Assessment of the Performance of the Pharmaceutical Supply Chain of Public Health Facilities: A Case of Tabora Region, Tanzania

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Abstract

Performance of the Pharmaceutical Supply Chain is a cornerstone to achieving universal access to Essential Medicines and Health Supplies (EMHS), however it is influenced by several factors. Several indicators have been developed to measure performance of the Pharmaceutical Supply Chain, making possible to identify areas of improvement for continuous transformation. This study aimed at assessing the performance of the Pharmaceutical Supply Chain in Tabora Region, Tanzania. Quantitative research approach was employed in a cross sectional descriptive study. A sample of 58 health facilities was selected using stratified sampling technique. Pharmaceutical supply Chain Performance was summarized using frequency Tables using weighted average score from quality, cost/financial, responsiveness and productivity indicators scores. The performance was classified using average score range that is <50% equals 'low' performance, 50% - 79% equals 'moderate' performance, and >79% equals 'high' performance [49]. Logistics Information System Tools available at the facility was used to gather the information for indicator calculation. The public health facilities pharmaceutical supply chain performance with regard to all indicators was found to be Highly Performing at 82.5% score. The notable low performance in this assessment was order fill rate from MSD which was about 38.6% while efficiency in utilization of space, timely entry of received orders into registers, heath commodities availability rate, adherence to forecast and proper arrangement of inventories performed moderately. Furthermore, only 10% of surveyed facilities had adequate pharmaceutical personnel and 14% of surveyed facilities had adequate number of Laboratory personnel performing PSC activities.

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Since majority of parameters are moderately performing with the exception of low order fill rate from MSD and few pharmaceutical personnel supervising supply chain activities. Therefore managers supervising the Pharmaceutical Supply Chain should pay particular attention in improving Prime Vendor System to fill the gap of MSD and improve the skills of task shifted non-pharmaceutical personnel supervising supply chain of Health commodities in public health facilities.

Keywords: Public health facility; Pharmaceutical Supply Chain performance; Human Resource and Data quality factors.

1. Introduction

Reliable Pharmaceutical Supply Chain is one of the four building blocks of access to essential Medicines and Health Supplies (EMHS) [54]. The system consists of structures and processes that ensure sourcing, procurement, transportation, storage, distribution and use of EMHS [7]. The interactions between these interdependent structures and processes have significant contribution on the availability and affordability of health commodities, which are essential key aspects to access of EMHS [7]. Therefore, achieving universal access to EMHS depends on a high performing Pharmaceutical Supply Chain that promotes delivery of Essential Medicines and Health Supplies from the initial supplier to the final consumer in a timely manner, to the right place and to the right people in the quantities required [34].

Measurement of performance gives results that can be recorded and communicated in order to upgrade and enhance operations [34]. With efficient performance of the PSC functions, health facilities would be able to deliver effective treatment schedules. It also fulfills the requirements of a dynamic capability, as it helps health-care units such as the public health facilities in Tanzania to adapt to their environmental needs rapidly [36]. Unfortunately Yadav, [59] asserts that lesser is known about the functioning of the Pharmaceutical Supply Chains in developing countries and if any exists in developing countries, a deeper and structured understanding of PSC issues is lacking. This study aims to assess the performance of the Pharmaceutical Supply Chain of Public Health facilities in Tabora Region, Tanzania.

2. Materials and Methods

2.1 Study design

Quantitative cross sectional study was used to assess the performance of the PSC of public health facilities in Tabora Region, Tanzania.

2.2 Study setting

This study was conducted in Public health facilities of Tabora Region, Tanzania. The public health facilities in Tabora region are 290, which includes 8 hospitals, 34 health centers and 248 dispensaries [8].

2.3 Study subjects

The primary study units was public health facilities providing health care services to the community that are found in Tabora Region, Tanzania. Due to technical aspect of this study, respondents at the health facilities were facility pharmacy in-charges regardless of the cadre, who largely spearhead all the PSC activities at the facility.

The sample size was calculated using formula for calculating sample sizes in finite population bases multiplied by the Finite Population Correction (FPC) factor due to predetermined total number of health facilities in Tabora Region. 58 public health facilities were studied in which there were 2 hospitals, 7 Health Centres and 49 Dispensaries involved sorted by stratified sampling technique. Individual facilities were selected using simple random sampling from different strata.

2.4 Data Collection

Quantitative data was collected using a structured questionnaire which consisted of four [4] parts. The first part was demographic information of the facility and the second part was Key Performance Indicators for measuring performance of the PSC. This tool has been adapted and modified from USAID/DELIVER PROJECT [3]. Hence the questionnaire provided the necessary information for this research for all objectives.

Principal researcher and research assistants visited each selected facility. Data was derived from document review for performance assessment of the pharmaceutical supply chain. Order records, invoices, stock cards, stores ledger, issue vouchers, dispensing register and physical counts was used to get data for assessing performance of the PSC.

2.5 Data Analysis

Data compilation and processing started immediately after the end of the major field work. Questionnaires had four [2] parts, demographic data of facilities and measuring performance. The Questionnaires were coded, revised, and reviewed for completeness, accuracy, uniformity and comprehensiveness. Coded data was entered by the principle investigator into IBM SPSS statistical package version 29 for further analysis. Entered data was cleaned for validation and consistency. Reliability of a questionnaire was tested by computing cronbach's alpha coefficient. The results of the alpha coefficients for all items ranged from 0.70 to 0.90. This assures that, the questionnaire was reliable as a data collection instrument for this study [15].

3. Results

3.1 Characteristics of the study population

Table 1: Results of study population characteristics

Characteristic assessed	Facilities	%
Availability of designated staff working in the supply chain		
Available	58	100
Training status of staff working in the supply chain		
YES	51	88
NO	7	12
Availability of designated staff for reviewing and approving R&R		
Available	58	100
Cadre of supply chain staff - Pharmaceutical/Laboratory personnel		
Available	13	22
Not Available	45	78

The number of Health Facilities surveyed were 58 from Eight Councils of Tabora Region. There were 2 District Hospitals, 7 Health Centres and 49 Dispensaries. Among the respondents, 22% were qualified staff to undertake Pharmaceutical supply Chain activities (Pharmaceutical and Laboratory personnel). The rest were from other cadres performing PSC activities. 10% of surveyed facilities had adequate pharmaceutical personnel and 14% of surveyed facilities had adequate number of Laboratory personnel performing PSC activities (Table 1).

3.2 Performance of the Pharmaceutical Supply Chain

Table 2: Indicator Scores for Measuring Performance of the PSC

Measurement Item	N	Minimum	Maximum	Mean	Std Deviation
QUALITY INDICATORS	58	57.83	88.50	75.03	7.93846
RESPONSIVE INDICATORS	58	44.67	100.00	78.06	17.00252
COST INDICATORS	58	69.65	99.38	91.35	6.88105
PRODUCTIVITY INDICATORS	58	61.00	100.00	85.57	7.36926
OVERALL				**82.50**	**5.5299**

Performance of the Pharmaceutical Supply Chain was measured using four (4) parameters namely; Quality indicators, Responsive indicators, Cost indicators and Productivity indicators. Average scores from these indicators determines the Performance (efficiency) of the PSC. High performing PSC means Pharmaceuticals will always be available in adequate amount whenever needed by customers. Over all the Performance (Mean) of the Pharmaceutical Supply Chain was found to be 82.5% as summarized in Table 2 above.

3.2.1 Quality Indicators

Table 3: Mean and standard deviation of Quality indicators scores at Public Health facility 2023, Tabora

Measurement Items (Quality Indicator)	Mean	Std. Deviation
Products selected for the facility for procurement are based from National Essential Medicine List or facility formulary	95.1724	10.8759
Forecast accuracy -The facility forecast accurately and adheres to it	74.5862	21.8247
Put-Away Accuracy – The facility arrange properly inventories	74.6379	24.8805
Inventory accuracy rate – The facility records inventories properly	92.4431	13.6624
Health Commodities Availability Rate - The customers get product that they need from the facility	74.7551	16.7911
Facility order fill rate – The facility orders are full filled by supplier	38.5689	13.9234
Weighted average performance of quality Indicator	**75.0273**	**7.9385**

Source: own Survey**,** 2023

Facilities are expected to procure Pharmaceuticals from National Essential Medicine List or Specific Facility Medicine List (Formulary). This helps to restrict procurement of pharmaceuticals only from approved list and achieve efficiency with scarce resources as we know majority of diseases are cured by few medicines. In this study, majority of health facilities (95%) adhered to National Essential Medicine List as shown in table 3 above. This high adherence to Essential Medicine List supports the idea brought forward by WHO that the use of a limited number of well-known and cost-effective medicines may lead to improved long-term medicine supply, lower costs and better health care provision [57]. A study done in Sudan also found that all medicines on the Central Medical Store are selected from the Sudan National list of Essential Medicines [12]. In Ethiopia a similar study was done and established that, 92% of public health facilities procure EMHS by adhering to facility specific drug list [28]. Another study done in Rwanda found only 60% of EMHS were ordered following National Medicine Essential List [47].

Public Health facilities are supposed to forecast Pharmaceuticals according to their needs and adhere to it. It is important for the facility to adhere to forecast and procurement plan since the supplier stock items according to facilities forecasts. Failure to that means shortages become the norm. In this study, adherence to forecast by facilities was 74.6% as shown in table 3. This is moderate adherence to forecasts contrary to the purpose of accurate forecasts and supply planning which aims to ensure a sustained and effective supply of health commodities [23]. There is a need to look for a solution to help the facilities understand what has happened and to make changes quickly if necessary.

In this study facilities were evaluated on their ability to stock items in the correct location so they can be quickly and easily located. Keeping inventories in correct location is an indication of whether staff is practicing good warehousing practices and guidelines. The results shows that, 74.6% of facilities stocked items in correct location as shown in table 3 above. This result indicate that public facilities in Tabora region store commodities in correct location moderately which is not sufficient. Warehouse management involves proper storage locations for pharmaceutical products and other health supplies to maintaining their quality, safety, and efficacy. Insufficient storage management practice may lead to shortage, wastage, irrational utilization of drugs or overage of essential medicines [62].

Facilities are expected to control inventories over a set of review periods in order to know how much they have in stock at any given point in time and to know when a new order must be placed to replenish stock. Any discrepancies can help managers to improve overall inventory control performance. In this study inventory control performance was found to be 92.4% as shown in table 3 above. This results indicate that, Public Facilities in Tabora region adequately control inventories which is critical in ensuring the availability of essential medicines and provision of quality of pharmaceutical services. This is contrary to a study done in Namibia which found that, inventory control was 50%. Inadequately controlling inventories can lead to problems in the decision making in purchasing drugs and optimizing cost as it was established by Kagashe [24], that poor inventory control was behind medicines stock outs in Tanzania public hospitals.

The Tanzania National Goal is to have 100% availability of essential health commodities. In this study availability was assessed based on observed and reported availability rate during the twelve months of the year 2022. Since every facility conduct physical count by recording into stores ledger and physical count form, but also reports stock status monthly into eLMIS, average availability and stock out rates were easily calculated within the twelve months period of the year 2022. The study has found that, availability rate within 12 months was 74.8%, which is far below from the target as shown in table 3 above. Availability of EMHS is a sign of the quality of healthcare service delivery system [1]. This indicate that the quality of health care service of public health facilities in Tabora region is moderate similar to a study done in Ghana which established that patients were unable to receive all their entitled medical commodities at public healthcare facilities [1]. A study done in Ethiopia found a little bit lower availability of EMHS in public health facilities of 56% [54]. In Rwanda, a close neighbor to Tanzania, availability of EMHS was far better at 88% [47].

Supplier's ability in satisfying orders was also assessed in this study. To calculate this, the products ordered was compared with the same period products received for essential pharmaceuticals during the review period. Since orders are available into eLMIS and a copy of Invoice for received items is available at each facility, it was easy to track data accurately for the review period of 2022. In this study the percentage of facilities resupplied with the products ordered was about 38.6. This conforms to studies on supply chain performance of MSD which showed that until 2020 MSD was able to fulfil about 40% of the facility's requirements (44). It is possible to achieve adequate order fill rate like it is shown in a study done by *Levenger* [33] in Ethiopia which found a high order fill rate of 80%.In Rwanda the results of order fill rate were near to that of Tanzania at 47% [47].

The order fill rate helps to gauge the Supplier (MSD) response to facility needs when making orders. The Medical Stores Department, known as MSD, had a near monopoly on the national medical supply chain for Tanzania's public facilities, any inefficiencies in its distribution affects tremendously the overall health care system. The ideal order fill rate is 100%, which means that a facility receives the exact products that was requested when placing its order to suppliers (MSD). There is a need to strengthen the suppliers of EMHS in developing countries through common procurement.

The overall performance (weighted average) for quality indicators was found to be 75% as shown in table 3 above. This can be regarded as moderate performance. Quality is one of the key components that measured PSC performance. Organizations need to offer quality pharmaceutical services that create maximum value to the customer [13].

3.2.2 Responsive Indicators

Table 4: Mean and standard deviation of Responsive indicators scores at Public Health facility 2023, Tabora

Measurement Items	Mean	Std. Deviation
Responsive Indicators		
Facility on-Time reporting - The facility adheres to reporting schedule	66.6551	27.9941
Timely Delivery of Pharmaceuticals from Supplier/MSD -The Facility receives pharmaceuticals on time	98.7931	5.3238
Good receiving practice (Orders Entry Time) – Facility enters commodities received into LMIS timely	69.0172	27.0285
Weighted average for Responsiveness indicators	**78.0632**	**17.0025**

Source: own Survey**,** 2023

Public Health facilities are supposed to adhere to reporting schedules to maintain a minimum stock level of two months and maximum of four months for essential medicines. It is important for the facility to receive their fresh supplies before they run out of stock. Therefore, timely ordering secures new EMHS earlier and avoid out of stock situation. In this study facilities timely reporting is 66.7% as shown in table 4 above. This moderate timely reporting rate can jeopardize constant availability of health commodities in facilities causing patients to suffer and inconvenience if supplies of medicines are disrupted. This findings are supported by a study done in Dodoma region, Tanzania by Kuwawenaruwa [29] who reiterates that, improved availability of medicines needs timely ordering at health facilities.

Delays in receiving product can result in shortages and even stock outs throughout the distribution network. The survey evaluated the timeliness from ordering to receiving products from supplier (MSD) which is 18 days according to redesigned eLMIS system. Facilities which received products requested within schedule were 98.8%. In this study timely delivery to Tabora health facilities was not an issue contrary to a report by Printz [42] that, distribution of medicines from MSD does not always follow prescribed schedules. But a similar study conducted in Namibia showed that 85% of public facilities received EMHS within the scheduled delivery date [33]. In Rwanda timely delivery was worse than in Tanzania at only 54%.

According to established SOPs, received orders must be entered into Ledger and other Logistics Management Information System Tool (LMIS) within seven [7] days. In this study 69% of facilities entered received orders within schedule as shown in table 4 above. After *receiving* the *medicines*, the next step is *to enter* them *into* Inventory Management Tools as a Good Receiving Practice in Inventory Management. This study has found timely securing commodities into inventory tools to be moderate which could cause inefficiencies in inventory management because of inaccurate real-time information on how much inventory is in stock. This increases the risk of mistakes in reordering EMHS from suppliers hence causing wastages or shortages. Jobila [20] emphasize that, in order to ensure an uninterrupted supply of safe, effective and affordable EMHS we need a high performing inventory management.

Over all Responsiveness of PSC was 78%. The overall responsive indicators performance in this study was yet moderate which means the PSC of Tabora is yet to be fully responsive. Sarpong [46] also found responsiveness to be 50.7%, moderate though he called somehow responsive which affects performance of the PSC.

3.2.3 Cost/Financial Indicators

Table 5: Mean and standard deviation of Cost indicators scores at Public Health facility 2023, Tabora

Measurement Items		Std.
Cost Indicators	Mean	Deviation
Wastage minimization efficiency -The facility is successful in minimizing total product expired/damage in the drug store like product deterioration, breakage, leakage etc	95.2	9.7235
Efficiency in minimization of Transportation Cost to Value of Product	87.5	10.3608
The weighted average value for cost/financial indicator	**91.4**	**6.8811**

Source: own Survey, 2023

Deficiencies in storage can also be measured by the total value of stock that was unusable during the review period. This percentage helps managers to adjust order quantities and avoid wastage of products and monetary losses. In this study, 95% of the facilities has no stock of Unusable products in the drug store. A study done by Daniel, 2014 in Cameroon found that stored active stock was only 60%, far less than results from this study. A study with similar results was done in Ethiopia which found efficiencies among public health facilities in wastage minimization ranging from 99% - 89.4%

Efficiency in minimization of Transportation Cost to Value of Product shipped, aims at reducing budgetary constraints. High transportation costs means reducing the amount of fund needed for purchasing pharmaceuticals. This study evaluated the efficiency in reduction of transportation cost to value of products received by facilities and found to be 87.5%. This means transportation costs for majority of Health facilities is Low. Transportation costs significantly increases percentage of the value of *medicines* distributed to health facilities if not controlled, that's why the government of Tanzania have standardized transportation costs to all health facilities with the exception of emergency orders. This results implies that, medicines in public facilities of Tabora region have little hidden costs due to transportation hence affordable to many Tanzanians residing in Tabora region contrary to study done by Yenet [61] who found that, in East African countries most of medicines are not affordable by majority of populations.

Overall Cost Indicators was 91.4% which is high performance which indicates how efficiently public money is spent for the procurement of medicines [19].

3.2.4 Productivity indicator

Table 6: Results of Productivity indicators of Public Health Facilities 2023, Tabora, Tanzania.

Measurement Items Productivity Indicators	Mean	Std. Deviation
Efficiency in minimization of facility Emergency Orders	96.2	11.2167
Storage Space Utilization efficiency	61.4	17.8005
Facility orders Reporting Rates	99.1	4.839
The weighted average value for Productivity indicators	85.6	7.3693

Source: own Survey, 2023

Facilities are supposed to order accurately during normal ordering periods to avoid emergency order which are usually associated with high costs of delivery. Emergency orders are not delivered by supplier (MSD), hence facilities incur costs to transport emergency ordered products. This also can indicate poor processes during ordering which includes poor data use, inadequate knowledge of proper ordering etc. In this study, 96.2% of facilities managed to avoid emergency orders as shown in table 6 above. We have studied several different models for issuing emergency and normal replenishment orders in an inventory system in which both order types incur fixed costs. Johansen. S and Thorstenson. A., 2014 [21], also acknowledges that, emergency orders are costly unless there is a model which make sure that, normal orders and emergency orders, both incurs fixed costs which is not the case for Tanzania.

In this study facilities' ability to maximize storage space so as to improve storage capacity was also assessed. 61.4 percent of facilities were able to utilize storage space efficiently as shown in table 6 above. Storage space need to be used appropriately to provide for sufficient space between and for each EMHS. Maximization of storage space is important to ensure the quality of the EMHS are not affected since all storage conditions can easily be met [56].

All operational facilities are supposed to send their orders to supplier for re-supply according to schedule. Facilities that completed and submitted reports according to defined reporting schedule were 99% as shown in table 6 above. In Tanzania there is a "pull" system that required health facilities to order according to their needs. This means facilities which does not order will not receive EMHS from supplier hence disruption of supply chain. In this study facility submission of orders is not 100% as it is supposed similar to a study done by Chimnani and his colleagues 2010 in Tanga region, Tanzania which observed delays of submitted orders due to facilities not ordering per schedule until they are forced to do so hence affecting delivery from supplier (MSD). A similar study study in Rwanda facility reporting rates were also high of over 90% for the entire assessment period [47].

Overall productivity is 86% which is high performance although there is a need to focus on achieving 100%. This is almost similar to a study done in Ethiopia which found productivity to be 82% [3].

4. Discussion

4.1 Performance of the Pharmaceutical Supply Chain

Supply Chain has become complex such that practitioners and researchers seek to track the performance of the Pharmaceutical Supply Chain to ensure it is working efficiently. The overall performance of the Pharmaceutical Supply Chain Performance in this study was calculated with a mean value of 82.5%. This implied that the PSC of public health facilities in Tabora region was Highly Performing. This performance has positive implications on access to medicines and quality health care in Tabora region. The results are in agreement with a study done in Uganda which ascertained that access to Essential Medicine and Health Supplies (EMHS) is contingent on a high performing Pharmaceutical Supply Chain System that moves medicines and supplies from supplier to end user health facilities [34]. High performing PSC means effectively delivering products to the right place at the right time and at the lowest possible cost hence improving access to EMHS [46]. Availability of the health commodities in public health facilities in Tanzania remains a challenge, and has been reported to be below 70% on average [42].

Low performance was observed for facility order fill rate (38.6%) from MSD which need to be taken care of by supply chain managers. Parameters which moderately performed includes, efficiency in utilization of space, timely entry of received orders into registers, heath commodities availability rate, adherence to forecast and proper arrangement of inventories which needs corrective actions for better performance of the PSC. Furthermore, only 10% of surveyed facilities had adequate pharmaceutical personnel. High performing PSC needs supply chain specialists like pharmacist/Laboratory personnel to improve management practices of Health

Commodities. Different studies consistently indicate that pharmaceutical personnel involvement in the pharmaceutical supply chain improves management strategies [55].

Therefore, to assess the performance of the Pharmaceutical Supply Chain and take corrective actions will enhance the availability of the health commodities in the public health facilities in Tanzania.

5. Conclusion

The objective of this study was to assess the performance of pharmaceutical supply chain of public health facilities using key performance indicators. A quantitative research design was used to meet the research objectives. From the findings of this study we can conclude that the Pharmaceutical Supply Chain in Tabora region, Tanzania is highly performing in terms of quality, responsiveness, cost effectiveness and productivity. A highly performing PSC can help improve availability of EMHS and improve customer satisfaction. The severe weakness in this assessment was order fill rate from MSD. Prime Vendor System need to be strengthened to fill the gap from MSD in order to attain continuous availability of health commodities at health facilities.

By assessing the Pharmaceutical Supply Chain Performance and the factors contributing to its performance, you can identify areas where weaknesses are existing along the supply chain and take corrective measures.

6. Recommendation

The following suggestions are made in support of the results

- To conduct Annual operational researches on the performance of the Pharmaceutical Supply Chain and observe strengths and weakness for continuous transformation in order to improve access EMHS.
- Creating Dashboards into eLMIS using Key Performance Indictors to ease review of the performance of the Pharmaceutical Supply Chain for managers to take corrective actions in real-time.
- Employment of Pharmaceutical/Laboratory cadres and On Job trainings in Public health facilities should be emphasized for better performance of the PSC and improved Pharmaceutical services.
- Strengthening collaborative planning, forecasting and replenishment between public health facilities and supplier.
- There is a need to strengthen MSD to improve fill rate since majority of Government fund are disbursed to them and there is no way to transfer fund to prime vendor.
- MSD should see the possibility of managing Prime Vendors to improve fill rate using Government fund disbursed to them.

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7. Availability of Data and Materials

Data Sets and materials for information in this manuscript are available from principle investigator upon reasonable request.

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