). Visual management has also been identified as a lean practice which use visual follow-up boards to make organizations' processes and roles clearer and more understandable (Jaca C., et al. 2014). Existing evidence indicates extensive advantages of LSC, such as reduction of inventory and improvement of material flow (Lin et al., 2013). Although the literature identified different lean practices, there is a need to explore the practices in health industry, especially for developing countries.

Furthermore, the literature posits that organizational readiness to implement lean practices is an important factor to be considered (Shafiq and Soratana, 2020). Lean readiness requires positive behavior and acceptance for the proper implementation of lean techniques. Based on that, process management, coordination management and a positive organizational culture, among others, have been identified as critical factors for the successful implementation of lean (Shafiq and Soratana, 2020). It is well-known that lean implementation started with the manufacturing sector; however, today, other sectors, including the health sector, have also adapted lean practices. The existing literature shows that the application in the health sector has been focused on improving the efficiency of health-care delivery, reducing waiting times and medical SC management, ranging from the local organizational level to decisions on national health-care policy (Sloan et al., 2014).

The literature on determinants of successfully lean implementation in health-care organizations emanates from the leadership side as well as employees' perspectives. Morrow

et al. (2014) Examined 13 national health service case studies on the nature and impact of leadership in lean implementation. They found that leadership at multiple levels was critical for effective lean implementation. Later, Drotz and Poksinska (2014) examined lean implementation in health care from the employee's perspective and found that well-established functional work teams as a key factor to be considered. Timmons et al. (2014) revealed that acceptance of lean methods in health care is highly influenced by professional status of the participants. Mazzocato et al. (2014), through multiple case studies of hospitals, revealed that care process complexity is a significant source of variation in the successful implementation of lean practices. Regarding motivation factors for health-care organizations to implement lean practices, Antony et al. (2019) conducted a systematic literature review of lean in health care and revealed that: provision of better services to patients; process and operational efficiency improvement; service quality improvement; transformation of organizational culture; standardization and streamlining processes; reduction of delays, operational time, staff and administrative inefficiencies; and elimination of waste and nonvalue adding task were common motivation factors. Furthermore, it was observed that lean implementation in the health sector varied in its approach and scope; however, the benefits of lean implementations include improved operational efficiencies, reduced delay and improved cycle times (Antony et al., 2019). Although there are some benefits observed, previous studies have identified potential limitations of lean implementation in health-care services; thus, lean is new in the health-care sector, that makes it difficult to implement (Ishijima et al., 2016), lack of empirical evidence to convince top management (D'Andreamatteo et al., 2015), lack of coordination between functions (Chiu et al., 2016), managerial resistance to change and employee resistance to change (Chiu et al., 2016).

Methodology

This study focused on a holistic view of the entire medical commodities SCs in a resource-constrained context. To gain more insights on these complex SCs characterized with limited knowledge, especially in developing countries, a qualitative study is of critical importance. A qualitative study gives a holistic view of an object, enhancing in-depth analysis and knowledge building (Azungah, 2018). Thus, this study adopted a qualitative approach to collect detailed information that can enable the researchers to achieve the objectives of the study. A case study approach is, therefore, an appropriate methodology when one wishes to answer the study's research questions from the perspective of current practices versus theoretical reasoning (Yin, 1994). With arguments, the study focused on investigating the current practices in the SC of Tanzania health sector. The unit of analysis for the selected case studies was the case study. Within-case and across-case analyses were used to identify drivers, waste, lean tools and practices, and finally the contextual factors defined as challenges and success factors. This study covers different zones that are served by MSD. During the study MSD, which is the main supplier for medical commodities to public health facilities, had nine zones all over the country.

Given the geographical location of the country and the representative nature of the targeted respondents, it was difficult to cover all zones. However, four zones were purposively selected for the study, which includes Dar es Salaam where the headquarters of MSD is located, and Mwanza, which is also among the big zones. Kilimanjaro and Mtwara were also covered to have information from areas which are not considered to be big cities. In addition to MSD zones, one PV located in Dar es Salaam was included in the study. The key informants were medical officers in charge, procurement officers or pharmacists of these health facilities. In most cases, interviews were conducted to more than one respondent in each facility. Apart from the in-depth interviews to key informants of health facilities, all four managers of the selected MSD zones, one PV and four suppliers of private health facilities within the zones were interviewed. Two focus group discussions were conducted in each zone, with composition of between seven and 12 participants from both public and private sectors. Specifically, the participants of the focus group discussion included officials from MSD, regional medical in charge, pharmacists and procurement managers from selected health facilities, as well as private health facilities' suppliers. Table 1 shows the number of individuals who were interviewed in different regions.

For the purpose of data analysis, thematic analysis was adopted to develop themes to achieve the research objectives. These themes included the drivers of waste, types of waste, lean tools and practices at SC and organizational levels. The fourth theme was the contextual factors at the organization and SC levels. In this case, the main theoretical output is propositions to be tested in future surveys. All interviews were transcribed, and reflective notes were included to develop the themes.

Findings of the study

Supply chain for medical commodities in Tanzania

The findings revealed different levels of medical commodities SC depending on whether the referred health facility is public

or privately owned. Within the public sector, there is a difference between regional and referral hospitals, and at the district level, between health centers and dispensaries. Publicly owned facilities are required to prepare annual projections for the need of medicine and other laboratory equipment. This is prepared once and then submitted to MSD. The projections are expected to show the sources of funds and be placed electronically. During interviews, one procurement officer averred that:

[...] in our hospital the steps of supply chain for buying medicine and other laboratory equipment starts with preparing projection or forecasting of relevant medicines and other laboratory reagents. This is done by the head of pharmacy basing on the request of other departments and this projection is made only once per year. [...] also, when making the projection you should indicate the sources of finance to pay for the order placed. This process is normally done electronically [...] (Procurement Officer- Public Health Facility).

The findings further show that the ordering process for health centers and dispensaries is different as compared to regional and referral hospitals. In this case, it was reported that the SC of medical commodities at health centers and dispensaries involves the identification of the available balance, list of demanded items, preparation of the order, approval from the medical officer in charge, discussion and sharing with the district pharmacist and then the district pharmacist forward the order to MSD. Public health centers and dispensaries have no power to send the order directly to MSD, which contributes to delays as compared to big hospitals. In this case, the order processing may create delays, as it was noted in the interview with a pharmacist of one of the regional referral hospitals:

[...] the procedures are clear that when MSD cannot fulfill the orders the facility should be supplied by prime vendors. It is however mandatory for MSD to issue a notification that allows the facility to look for alternatives from the prime vendors. However, when the prime vendor cannot supply the order, you have to request again from MSD. So when they do not receive another request from you, then MSD assumes that you have received your request from the prime vendor [...] (Pharmacist, Public Health Facility).

Table 1 Respondents of interviews in each region

Interviewees	Category	Regions				Total
		Dar	Mwanza	Mtwara	Kilimanjaro	
MSD managers (Zone)	Public	1	1	1	1	4
Prime vendor	Private	1				1
Private supplier	Private	1	1	1	1	4
Pharmacists (HFs)	Public	1	1	1	1	8
	Private	1	1	1	1	
Procurement officer (HFs)	Public	1				2
	Private				1	
Storekeepers (HFs)	Public	1	1	1	1	7
	Private	1	1	1		
Hospital administrator (HFs)	Private			1		1
Doctor in charge (HFs)	Public	1	1		1	6
	Private	1	1	1		
Clinical officer (HFs)	Public	1	1	1	1	7
	Private	1	1		1	
Regional pharmacists	Public	1	1	1	1	4
Municipal pharmacists	Public	1	1	1	1	4
Total		14	12	11	11	48

Source: Table created by author

The ordering process and SC of medical commodities for private health facilities were observed to be different from public facilities. Normally, the process is very short as compared to public health facilities. One administrator of this private health center added:

[...] the ordering process involve doctors and nurses from various departments who identify priority medicines and medical equipment. Then the list of demands is submitted to the pharmacist for compilation. After compilation, we normally discuss with the medical officer in charge, the accountant as well as the purchasing officer who submit the order to the supplier, which is a big pharmacy in the region. In some cases, laboratory commodities are supplied by another supplier. The order may be placed by calling but we use the manual work/paper and not computerized system [...] (Hospital Administrator).

The above findings indicate that both public and private health facilities use a participatory approach in identifying the required medical equipment. Different departments are involved in the process, and therefore what is ordered involves decision organs to identify priorities according to the available resources. Furthermore, while a computerized system is mandatory for placing orders in public health facilities, it was not the case for private health facilities. Although the manual system used by private facilities enabled a quick response on the orders of private health facilities as compared to public health facilities, record-keeping for facilities is considered to be a challenge. While public facilities can only purchase from a different supplier with MSD approval, private health facilities can flexibly shift from one supply to another. This has enabled private health facilities to get medical commodities quicker with reasonable price as compared to public health facilities. The schematic diagram of SC for medical commodities is presented in Figure 1.

In Figure 1, the chain starts from a manufacturer who can supply either to MSD, PV and private suppliers. MSD distributes medical commodities to different zones and the zonal offices distribute to public health facilities. On the other hand, PVs and private suppliers normally receive commodities from manufacturers and supply to private hospitals and sometimes to public hospitals if MSD cannot meet that demand. There is always information flow on demand for health commodities from health facilities through MSD, PVs and private suppliers to manufacturers.

Drivers of waste in medical commodities supply chains

The first objective of the study was to explore drivers of waste in the medical commodities SC in public and private health facilities. From the analysis, seven drivers emerged: demand management, supplier development, institutional framework and governance, SC capabilities, management information systems, culture and incentives. This section details the discusses these drivers as highlighted from the field findings.

Demand management

In this study, demand management was associated with the medical commodities quantification problem. In a discussion with one of MSD's zonal managers, it was revealed that inaccurate demand estimation at the primary health facilities, i.e. health centers and dispensaries, was a serious issue not only for repeated number of orders but also in piling up of stock. Wrong quantifications from the primary health facilities result into overstocking/understocking at the zonal warehouses, which affects MSD's ability to service the health facilities. This was evidenced by one MSD zonal manager that:

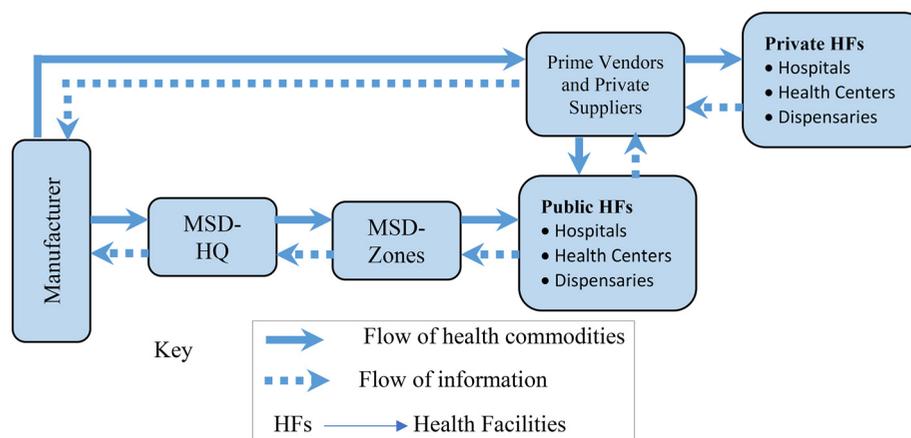
[...] poor quantification of medical commodities at the health facility levels has contributed to over procurement of medicines at our warehouse; what they indicate as their need, later is not consumed [...]. (Zonal Manager-MSD).

It was also noted that there was limited collaboration between the key suppliers of medical commodities and public health facilities (MSD PVs health facilities) in demand management. MSD being a sole supplier, is also not integrated in the demand planning activities at the facility level. One pharmacist of public health facility insisted that:

[...] we are not involved in their planning or even management meetings of MSD, sometimes we have to request for chance to participate in MSD meetings to make our own presentations which will guide them in their procurement decision making [...]. (Pharmacist Public Health Facility).

Moreover, in one of the focus group discussions, it was revealed that the existence of variety of lab equipment, which demands different types of reagents, contributes to complexity in the demand planning hence make the SC inefficient. In addition to that, poor calibration of lab equipment led to high consumption of reagents more than the technical design; hence hard to manage the demand for lab materials, was also identified as a

Figure 1 Supply chain for medical commodities



Source: Figure created by author

driver toward over/undersupply of laboratory reagents. It was also mentioned that the exemption policy that exempt for old people, maternal and under five children from paying user fees in public hospitals, intensifies uncertainty in managing the demand for health care, as well as significantly contribute to inadequate financial resources. Generally, poor demand estimation creates inefficiencies in the form of surplus or shortages; thus, MSD ends to procure more or less than what is actually demanded (overstocking/understocking), which are considered as wastes in SC of medical commodities. This is supported by [Daud and Zailani \(2011\)](#) who argue that to improve outbound SC efficiency, demand management is considered a key principle.

Supplier collaboration and development

Supplier collaboration and development is a strategic practice which supports organizations to ensure leanness in their SC processes ([Wafa et al., 1996](#)). In interview with PVs, it was revealed that public health facilities and PVs are yet to develop collaborations, which focus on developing the PV as the main alternative supplier when MSD is out-of-stock. While it was expected that the government should develop the capacity of PVs, e.g. provide training on required guidelines/procedures received. This has contributed to the poor performance of PVs, as it was reported that out-of-stock is also a common problem with PVs:

[...] we do not receive training on government guidelines e.g. standard treatment guidelines shaping medical commodities supply chain. Government guidelines not timely delivered to the Prime vendors and other distributors [...]. (Prime Vendor).

The results further showed that in private health facilities, there is a close collaboration with their suppliers. In this case, the suppliers feel like part of operations for the health facilities to the extent that they can supply with credit arrangement to these facilities. It was also mentioned that private hospital suppliers deal with their stockouts; thus, they take the trouble to find the missing commodities from other suppliers and deliver them accordingly. It was noted that close interactions created strong awareness of the operations of the health facilities to the extent that suppliers can even supply the required commodities without much formalized procedures. In this case, trust between health facilities and suppliers governs the exchange relationship. The collaboration, therefore, strengthens the relationship between the supplier and buyer, which is considered a safeguarding mechanism in the exchange relationship.

Institutional framework and governance

The results further showed that in public health facilities, the governance mechanisms are policies and standard guidelines on how material, information and fund should flow. Findings from interviews revealed that, in the public sector, guidelines are adopted to reduce the uncertainty and complexity associated with routine operations. One of the respondents who argued that:

[...] in public hospitals we are guided by the laws and policy documents which are issued by the Ministry of Health [...] and these guidelines are meant to reduce the uncertainty and complexity which are caused by the routine operations [...]. (Focus Group Discussion with Different Stakeholders).

Despite the existence of guidelines in placing and receiving orders, it was revealed that the availability of funds is among a key determinant of when, how and the quantity to order. The findings from the focus group discussion with MSD staff, public health facility staff members, regional and district pharmacists revealed that quantification guidelines require health facilities to plan their demand/orders based on funds available from their different sources. In this case, MSD demanded that health facilities must pay before they receive their orders. In this focus group discussion, it was mentioned by one member that:

[...] you cannot place an order if your account at MSD has no enough funds. If the account is empty or has less amount of money than the order placed, then the facility should pay the difference before the delivery of the ordered commodities [...]. (Focus Group Discussion with Different Stakeholders).

The results further show that centralization as a governance mechanism contributes to inefficiencies in the health sector because the demand for health services is so unpredictable. The results revealed that the ongoing system redesign in the public health commodities SC has added another approval layer from the district pharmacist to the regional pharmacist. The new structure demands the regional pharmacist to cross-check and approve orders from health centers and dispensaries, which has made the SC longer. It was also mentioned that the existing public procurement procedures based on procurement laws were too long, which contributes to delays and results in out-of-stock situations. This was cemented from the interview with a pharmacist who narrated that:

[...] in public hospitals we are following procedures of procurement as provided by the government which are very long and involving so many people whereby in private hospitals procedures for procuring medical drugs are very short i.e. the process starts from a pharmacist, procurement officer, to the department of finance. [...]. (Pharmacist- Public Health Facility)

In comparison with private health facilities, there were differences in the institutional framework and governance of their SC. In this regard, the differences started from the operation procedures of private health facilities and autonomy over finances. They do not have a standard guideline on when and how much to purchase; they buy directly depending on needs. It was from this observation it was revealed in an interview with the medical officer in charge of one private dispensary that:

[...] our ordering process is not guided by any procedures. Sometimes the owner of this dispensary who is not the medical doctor by profession decides when and which medicine or medical equipment to buy. Sometimes, the owner decides not to buy some of the priority medicine ordered because are expensive [...]. (Medical Officer in Charge, Private Health Facility).

Although there are differences in institutional framework and governance of SC process in public and private health facilities, the operational practices for public health facilities require well-standardized procedures because of their big number. In this case, standardization has reduced complexity along the SC of public health facilities. Complexity is also contributed by the existence of multiple types of medical commodities with different demand patterns.

Supply chain capabilities

SC capabilities are described by the availability of organizational resources such as human resources with required skills, proper storage, as well as support systems (e.g. management information systems). In this case, effective SC of

health commodities will be achieved if all actors in the chain can execute their responsibilities with a high level of professionalism. The findings from the interview with MSD indicated that employees of primary health facilities (health centers and dispensaries) have very little knowledge and skills to support their SC activities such as demand forecasting, preparation of orders, placing of orders and management of available stock:

[...] most of the staff at the health centers and dispensaries do not have expertise on supplies management. It is common for nurses to process the orders, and these are the ones who have received less training in supplies management. In accurate order and poor stock management normally occur due to non-professional staff who are doing demand forecast, preparation of orders, placing of order and management of available stock [...] (Zonal Manager-MSD).

The above observations were supported by findings from primary health facilities interviews, where it was mentioned that:

[...] we do not have people with adequate expertise in supply chain management; and most of us have received on job training which is not always comprehensive and continuous [...] (Medical Officer in Charge Public Health Facility).

Limited human resource capability was also associated with the ineffective use of the e-LMIS for placing orders. Limited capabilities hinder the proper utilization of available technological resources to realize waste management. In addition, the findings revealed a shortage of health workers at the health facility levels, whom are also expected to support SC activities. Poor layout at the public health facilities and lack of modern and quality stores to keep drugs and lab reagents were also observed as weak SC capabilities.

Management information systems

Adoptions of advanced technological capabilities provide organizations with improved ways to visualize, monitor, control and manage their SCs. However, discussions with the public health facilities revealed that the existing management information systems have added complexity and inefficiencies due to their inherent limitations. Specifically, focus group discussions with all public health facilities indicated critical problems with the management information system "GOTHOMIS." This system is designed to support stock visibility and monitoring within a health facility. However, the findings reveal that it has operational errors/problems which limit its ability to provide realistic and accurate/quality data:

[...] the system is not stable and more often we are using hard copies. Also you cannot get the report from the system and sometimes the system displays false information, it sometime shows you still have stock while in reality it is not available, this affects the expected quality of information and orders we prepare [...] (Focus Group Discussion, with Different Stakeholders).

The quality and integration of different information systems were also observed to be a challenge. The findings revealed that in the current SC, health facilities use an e-LMIS to place the orders, while MSD uses Epicor 10 to process the orders. From the discussions with MSD, it was revealed that the two systems were not compatible as one respondent from the MSD narrated that:

Sometimes we spend more than 24 hours waiting for information to be transfer from e-LMIS to Epicor 10; Due to system interoperability problems. We need to transfer order from e-LMIS to Epicor 10 system [...] (Focus Group Discussion- with Different Stakeholders).

Generally, it was observed that the electronic systems deployed by the health facilities in the medical SC have brought the biggest challenge as the facilities lacked enough knowledge on how to use it, lack of skilled personnel and other related technical difficulties as the system is always not stable and produces wrong information.

Culture

Culture as a driver for waste in SC of medical commodities is based on how actors of the chain behave at different levels. Similar to previous studies such as Kwak and Anbari (2006) which support that cultural characteristics were the most important factor in lean processes, in this study, several cultural dimensions were identified as waste drivers.

Cultural preferences: the findings revealed that different people in the chain behave differently due to that their perceptions and beliefs toward appropriate treatment protocols. For example, it was revealed that some doctors and patients have different preferences toward certain types of medicine, which has contributed to stockouts and overstocking problems:

[...] based on cultural preferences, some of the doctors have preferences on certain medicine, which are not available at MSD. However, MSD may provide alternatives but doctors, especially the super-specialists may not accept the MSD alternative. This necessitates back and forth arguments and MSD may offer notification to allow the use of prime vendor or may deny the use of prime vendor and insist on alternative [...] (Medical Officer in Charge- Public Health Facility).

Collectivist culture: this entails interdependence between actors and organization to fulfill a goal. Collectivism breaks down barriers between departments and organizations, and it builds on interorganizational relationships. Generally, collectivism culture requires health facilities to treat suppliers as integral stakeholders for success. This is indicated by the adoption of team-based approaches in solving problems (joint action and information sharing). Despite the merits associated with the collectivism culture, in this study, it was indicated that individualist culture is still dominating the medical commodities SC.

For example, it was revealed that within a health facility, a pharmacist may not get up-to-date information on the available stock of medicines at the user department because the personnel at the user department do not consider stocktaking of received medicines as part of their responsibilities. They only dispatch and use the medicine and medical equipment without transferring the information of remaining stock to the pharmacy section. This culture created a problem in inventory management because the pharmacists who are responsible for the management of hospital medicines and medical equipment are not informed on available stock. It is from this observation that the pharmacist of one of the regional referral hospitals argued that:

[...] it is tedious in our office because the user departments do not provide accurate information of available stock. They feel not their responsibility to input the rate of medicine and medical equipment consumption in the system. It is therefore a challenge in our side because you may find that the departments are out of stock while the section of pharmacy is not informed [...] (Pharmacist Public Health Facility).

Similarly, limitations were observed in the dyadic relationship between public health facilities – MSD and the PV; thus, the three key actors were not integrated; there is weak collaboration between them. This is different from the private health facilities, which indicated that they collaborate with their

suppliers to solve problems, and their suppliers have strong collaborations among themselves. This was not observed to happen between MSD and PVs and may contribute to the observed waste as it is evidenced that individualism does not support leanness (Wiengarten et al., 2015). The findings also revealed that public health facilities have more of a masculine culture which values control, standardization and efficiency with limited employee involvement, creativity and problem-solving.

Incentives

The interviews indicated that employees from private hospitals were more likely to be motivated with incentives as compared to the public health facilities. Furthermore, it was revealed that in most public health facilities, those responsible for treatment were also supposed to support SC activities, which are considered noncore based on their profession; hence they get overwhelmed. In this case, they were not motivated for extra work, as noted in the interview with the procurement officer of the National referral hospital that:

[...] some of the nurses are not willing to participate effectively into stock management because they are not motivated to pursue extra duties. In this case there is a need to incentivise them by giving them extra pay for any extra activity performed [...] (Procurement Officer, Public Health Facility).

Wastes associated with medical commodities supply chains

The findings from interviews with public and private health facilities, MSD and private vendors suggest that the medical commodities SC experiences waste in the following categories: inventory, operational costs, transactional costs, excessive movement and delays.

Inventory

In this study, inventory is referred a complete list of items such as lab reagents and medicines used to provide health-care services. The findings classify inventory management issues as oversupply, undersupply and shortage/stockouts. According to interview results, oversupply was commonly identified by the four MSD zonal warehouses. Through the discussions, it was revealed that oversupply was for both vertical program commodities, as well as priority commodities supplied under the integrated logistics system (ILS). Vertical programs have adopted a PUSH system, which sends commodities not based on actual demand. This has contributed to overstocking, as well as additional distribution costs, as sometimes MSD deviates from the delivery schedules to deliver VP commodities. It was also revealed that MSD found itself keeping high inventories of medicines because of the deviation of the actual order from the forecast, as one respondent from MSD had this to say:

[...] we buy and stock based on what health facilities indicated as their demand. However, they order less due to limited funding, and we cannot deliver unless they have paid for orders. We therefore force them to take all that they indicated in their demand [...] (Zonal Manager-MSD-).

Oversupply of medical commodities is a waste dimension as it contributes to increased cost of operations due to an increase in inventory levels. Surplus leads to a high level of inventory, which contributes to high storage costs and expiry. It also contributes to the high administrative costs in the form of stock monitoring and reporting.

The second form of inventory waste reported was the tendency of expiring of the medical commodities within the health facilities. The discussion with the medical officers in charge and pharmacists revealed that the expiring of commodities is caused by the misalignment between what has been bought and prescribed, changes in the treatment regime, particularly for ARVs, poor quantification and a lack of skills/knowledge to manage the stock due to an inadequate number of pharmacists to perform the task appropriately. This observation was emphasized by one respondent, who said that:

[...] Sometimes drugs are expiring due to the change of treatment regime [...] the usage of drugs are changing from time to time due to the preset regime at the moment [...] (Pharmacist- Public Health Facility).

Another respondent further narrated that:

[...] expiring of drugs in our hospital occurs when the purchasing officer bought high stock relative to the demands of the customers [...] also due to the mismatch between what has been prescribed by doctors or demanded by patients; and what has been purchased create pill up of stock and therefore expiries. This do happen because of arrogance and lack of professionalism in medical issues [...] (Medical Officer in Charge - Public Health Facility).

The third dimension was a shortage of medicines and lab reagents; it was reported that there is undersupply of medical commodities within public health facilities, which acts as a great challenge to health-care service delivery. This is similar to previous contributions by Sloan et al (2014), who indicated missing items as a waste in the health sector.

The findings revealed that all public health facilities agreed that the MSD and PV's out-of-stock situations contribute to the limited availability of essential medical commodities. It was from this observation one respondent from the health facility mentioned that:

[...] the main challenge that exists is unavailability of medicine from both the MSD and the prime vendor. Sometimes you are ordering medical commodities from MSD but you do not get them on time and sometimes you do not get them at all. When you start finding them from prime vendor again you won't get that particular medicine because they are out of stock [...] (Focus Group Discussion with Different Stakeholders).

Operational costs

In this study, operational costs (delivery and distribution costs) were considered as the expenses. These costs were considered as waste when contributed by inefficiencies and ineffective SC management processes. The results indicated that public health facilities and MSD experience excessive transport costs, which were not budgeted for due to an increase in emergency orders. This was revealed during a focus group discussion with participants from health facilities:

MSD delivers items that are on their schedule but they do not deliver items that were issued in an emergency order. Therefore, we have to incur all costs to pick all emergency orders from their store [...] (Focus Group Discussion with Different Stakeholders).

Similarly, discussions with MSD revealed that they also incur excess distribution costs, as they have to deliver vertical programs commodities due to limited orders from health facilities; it has been hard for MSD to integrate these commodities into their standard delivery schedules.

Transaction costs

The transactional costs were associated with extra time and resources incurred in managing the relationship between MSD and health facilities. These include monitoring costs, follow-up costs and bargaining associated with the implementation of

different SC processes. The results indicate that time wastage in the public health medical commodities can happen during follow-up on order delivery and stock-out notification from MSD; long follow-up time to NHIF due to late reimbursements of funds; and time wastage due to physical stock counting and filling manual ledgers. It is from these observations one of the respondents in interviews noted that:

[...] there are so many challenges here, first for all to make a follow up of all drugs and lab reagents from MSD and other vendors is problematic. It needs a lot of time. This is also applying on purchasing lab reagents [...] (Pharmacist- Public Health Facility).

Delays

The study has also observed unnecessary delays both within the health facilities and between health facility and suppliers of medical commodities. This finding supports previous contributions by Sloan et al. (2014), who indicated delays as waste in the health sector.

According to the participants of focus group discussion from MSD and public health facilities, delays occur during ordering and delivery due to misalignment between funds and material flow and long order processing time at MSD due to increased delivery schedules beyond their capacity, as well as system interoperability problems between the e-LMIS used by public health facilities and Epicor 10 used by MSD. This resulted in delivery delays because the transfer of order data from e-LMIS to Epicor is done manually and consumes a lot of time (sometimes more than 24 h). It was also observed that the long approval structure (bureaucracy) which has been introduced by the system redesign (district-regional-MSD) and the long process of getting money from NHIF delay the entire process:

[...] in the processes of ordering and delivery, it is sometimes too long and therefore cause delay or timely delivery. Transport charges are equally burdens and at some point, the hospital has no cash for alternative transport and therefore cause delay in delivery. Delay also occurs when the requested order is not available at the MSD and at the same time the hospital has no fund to buy to prime vendor [...] (Focus Group Discussion with Different Stakeholders).

Lean tools and practices in medical commodities supply chains

The study revealed that the main difference between public and private medical commodities SC is on the extent of standardization. Both public and private SCs have adopted digitization and IT solutions for continuous improvement.

Digitization and the use of information technology

It was revealed that public health facilities used computerized information systems to support their logistics processes. For example, public hospitals use of GOTHOMIS and e-LMIS for the ILS, which supports the ordering process between MSD and health facilities. On the other hand, MSD uses ERP system Epicor 10. The existing literature suggests that lean and digitization were complementary (Lorenz et al., 2019). However, this study observed that the use of the systems mentioned above in the public health facilities has problems in terms of their applicability in the whole system of procurement of medical drugs, as one respondent mentioned that:

[...] ideally, GOTHOMIS were supposed to do that, but unfortunately the system as we said it has a lot of challenges so it cannot do that. The system was also expected to link with other financial systems. In Tanzania we are still have big challenges on the usage of these systems and this is caused due to the challenges of the technology [...] (Procurement Officer- Public Health Facility).

Supply chain integration

Joint action and information sharing along a SC is very important for mitigating waste, and achieving of full benefits from the chain; however, the findings revealed weak integration in the public medical commodities SC in terms of joint action between MSD and the PV; thus, they are not linked in terms of plans, delivery and even in managing out-of-stock situations from each other. Thus, MSD, which is complimented by the PV, is not aware of the dealings between PV and health facilities. For instance, when a pharmacist from one of the public health facilities was asked when MSD issued out-of-stock notification, how do they make a follow-up that health facilities have received the requested drugs from the PVs? She responded by narrating that:

The MSD simply assume that you have received the drugs that you have requested. The procedures are clear, when the MSD issues out of stock notification you have to look for alternatives from the prime vendors. When you do not get that stock from the prime vendor you have to request again to MSD. So when they do not receive another request from you they assume you have received your request [...] (Pharmacist- Public Health Facility).

This observation implies that there is a weak integration in SC of medical commodities between MSD and the PV; thus, they are not linked in terms of plans, delivery and even in managing out-of-stock situations from each other. In addition, it was noted that information flow on funding is still fragmented; thus, public health facilities were not aware of how much money is deposited into their accounts for buying medical commodities, and also the remaining balance was not known. Thus, after ordering from MSD, that is when they were told that they do not have enough funds.

Contextual factors in the medical commodities supply chains

This section presents findings that answered the fourth research question of the study, which was to explore contextual factors critical for effective lean application in the medicines and laboratory commodities SCs, both at the health facility level and dyad. Different tools, including supportive infrastructure, guidelines and SC integration, were identified.

Supportive infrastructure “unreliable internet supply”

In this study, unreliable internet supply was revealed as a key issue that hinders the effectiveness and efficiency in the SC of medical commodities, as it was narrated by one respondent from the public health facility who said that:

[...] sometimes we have to wait for many hours for GOTHOMIS to resume from internet breakdown [...] (Pharmacist, Public Health Facility).

Another respondent further narrated that:

[...] availability of electricity all the time is also another challenge, when the electricity goes off, it become very difficult for us to access the internet since the system needs internet to function thus affecting patients that need our service by that time [...] (Pharmacist- Public Health Facility).

Similarly, other scholars, such as Ghobakhloo and Fathi (2019) indicated that, in digital transformation, internet technologies and connectivity play a core role in the deployment and use of more traditional IT and of more innovative or emerging IT. It is, therefore, clear that the absence of digital transformation, internet technologies and connectivity will limit lean practices in SC of medical commodities.

Limited provisions in guidelines

Some of guidelines, including NEML, do not capture needs for specialized hospitals, which leads to complexity in inventory management due to a significant proportion of special procurement items, as one respondent from MSD mentioned that:

[...] our catalogues are mainly informed by the standard treatment guidelines (STGs) and National essential medicine List (NEML); hence management of special procurement items is bringing more challenges as these commodities are not commonly used in all facilities [...] (Zonal Manager-MSD).

Environmental uncertainty

In this study, environmental uncertainty was understood as the unpredictability of the external environment (Heide and John, 1990) or unanticipated changes in circumstances surrounding a transaction. This study identified two types of environmental uncertainty; which are change of treatment regimens and variation of physicians and patient's preferences on medication. It was from these observations one respondent argued that:

[...] the nature of the people is different so their preferences on certain medicines are different [...] for instance, customers may demand particular drugs from UK which are not available at the particular moment [...] in this case the supply chain may be considered as inefficiency but in actual fact was caused by preference of one person [...] (Procurement Officer- Private Health Facility).

Conclusion and implications

Conclusion

This study used an interview checklist to collect data from different actors in the medical commodities SC. There were four main research objectives:

- 1 to determine drivers of waste in the medical commodities SC in the public and private health facilities;
- 2 to determine wastes associated with medical commodities SC in the public and private health facilities;
- 3 to identify existing lean tools and practices and explore their application in the medical commodities SC processes; and
- 4 to explore contextual factors (challenges and success factors) critical for effective lean application in the medical commodities SCs, both at the health facility level and dyad (linkage to suppliers).

Based on objective one, seven drivers for both medical commodities were identified: demand management, supplier development, institutional framework and governance, SC capabilities, culture and incentives. A notable difference between public and private health facilities was observed on the role of the institutional framework and governance. Private health facilities have a limited institutional framework to guide procurement and distribution of such medical commodities. In terms of waste, it was observed that inventory, operational costs, transactional costs, excessive movement and delays were the common waste in the SC of medical commodities. Furthermore, the findings show that standardization and automation/digitization were commonly used by both public and private health facilities as lean tools, while visual management was common for private health facilities. Moreover, the results showed that public health facilities have longer SCs due to many procedures compared to private ones,

and the funding for the private health facilities was more reliable. Unreliable internet, environmental uncertainty and limitations in the national essential medicines list and standard treatment guidelines were indicated as contextual factors which influence the link between drivers and waste.

With regard to the existing literature, the findings of our study differ in different ways, including drivers of waste in LSC in the health sector. However, there are a number of studies such as Antony *et al.* (2019) and Papalexli *et al.* (2016) who highlighted the benefits of lean, which is consistent with the findings of this study.

Theoretical implications

The findings from this study are considered a rich source of insights about drivers, wastes, lean practices and contextual factors in medical commodities SC in a developing country context. Of interest was the ability to engage both public and private health facilities as well as public and private suppliers (PVs) of medical commodities. Without understanding the possible waste and their drivers, adoption of effective lean practices and sustaining the lean efforts will be impossible. This is also supported by Eriksson *et al.* (2016), that the extent of which lean practices contribute to long-term sustainable change depends on the degree of understanding and responsiveness of possible waste and drivers between different stakeholders, including top managers, middle managers, change agents and other employees. The literature further identified categories of waste within the SC in different sectors; however, this study is the first attempt to explore waste in medical commodities SC in a developing country context. It shows the role of ownership structure (public vs private) and proposes that public health facilities were exposed to more waste as compared to private ones due to several factors, including the institutional and governance framework (policies, guidelines and standardization). Moreover, this study brought out contextual factors which may condition the role of drivers/lean practices on waste. The literature reviewed also indicated that most of the contributions on LSC were focused on individual aspects of LSC (Terra and Berssaneti, 2018; Tortorella *et al.*, 2019); this study extends such contributions by including both upstream and downstream activities of the medical commodities SC.

Theoretically, the study, therefore, proposes that in a medical commodity SC:

- P1. Waste in terms of inventory is influenced by demand management, supplier development, institutional framework and governance, supply chain capabilities and culture.
- P2. Waste in terms of operational costs is influenced by demand management, institutional framework and governance and culture.
- P3. Waste in terms of transaction costs is influenced by supplier development, institutional framework and governance, supply chain capabilities and culture.
- P4. Waste in terms of delays in service and commodity delivery time is influenced by institutional framework and governance, supply chain capabilities and culture.

- P5. Environmental uncertainty moderates the role of supplier collaboration and development; demand management, supply chain capabilities on waste.
- P6. Internet moderates the role of IT systems and standardization on waste.
- P7. Effective automation/digitization will improve the effects of lean practices (standardization; visual management) in waste elimination.

Managerial implications

The findings are valuable for health systems and medical commodities SCs, which have not and those already started implementing lean management and they want to improve. Different stakeholders, as detailed below will, therefore, benefit from this study as follows:

- The government under the Ministry of Health and other key sector ministries, such as local and regional government, should understand better the role of the identified drivers; and adopt system-wide reforms to support improvements in stated drivers. For example, the current institutional framework creates an administrative block and hence leads to waste. This bureaucratic procedure should be removed to minimize waste along the chain. In addition to that, capacity building and professionalism should be given a priority because the philosophy of lean focuses on waste removal and continuous improvement, which highly depends on the quality of human resources (Brito et al., 2020). With limited human resource capabilities in the SC management will, therefore, result into poor operational efficiency, which are wastes.
- Moreover, the key ministries should cooperate with development partners to review the existing management systems, to have an in-depth understanding of the shortcomings and provide ways for improvement. Systems interoperability is key to waste minimization and, therefore, demands interventions.
- In terms of supplier development and their linkage to the public health facilities, the government should harmonize the process such that the PV should collaborate directly with MSD to manage the demand for medical commodities at the health facility level. This will reduce the follow-up times, as well as the order cycle times and also improve demand management.
- It is also recommended that the Ministry of Health should adopt a participatory approach to review and update the NEML and the STG; emphasis should be on the engagement of health workers and other supporting staff at the health facility levels.
- It is also recommended that the government should revise the financial policy and adopt a 50/50 fund distribution; thus, 50% should be sent to MSD, and the remaining 50% should be kept at the health facility level to reduce delays.
- The government should further diagnose the existing culture and implement cultural transformation initiatives to support waste reduction.

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