Save life! Optimization of dynamics for pharmaceutical distribution performance

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Abstract

Purpose – Optimization of dynamics determining distribution performance of pharmaceuticals is vital in realizing Sustainable Development Goal (SDG) number 3 which insists on provision of good health and well-being to the society. This study was designed at unfolding diverse factors that influence the distribution performance of pharmaceuticals in the Medical Stores Department (MSD) of Tanzania.

Design/methodology/approach – This study utilized cross-sectional survey strategy in gathering data from 67 staff members working in the MSD using census approach. A structured questionnaire facilitated the collection of quantitative data which were later analyzed using ordinal logistic regression.

Findings – The results disclosed that all variables of inventory management, information management system and facility location positively and significantly govern the distribution performance and henceforth rejection of the foreseen null hypothesis.

Research limitations/implications – This study realized dynamics inducing distribution performance of pharmaceuticals but did not cover the role of 3PLS and 4PLS in enhancing the same, and hence, an imminent study ought to seal this gap. Also, having grasped management information system is of strategic pillar, then it would sound imperative to analyze the application of artificial intelligence in distribution system performance.

Originality/value – This paper assimilates the concept of subaspects of supply chain management in footings of distribution management and that of pharmaceuticals and hence multidisciplinary value addition. Also, this study illustrates the applicability of strategic choice theory in strategic management in developing countries through pertinent choice of inventory management, information management system and facility location in triumphing SDGs.

Keywords Supply chain management, Distribution management, Operations management, Logistics management

Paper type Research paper

1. Introduction

1.1 Background to the problem

The pharmaceutical sector has grown for many years worldwide, and this has impacted the ever-growing accelerating distributions and logistics challenges (Aytekin *et al.*, 2023; Wu and Dong, 2023; Yaroson *et al.*, 2021). The distribution system of pharmaceutical items is featured by dynamics (Diaz *et al.*, 2023). This intricacy is regarded one of the primary hurdles to the

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performance and efficiency of a pharmaceutical supply chain. Grujić *et al.* (2020) revealed that glitches of procurement and distribution significantly contribute to the overall inefficiencies of health systems in different nations by reducing complaints of limited access to necessary medications (Mackintosh *et al.*, 2018). Increased customers' needs force most of the business and non-business sector to optimize distribution process in order to mend customer service through product quality and availability while minimizing the logistics-related costs (Purvis *et al.*, 2021; Tukamuhabwa *et al.*, 2011). United Nations Sustainable Development Goal No 3 emphasized on the need to ensure good health and well-being to the public through accessibility of health supplies (Zimon *et al.*, 2020). Globally, a well-planned and executed distribution system keeps medicines in good condition throughout the distribution process, minimizes losses from spoiling and expiration, maintains accurate inventory records, keeps medicines in a steady supply, rationalizes medicine storage locations and guarantees that transportation facilities are used (Supply, 2012). On the other hand, effective and efficient flow of pharmaceuticals depends on the distribution management for ensuring the key objective of distribution management of maintaining a steady supply of pharmaceuticals (Hou *et al.*, 2017; Supply, 2012). The World Health Organization has primary functions that include increasing access to key pharmaceuticals and other medical developments as well as collecting, evaluating and using critical information (Githendu *et al.*, 2020).

In developed countries, effective distribution of pharmaceuticals depends on several dynamics, including logistics system in place, good inventory management, effective communication and coordination between the pharmaceutical manufacturers, distributors and health centers (Grujić *et al.*, 2020). The proper medications may be made available at the optimal time, in the optimal quantity and at the right place with the help of effective management information system (Wang *et al.*, 2024). This helps to prevent stock outs and overstocking, which can lead to wasted resources and decreased patient access to necessary medications. Good inventory management allows the pharmaceutical distribution system to run more successfully and efficiently (Volland *et al.*, 2017). Equally important, a reliable information management system is vital for coordinating the distribution network (Aytekin *et al.*, 2023). The information system tracks inventory levels, buy and sale prices and the distribution and reception of medications using forms and procedures. The system could be manual, automated or both (Supply, 2012). Effective information management systems can track the movement of drugs from different distribution centers, monitor their storage and handling and ensure that they are not expired or contaminated. Optimal information management practices can improve the safety, efficacy and efficiency of pharmaceutical distribution (Yousefi and Alibabaei, 2015).

Also, the location of the facility should be strategically chosen to minimize transportation costs and time while also ensuring that the facility is easily accessible to the target customer base (Savadkoohi *et al.*, 2018). Having multiple facilities in different locations can also help to ensure continuity of supply in the event of disruptions at a single facility. Finally, the efficiency and efficacy of pharmaceutical distribution can be greatly impacted by the placement of distribution centers (Jung *et al.*, 2021). Therefore, important distribution components are optimized to boost cross-regional commerce growth, establish material time-space matching, increase flowing material values and implement data collection and information management systems. A sustainable material flow system that accommodates competition enhances social and economic development in a community (Hou *et al.*, 2017). Adopting system inventory management best practices in the health sector can enhance donor collections, component manufacturing and the inventory that a hospital and blood supplier must maintain on hand in order to satisfy patient requirements through real-time inventory management, information management systems and demand forecasting. The majority of Canadian public sectors struggle with inventory control (Stanger *et al.*, 2012).

Despite major international finance efforts, emerging African countries, particularly those in sub-Saharan Africa, are concerned about their healthcare systems, notably the availability of pharmaceuticals (Yenet *et al.*, 2023; Mackintosh *et al.*, 2018). There are complaints that in Tanzania, the distribution of pharmaceuticals is not promising and hence leads to unsatisfactory customer satisfaction, contrary to the current global move of saving lives through proper medication (Masui, 2024; Ruhago *et al.*, 2022). The current distribution networks in Tanzania and Kenya have negative impact on general community access to high-quality medications and subsequent health outcomes (Mackintosh *et al.*, 2018). A study by Mahuwi and Israel (2024) conducted in Tanzania in other settings described the usage of electronic means in the management of pharmaceuticals as crucial. Tanzania established the Medical Stores Department (MSD) as an autonomous institution under Act of Parliament No. 13 of 1993 [CAP 70 R.E. 2002], which is in charge of, among other things, the distribution of health goods. The MSD aims at guaranteeing that medications and medical supplies of adequate quality are always available to all healthcare facilities in the entire nation (URT, 2023). The distribution process begins at MSD Headquarters Central Warehouse and extends to the last mile (individual health institutions) via MSD zonal stores and sales stations. It should be taken into note that the MSD in Tanzania is a giant organization which affects the global supply chain as the drugs are procured from different manufacturers and wholesalers located from different nations worldwide (URT, 2023).

Research has shown that most low- and middle-income countries' pharmaceutical and health commodity distribution systems face difficulties with inventory management, information management, projections and preservation (Githendu *et al.*, 2020). Specifically in Tanzania, the MSD distribution system is featured with unsatisfactory performance with frequent stockouts in health facilities (HSSP, 2015). Inventory management, information management system and facility location are very vital for the distribution performance in supply chain management system (Meredith and Shafer, 2023; Rushton *et al.*, 2022). Given that MSD is a life-saving organization that works to guarantee the timely distribution of medications throughout the nation, it is crucial to identify the precise cause of the subpar performance in the context of developing nations. This can be done by concentrating on the locations of facilities, information management systems and inventory management in Tanzania's pharmaceutical distribution system, as well as by setting a precedent for MSD users through this rigorous research. Therefore, based on the background of this study, the main objective was to establish the dynamics that need to be optimized for the distribution performance of pharmaceuticals in Tanzania. Moreover, in order to achieve the main objective, the following questions were addressed in this study;

RQ1. What are the inventory management dynamics that optimize distribution performance of pharmaceuticals?

RQ2. How do information management system dynamics optimize distribution performance of pharmaceuticals?

RQ3. Do facility location dynamics optimize distribution performance of pharmaceuticals?

1.2 Research gap

Pharmaceuticals are needed to treat and prevent human diseases (Ghadge *et al.*, 2023). The challenge of drug stockout resulting from an unsatisfactory distribution management system has been persisting in Tanzania, leading to unnecessary deaths (Elias and Mushi, 2024; Mollel *et al.*, 2024). Shortage of pharmaceutical requirements in healthcare facilities due to unsatisfactory distribution contravenes the UN SDG Number 3 which encourages good health and well-being of citizens. The Government of Tanzania took initiatives to establish

MSD to ensure adequate distribution management of pharmaceuticals to health facilities (HSSP, 2015). Despite the adopted initiatives, the Controller Auditor General (CAG) report of 2020/2022 noted the continuity of unsatisfactory supply to the health facilities featured with stock outs and slow moving of short-life-span drugs, which in turn affect the health of the public. It was also reported that MSD managed to fulfill only 34% of total customers' orders for 43,180,884 products, leaving 66% unfilled resulting into inadequate customer service (CAG Report, 2020/2021). The CAG report has recommended for the need to establish effective distribution management of pharmaceuticals. Moreover, inventory management and information management system are documented elsewhere as key dynamic factors for the distribution performance (Meredith and Shafer, 2023; Rushton *et al.*, 2022). Furthermore, shortage of pharmaceuticals normally results in loss of life in Tanzania (Sequeira D'Mello *et al.*, 2020; Kazibwe *et al.*, 2022). Therefore, having unsatisfactory distribution performance of pharmaceuticals in Tanzania compelled for the need for scholarly studies on how to optimize dynamics for the distribution performance in the context of Tanzania.

2. Literature review

2.1 Theoretical review

In the present inquiry, the strategic choice (SC) theory was used to shed light on the factors that influence pharmaceutical distribution. SC theory initially was proposed by Child (1972). According to Child, SC theory proposes that individuals' decisions such as those from top management about how to respond to external conditions like change in technology, location of facilities and availability of physical resources are key performance determinants. SC theory distinguishes one organization from another by emphasizing the significance of identifying, explaining and forecasting the factors of organizational success as well as understanding why some organizations outperform others (Bowersox *et al.*, 2020). These strategic decisions were taken as part of a company-specific learning process. SC theory focuses on addressing strategic issues of the organizations (Luu, 2023). Furthermore, SC is documented as a tool for the success of the organization targets (Ali, 2024). Better planning is very important, but SC always demands re-examination (Born, 2024). Management of pharmaceuticals distribution involves strategic decisions in order to attain long-term plans of the firms especially in terms of customer satisfaction (Guru *et al.*, 2023). Strategic decisions of pharmaceuticals distribution involve inventory management, information management system and facility location, which fall under strategic decision in terms of choice making while centering on the strategic orientation of the firms (Meredith and Shafer, 2023).

SC theory which specializes in best choice making is capable of elucidating the most suitable supply chain models that result in organizational performance (Tiwari *et al.*, 2023). Furthermore, the theory holds that sustainability of the organizations relies on how decisions are strategically made while taking care of the surrounding business environmental dynamics (Malik and Bebenroth, 2022; Hitt *et al.*, 2021). The theory has further proved to be relevant in determination of personal values (Lichtenstein *et al.*, 2022) and hence had to be conducted and tested in the context of distribution performance of life-saving commodities with emphasis on inventory management, information management and distribution facility location using MSD.

2.2 Empirical literature review

In order to think of and come up with the proper direction of this academic investigation, diverse findings were empirically analyzed and the gaps gained were used as the basis of seeking answers to undressed concerns as follows:

2.2.1 Inventory management of pharmaceuticals. Gabriel (2020) conducted a study on the rationale of inventory control systems in Tanzania's public health sector using descriptive

research methodology and a purposive sample technique to identify representatives. Data were obtained via questionnaires. The findings suggest that there are weaknesses in the inventory management system utilized by the organization on the issues facing the system in MSD. In this study, issues concerning managing stock level and outbound operation in physical inventory management on performance of an organization were not covered, so this study intended to find more information on those indicators. The study of Gabriel (2020) was descriptive and hence failed to explain the root cause of the performance using cause–effect relationship for wide generalizability. Nkuba (2019) conducted a study on pharmaceutical inventory management practices on service delivery using qualitative research design aided by the interview method to collect data. The findings revealed that Nyamagana Hospital uses both manual and computerized inventory recording systems. Knowing that MSD supplies pharmaceuticals to the entire country prompted for survey design aided with the usage of a questionnaire for wide generalizability. Yornu and Ackah (2020) carried out a study on the affiliation of efficacy of Inventory and Stores Management on Turnover of Central Medical Stores and realized that inventory management strategies have a positive impact on inventory turnover. The study of Yornu and Ackah (2020) was conducted in Ghana while focusing on turnover. MSD as an institution specially designated to render service to the public of Tanzania, and it is more of service delivery rather than turnover concerns and hence prompted for the same aspects to be tested in the context of public service delivery in Tanzania while focusing on customer satisfaction of MSD distribution performance.

2.2.2 Information management system of pharmaceuticals. Layti *et al.* (2020) conducted a study on logistics information systems versus traceability of pharmaceutical products hospitals. A questionnaire was used to collect data on reverse logistics traceability of pharmaceutical products. The results of analyzed data reveal that more than 90% of health institutions utilize basic/office automation combined manual systems for controlling their drug stockpiles, resulting in low traceability. Moreover, while the study of Layti *et al.* (2020) focused on reverse logistics, the undertaken study focused on the forward logistics movement of the drugs centered on order management during physical distribution management. Similarly, Yornu and Ackah (2020) found that inventory information management has a large effect on demand forecasting and a direct effect on turnover, but their study was done in the context of another developing country in Africa. Also, Oraini (2024) conducted a study on the role of information systems on performance in the pharmaceutical sector and revealed that the current information system directly effects the performance of pharmaceutical enterprises in the Middle East, which has eventually affected how decisions are made within the firms. The scope of the study focused on general contribution of information management on firm performance and not specifically on the effectiveness of distribution of pharmaceuticals toward firms' performance, and hence, the study aimed at filling this scholarly gap. Firms' performance is a function of both logistic input and output. Based on the contextualized problem of this study, it was specifically focused on analyzing distribution of pharmaceuticals and hence systematically stuck on logistic output as prompted by the study problem.

Sehrish (2020) conducted research on the impact of integrating information systems on firm performance by referring the Platinum Pharmaceuticals Ltd. as a study area. The study examined the impact of procurement criteria in regards to information systems on the corporation's overall performance. A combination of research methods was employed to steer the study, and data were gathered utilizing a questionnaire. The integration of the information system in the procurement department has a beneficial impact on the annual return on investment of Platinum Pharmaceuticals Ltd., according to the data system results. The study was limited on contribution of the information system in inbound logistics toward firm performance. This study aimed to cover the relationship between information management and outbound operation toward firm performance in terms of customer care.

Furthermore, the primary goal of the selected firm was manufacturing while MSD is a non-manufacturing organization and thus this study called for wide generalization of the findings.

2.2.3 Facility location for distribution performance of pharmaceuticals. Onstein (2021) conducted a study on factors influencing physical distribution structure design. The study's findings revealed that the number of major facilities has increased over time, as has their contribution to the total developed surface area. As a result, large facilities play a significant role in developing spatial planning policies. Results also show factors that may contribute to the decision whether or not to relocate facility within the current region. The third question identifies three factors that determine companies' distribution structure design. The study explained factors influencing physical distribution structure design but did not state the contribution of location of distribution facility on the performance of a pharmaceutical industry. Furthermore, another scholar discovered an impractical warehouse site; the presence of redundant operations reduces distribution efficiency (Gabriel, 2020). Gabriel's (2020) study was observational, and thus, it failed to clarify the core cause of performance utilizing cause-and-effect relationship.

The study conducted by Kramer *et al.* (2019) on rich vehicle routing with due consideration to auxiliary depots and delivery speculations in pharmaceutical distribution attempted to show and clarify a routing challenge encountered by a 3PL provider in distribution of pharmaceutical supplies to health units. The study results reveal current routing decision resulted in unsatisfactory utilization of hospital medical warehouses, mismatch between demand quantity and supply quantity at the expense of distribution costs and unfair geographical proximity of the health centers and the distribution points. Routing is a subset of distribution management. Effective routing depends on the nature of facilities location and hence prompted for the need to look at the location of distribution facilities of MSD which serves as depots in Tanzania.

Sánchez-Sierra *et al.* (2018) conducted a study on facility location model with inventory transportation and management costs. The study's scope was to lay out an integrated inventory facility location model that minimized distance, transportation and inventory management expenses. Following analysis, the location of the suppliers and distribution facility was selected using only the basic model. By re-estimating (revising) the location of the distribution facility, it was found that the optimal location for distribution facility is minimized and also transportation cost in the revised location was minimized. The study covered effects of facility location on upstream transportation costs, but it did not explore downstream transportation costs.

2.3 Hypothesis formulation

Having reviewed theoretical and empirical literature reviews, it remained very important to postulate some hypotheses for scientific hypothetical deductive testing of the existing problem as follows while focusing on three key aspects.

Empirically, inventory management accounts for the firm's performance (Rashid and Rasheed, 2023). Equally important inventory management is closely linked with total quality management and hence better performance of the firms (Mahajan *et al.*, 2024). However, the study of Mahajan *et al.* (2024) focused on the overall performance of the firms in other countries apart from Tanzania, while this study is focused solely on the distribution performance. Focusing on the distribution performance might be of more advantage because in business management, there is a need for understanding the most beneficial area that contributes more to the performance. Furthermore, the limitations of the study area of Rashid and Rasheed (2023) called for the need of related studies to be conducted in other settings for wider generalizability. Equally important is the study of Mahajan *et al.* (2024) based on the systematic literature review and hence called for the need of quantitative study guided by

positivism paradigm. Therefore, based on those arguments, this study postulated Ho_1 to underscore what persists in other context persists in the context of inventory management versus distribution performance of pharmaceuticals in Tanzania?

HO1. Inventory management is not one of the dynamics for distribution performance of pharmaceuticals.

Also, studies conducted in developed countries counted management information system as a key driver for the supply chain performance of firms (Naceur *et al.*, 2024; Roldán Bravo *et al.*, 2023; Harju *et al.*, 2023; Kliestik *et al.*, 2023). However, the level of adoption of technology determines the viability of the use of systems and automation for real-time information use in the business. African countries are lagging behind because of the associated cost (Mwakyusa and Ngwebeya, 2022; Changalima and Ismail, 2022; Smidt and Jokonya, 2022). Interestingly, Ade-Ibijola and Okonkwo (2023) argued that the information system should be adopted in Africa quickly as it is regarded as a tool for alleviating poverty. Due to this debate, the inventory management remained as one of the dynamics worth hypothesis testing for wide generalizability as follows:

HO2. Management information system is not one of the dynamics for distribution performance of pharmaceuticals.

Similarly, facility location is described as one of the key issues for management of activities (Taouktsis and Zikopoulos, 2024; Yunusoglu *et al.*, 2024). However, with the invention of online services aided by Internet, facility location seems not to be a key issue (Rahman and Rahman, 2022). Arguably, facility location remains very vital in the distribution and marketing of physical goods from one point to another one for the accessibility to the user (Nazemi *et al.*, 2022). With the close proximity of the facility location to the customers, there is reduction of transportation cost and hence enriched customer care (Rajak *et al.*, 2018, 2021). Therefore, based on those mixed results, the following hypothesis was postulated:

HO3. Facility location is not one of the dynamics for distribution performance of pharmaceuticals.

2.4 Conceptual framework

Diagrammatic presentation of the relationship of variables showing dynamics that optimize distribution performance of pharmaceuticals was presented. Hereunder, inventory management, information management system and facility location were described as predictor variables assumed for the distribution performance measured in terms of customer care. See Figure 1 to see the relationship and *HO1*, *HO2* and *HO3*.

3. Methodology

3.1 Study area

The study was undertaken in Tanzania's regions of Dar es Salam, Dodoma, Mwanza, Mbeya, Kilimanjaro, Mtwara, Tanga and Kagera. The logic behind the choice of these regions is that MSD Headquarters Central Warehouse is located in Dar es salaam and Zonal Warehouses are placed in Mwanza, Iringa, Kilimanjaro, Mbeya, Tabora, Dodoma, Tanga, Mtwara and Kagera (Pyuza *et al.*, 2023; Mbwasi *et al.*, 2023). The operations found in the head quarter and zonal warehouses are the ones associated with physical management of inventories, information management system and facility location decisions accompanying with pharmaceutical distribution of MSD in Tanzania.

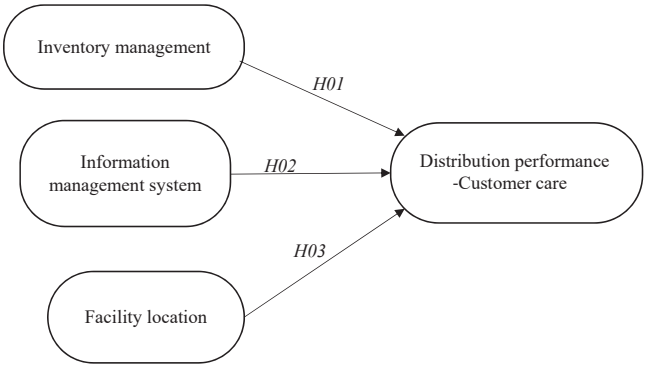


Figure 1.
Conceptual framework

Source(s): Adopted from the literature review (2023)

3.2 Research strategy

This study opted for a cross-sectional survey research design. In terms of time, data were gathered once there was no requirement for monitoring any temporal changes and therefore the cross-sectional approach. Geographically, the study covered different regions in Tanzania of the country, and hence the survey approach was aided by a structured questionnaire. This study was based on deductive quantitative methodologies due to the utilization of a survey approach. The logical method centered on employing SC theory. Quantitative approach aims to generate and analyze numerical data (Tashakkori and Teddlie, 2021). Furthermore, the quantitative method primarily involves a survey via questionnaires to collect data which are ultimately given in numbers for the application of statistical analysis tools (Creswell, 2021). The need to study the cause–effect relationship of determination of contributing dynamics of pharmaceuticals distribution on the performance of MSD in Tanzania called for the explanatory-survey design by using those contributing dynamics as an explanatory variable to explain the distribution performance as an outcome variable. The strategy centered on collecting numerical data from the sampled personnel of the directorate of distribution management present in the MSD zonal offices across the country.

3.3 Sampling and data collection strategies

The researcher gathered information from the staff members who are working in the warehouses that facilitate distribution management of pharmaceuticals in MSD. Therefore, having a total population of 67, it is then realized that the target population of this study was 67 respondents. Having realized that, only 67 are available for inquiring information; the census method was espoused for complete enumeration as sample size. Census tends to be more representative and hence eliminates biasness (Walker, 2023). Other scholars in the discipline of supply chain management that utilized a small sample size and hence used a census methodology are Kimario and Mwagike (2024) with 55 enterprises, Kimario and Kira (2023) with 55 firms and Kamau (2013) with 56 firms. Moreover, three of the targeted respondents did not react. The reaction level obtained was adequate for this investigation as it has been highlighted as a reaction level of more than 70% is acceptable (Mugenda and Mugenda, 2003). Staff members from the warehouses falling in the physical distribution management were targeted because of being at the position to explain how inventory management, distribution information management system and facility location decision affect the performance of MSD outbound logistic operations in terms of customer's satisfaction as they are the ones receiving complaints from the customers and handling them.

The usage of customer's complaints to index customer's satisfaction serves an extra advantage identifying the very specific concerns while providing prompt feedback for upgrading (Rane *et al.*, 2023). Data for this study were primarily collected using the questionnaire. Furthermore, quantitative data were collected via a survey approach using standardized questionnaires. For reliability purposes, questionnaires were exposed to a pilot of 11 respondents, thereby meeting the minimum suggested sample size of 10 as proposed by Creswell (2021). This study focuses on collecting quantitative data from employees operating in warehouses of the physical distribution management of MSD.

3.4 Operationalization of variables and data analysis

The operationalization of variables has helped to undertand the construct variables of the primary independent variables as well as assigning them numbers through coding so that they could be conveniently be processed by computer. The following builds were used to implement inventory management as the explanatory variable: inventory management in terms of issuing of stock (acceptance of customer requests, selecting what is under request and handing them to who has requested them), stock levels (indispensable inventory, which refers to the optimal quantity of items to be maintained for the smooth functioning of the firm) and safety stock (safety stock is a further quantity of items kept in the warehouse). The following components were used to operationalize the explanatory variable: inventory accessibility (access to each product's current location, available stock, relevant purchase and orders), order management (receiving, tracking, fulfilling and shipping an order to a customer), relationship (handling of different actors of distribution management of pharmaceuticals from headquarters down to the zonal warehouses and eventually the health facilities) and e-information sharing (sharing of inventory details via online system using electronic networked devices). Also, facility location was operationalized as proximity to the customers (nearness of the warehouse to the hospitals/health center), routing decisions (creation of the most cost effective path whilst minimizing travel time to stretch on loading and offloading plugs) and cost (refers to both standing and operational expenses associated with positioning of the warehouse at a certain point). Furthermore, the designated constructs were hypothesized using a five-point ordinal scale. This facilitated the understanding of the attitudinal expression in the form of an ordinal scale reflecting how inventory management systems are embraced in the context of pharmaceutical distribution management in MSD Tanzania. The five-point ordinal scale was coded under the following coding; 1-very low extent, 2-low extent, 3-ordinary extent, 4-great extent, and 5 very great extents.

This study's outcome variable is the distribution performance operationalized by customer satisfaction. The rationale behind the choice of customer satisfaction based on the usage of customer handling complaints arrangement which is an eye focus of all staff members of MSD involved in the distribution system of pharmaceuticals from the central warehouse down to the zonal warehouses. All complaints gathered through different means such as phone calls, emails, verbal communication and suggestion boxes are directly communicated to the staff involved in the distribution system. The usage of customer's complaints to index customer's satisfaction serves an extra advantage identifying the very specific concerns while providing prompt feedback for upgrading (Rane *et al.*, 2023). Information was captured using an ordinal scale. The choice of five points in the ordinal scale is an insight from past scholars who studied the connection between cause and effect in social sciences disciplines. Other scholars who analyzed social science traits using an ordinal scale of 5 points are Magoma (2021), Kimario and Mwagike (2021) and Mwaiseje and Mwagike (2019).

The collected data were analyzed with the help of Statistical Package for Social Solution (SPPS) using ordinal logistic regression. Congruently, the cause–effect relationship that exists between distribution of pharmaceuticals and the performance of MSD was inexorable.

Traditionally the best way to capture data for quantitative analysis is through using continuous numbers. Cause–effect relationship studies call for regression analysis as a quantitative approach. Customer service as an outcome of the relationship seems qualitative in nature. Precisely, customer satisfaction is an attitudinal aspect apprehended expressively using an ordinal scale. The use of ordinal logistic regression in this investigation was extremely useful and included strategies for automatically reproducing the important ordinal variable (Fernandes *et al.*, 2021). Tillmanns and Krafft (2021) use qualitative responses as an alternative for factors that cannot be described numerically using continuous numbers in multiple regression analysis. Thus, the alternative qualitative technique for assessing performance was chosen analogous to the practices of Chebichii *et al.* (2021), Kimario and Mwagike (2024), and Matimbwa and Masue (2019) who performed the same. Also, in order to enhance visual presentation of the findings, scatterplot graphs were used to show the relationship of the variables (Goh *et al.*, 2024).

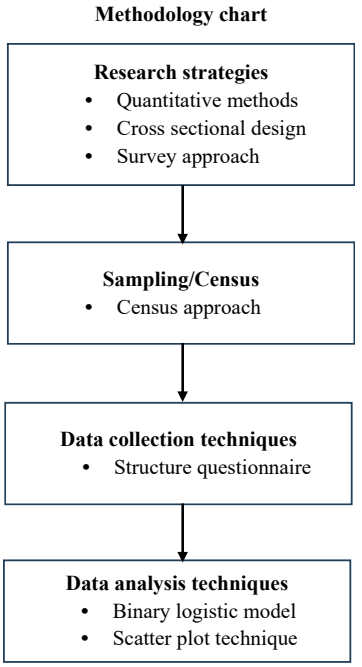
3.5 Flow chart of the methodology

In order to enhance audio visual presentation of the methodology, kindly see Figure 2 which shows the flow chart of the methodology.

4. Presentation and discussion of the findings

4.1 Reliability tests

Reliability of the variables that were independent shown by the findings of coefficient of reliability was evaluated by Cronbach alpha approach, and the results were as follows:



Source(s): Summary of methodology (2024)

Figure 2.
Methodology chart of the study

inventory management (0.77), information management system (0.85) and facility location (0.77). Therefore, the data for this study were generalized to be reliable as the coefficient of reliability was above 0.7, as supported by Purwanto *et al.* (2020).

4.2 Diagnostic test of the findings

Based on the fact that it is recommended when conducting a parametric study, it is important to conduct diagnostic tests before embarking on inferential statistical analysis. Diagnostic tests of the parameters of the ordinal logistic regression model had been verified before performing deductive statistical evaluation (Garren and Osborne, 2021). Therefore, model fitness and multicollinearity of the data were all tested before running logistic regression. Findings indicate proportionality of the predictor factors to the resultant variables validated using Pseudo R square of 62.4% for the appropriateness of the data. The Nagelkerke value, together with inventory management, information management and facility decisions, explains 62.4% of the variation in the result for the variable of customer service in MSD. Despite of the fact that SPSS produces two outputs, i.e. Cox and Snell and Nagelkerke, the latter was chosen in preference to the other one due to its ability to reach maximum theoretical coefficient value of 1 (Field, 2024).

The multicollinearity tests were checked. The relationship between each of the variables predicted was verified using both the inter-item matrix of correlation and the variance inflation factor (VIF). The inter-item correlation matrix revealed that the value of the coefficients of correlations varied between 0.1 and 0.6. According to the rule of thumb, a coefficient of correlations less than 0.8 shows the lack of multicollinearity. As a result, it is safe for ruling out the absence of multicollinearity in this data because the coefficients of corrleation of the variables that predicted controlling the dynamics of pharmaceutical distribution were all less than 0.8, as disclosed in Table 1. Furthermore, VIF collinearity statistics were as follows: inventory management (1.051), management information system (1.181) and facility location (1.192), and hence, there is an extension of the argument that there is no multicollinearity because the values were all less than 10 as ruled by Senaviratna and Cooray (2019). However, it should be understood that VIF is the most confirming technique

		Inventory management	Information management	Facility location	Effective distribution
Inventory management	Pearson correlation	1	0.169	0.195	0.375**
	Sig. (2-tailed)		0.178	0.120	0.002
	N	65	65	65	65
Information management	Pearson correlation	0.169	1	0.379**	0.483**
	Sig. (2-tailed)	0.178		0.002	0.000
	N	65	65	65	65
Facility location	Pearson correlation	0.195	0.379**	1	0.630**
	Sig. (2-tailed)	0.120	0.002		0.000
	N	65	65	65	65
Effective distribution	Pearson correlation	0.375**	0.483**	0.630**	1
	Sig. (2-tailed)	0.002	0.000	0.000	
	N	65	65	65	65

Note(s): **Correlation is significant at the 0.01 level (2-tailed)
Source(s): Field data (2023)

Table 1.
Inter-item correlation matrix

for checking correlation of variables (Field, 2024). Other social science researchers employed VIF, including Magoma *et al.* (2024) and Shahanga and Kasambala (2023).

4.3 Presentation and discussion of the inferential statistical upshots

During the course of data interpretation dyanamics that contributes to changes in pharmaceuticals, distribution effectiveness was analyzed using ordinal logistics regression analysis, and the *P*-value is considered significant when it is less than 0.05, implying the confidence interval of the results of this scholarly work is 95% (Di Leo and Sardanelli, 2020). As a result, hypotheses with *p*-values below 0.05 were significantly rejected. After the ordinal regression assumptions had been verified, the researcher proceeded to perform the inferential statistical evaluation through actual testing of the given assumption (Fernandes *et al.*, 2021). The regressions were conducted for every independent variable versus the dependent variables, as hypothesized. The inferential statistical results derived from ordinal logistics regressions are shown in Table 2.

HO1. Inventory management has no effect on distribution of pharmaceuticals. The HO1 having $< p$ value of 0.012 and β coefficient of 0.237 was significantly rejected at $p < 0.05$. The findings in their first impression concur with those of Alam *et al.* (2024) who argued that inventory management is very useful. The research investigation of Alam *et al.* (2024) took place in a developing country of Asia, and strangely, the findings accord with our study, which was conducted in Africa, signaling that developing countries globally should strive for improved ways of managing their inventories.

A step further of analysis as shown in Table 3 aimed to understand the parameters of inventory management issuing of stock ($p = 0.041$, $\beta = 0.6$), stock levels ($p = 0.002$, $\beta = 0.7$), safety stock ($p = 0.027$, $\beta = 0.1$) and steady stock supply ($p = 0.005$, $\beta = 0.3$) categorically and

Table 2. Ordinal logistic regression results on overall dynamics influencing distribution performance of pharmaceuticals

Model		Standardized coefficients Beta	Sig	95.0% confidence interval for B Lower bound	Upper bound
1	Constant		0.560	−1.026	0.561
	Inventory management	0.237	0.012	0.053	0.402
	Information management	0.259	0.009	0.075	0.512
	Facility location	0.485	0.001	0.305	0.712

Source(s): Field data (2023)

Table 3. Ordinal logistic regression results of inventory management vs distribution performance of pharmaceuticals

Parameter	Estimate	Std. error	Wald	df	Sig	95% confidence interval Lower bound	Upper bound
Threshold							
Effective distribution = 1.00	2	0.5	6	1	0.014	1	3
Effective distribution = 2.00	1.5	0.7	5	1	0.025	0.1	2.9
Location							
Issues of stock	0.6	0.3	3.5	1	0.041	0.1	1.1
Stock level	0.7	0.12	10	1	0.002	0.46	0.94
Stock safety	0.1	0.08	0.4	1	0.027	0.05	0.25
Steady stock supply	0.3	0.06	8	1	0.005	0.18	0.42
Link function: logit							

Source(s): Field data (2023)

significantly contributes to distribution management of pharmaceuticals that enhances customer care. Based on the findings, it has been noted that the distribution performance of pharmaceuticals is not promising because of failure to manage the safety stock properly in the distribution systems contrary to the expectations of the users. Interestingly, further analysis of the construct variables employed scatterplots to show the association of the independent variables to the dependent variables. In examining the influence of inventory management on the distribution of pharmaceuticals at the MSD, a scatterplot was employed (refer to Figure 3). The plot indicates a positive, although weak, connection between inventory management and effective distribution (R linear = 0.141). This indicates that while enhanced inventory management practices influence more efficient distribution, there may be additional factors impacting distribution effectiveness. However, the extent of R^2 does not necessarily matter and hence the described R^2 value of 9% and above is regarded as reasonable for inferential analysis (Itaoka, 2012). Therefore, findings of the specific parameters concur with those of Gonçalves *et al.* (2020), Motla *et al.* (2023) and Delshad *et al.* (2024) who argues proper inventory management in either safety stock, the manner of issuing and the levels to be kept is of high stake for the performance of the operations but should be well managed so as to realize its benefit.

HO2. Information management has no effect on distribution of pharmaceuticals. The HO2 having a p value of 0.009 and β coefficient of 0.259 was significantly rejected at $p < 0.05$. The findings generally concur with those of Yang *et al.* (2021) who argued that information management systems should be well optimized in the distribution of medical materials for effective public health service in developed countries. Therefore, same findings concurred in developing countries using Tanzania medical supply system as a lesson. Detailed analysis as shown in Table 4 aimed to understand the parameters of information management system revealed inventory accessibility through tracing ($p = 0.043$, $\beta = 0.8$), order management system ($p = 0.002$, $\beta = 0.95$) as supported by Guo *et al.* (2023) from developed country, e-information sharing ($p = 0.006$, $\beta = 0.4$) as supported by Esmaeilzadeh (2023) and relationship management through electronic systems such as ERP (Enteprise Resource Planning) ($p = 0.021$, $\beta = 0.15$) by Kumar *et al.* (2023) significantly contributes to distribution

Source(s): Field Data (2023)

Figure 3.
Scatter plot for inventory management vs distribution performance

performance of pharmaceuticals that enhances customer care. Figure 4 is the scatterplot that displays the connection between information management and the efficient distribution of pharmaceuticals in a medical store department. On the horizontal axis are the scores for information management, where higher scores indicate better practices in managing information. The vertical axis represents the scores for effective distribution, with higher scores indicating a more efficient distribution process. The line of best fit shows a positive slope, suggesting a positive correlation between information management and effective distribution. The R^2 value, $R = 0.234$, reveals that approximately 23.4% of the variation in effective distribution scores can be accounted for by the scores for information management and hence the model fitted the data as ruled by Itaoka (2012).

HO3. The location of distribution facilities has influence on distribution of pharmaceuticals. The HO3 having a p value of 0.001 and β coefficient of 0.485 was significantly rejected at $p < 0.05$. The findings concur with the argument of Hugos (2024) and Egri *et al.* (2023) that proper location of the distribution facilities ensures responsive distribution performance. A step further of analysis as shown in Table 5 aimed to understand the parameters of location

Table 4.
Ordinal logistic regression results of management information system vs distribution performance of pharmaceuticals

a. Indicator analysis

Parameter	Estimate	Std. Error	Wald	df	Sig	95% confidence interval Lower bound	Upper bound
Threshold							
Effective distribution = 1.00	1.2	0.35	4.5	1	0.034	0.55	1.85
Effective distribution = 2.00	2.3	0.6	6.8	1	0.009	1.1	3.5
Location							
Inventory accessibility	0.8	0.25	3.2	1	0.043	0.31	1.29
Order management	0.95	0.18	9.6	1	0.002	0.6	1.3
Relationship	0.15	0.07	2.4	1	0.021	0.01	0.29
E-information	0.4	0.08	7.5	1	0.006	0.25	0.55
Link function: logit							

Source(s): Field data (2023)

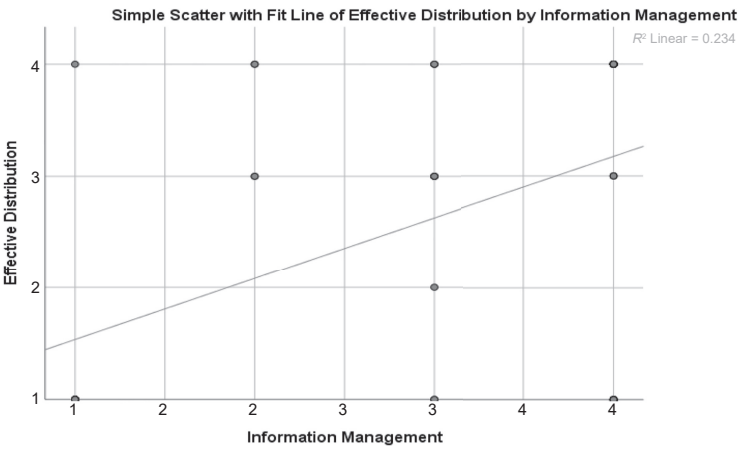


Figure 4.
Scatter plot for information management system vs distribution performance

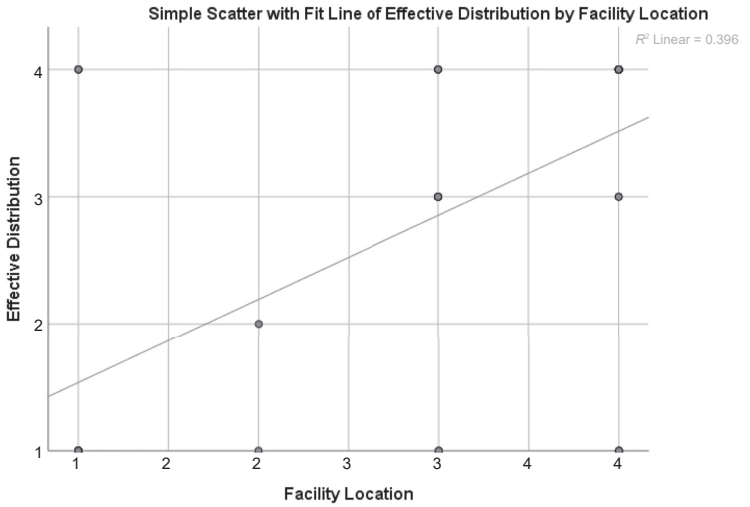
Source(s): Field Data (2023)

of distribution facilities and revealed proximity to the customers ($p = 0.044$, $\beta = 0.5$) as supported by Loussaief *et al.* (2023) and Ouyang *et al.* (2024), routing decisions ($p = 0.002$, $\beta = 0.8$) as supported in related context by Ning and Du (2023), facility location costs ($p = 0.009$, $\beta = 0.15$) as supported Meneses *et al.* (2023) and accessibility of the location facilities ($p = 0.006$, $\beta = 0.4$) as supported by Koenig and Diarra (2023) categorically and significantly contribute to distribution performance of pharmaceuticals that enhances customer care. Figure 5 is the scatterplot that displays the connection between information management and the efficient distribution of pharmaceuticals in a medical store department. On the horizontal axis are the scores for information management, where higher scores indicate better practices in managing information. The vertical axis represents the scores for effective distribution, with higher scores indicating a more efficient distribution process. The line of best fit shows a positive slope, suggesting a positive correlation between information management and effective distribution. The R^2 value, $R = 0.234$, reveals that approximately 23.4% of the variation in effective distribution scores can be accounted for by the scores for information management.

Parameter	Estimate	Std. Error	Wald	df	Sig	95% confidence interval Lower bound	Upper bound
Threshold							
Effective distribution = 1.00	1.8	0.52	5.2	1	0.022	0.8	2.8
Effective distribution = 2.00	1.2	0.69	4.5	1	0.034	0.2	2.2
Location							
Proximity	0.5	0.28	3.2	1	0.044	0.1	0.9
Routing	0.8	0.11	9.6	1	0.002	0.59	1.01
Cost	0.15	0.07	1.8	1	0.009	0.01	0.29
Accessibility	0.4	0.05	7.5	1	0.006	0.3	0.5
Link function: logit							

Source(s): Field data (2023)

Table 5. Ordinal logistic regression results of facility location vs distribution performance of pharmaceuticals



Source(s): Field Data (2023)

Figure 5. Scatter plot for facility location vs distribution performance

5. Conclusion and recommendation

5.1 Conclusions

This study examines dynamics determining the distribution of pharmaceuticals in Tanzania. The study concludes that inventory management in terms of issuing of stock, stock levels, safety stock and steady stock supply categorically and significantly contributes to distribution performance of pharmaceuticals that ultimately enhances customer care. On another hand, distribution management system in terms of accessibility through tracing, order management system and e-information sharing and relationship management through electronic systems contributes to distribution performance of pharmaceuticals that ultimately enhances customer care. Equally important, location of distribution facilities revealed that proximity to the customers, routing decisions, facility location costs and accessibility of the location facilities is of fundemental importance.

5.2 Implications

Distribution system of pharmaceuticals is supposed to be well optimized because it is a lifesaving bustle. Therefore, Tanzania, as a developing country, is recommended to optimize on this finding to revamp its current performance. Interestingly, this paper assimilates the concept of sub-aspects of supply chain management in footings of distribution management and that of pharmaceuticals and hence multidisciplinary value addition. Inventory management, management information system and facility location are both considered as the strategic supply chain dynamics which configure the future success of the distribution of pharmaceuticals in Tanzania. Thus, the study contributes to the thrilling literature on the debate of understanding dynamics that optimize distribution performance of pharmaceuticals in Tanzania. Also, while Tanzania is challenged by unsatisfactory customer care in health in terms of access of medicinal drugs, this study has filled the gap by identifying key factors to focus on while achieving SDG Number 3 which insists on equal opportunity of access to health services. Equally important, the Ministry of Health and Social Welfare of Tanzania through MSD is encouraged to re-organize its distribution system of pharmaceuticals in the country. Theoretically, the study contributes to SC theory by describing how SC is applicable to the distribution system of pharmaceuticals of developing countries through thought-out choice of inventory management, management information system and location optimization.

5.3 Limitation and areas for future studies

Despite the fact that this study accomplished the principal purpose, it went through some limits that merit future research to be conducted to bridge the gap. Knowing dynamics that determine the distribution system of pharmaceuticals, future can contemporarily be directed on the use of third- and fourth-party logistics given its trending worldwide application. Also, knowing distribution management system is a challenge, and future study should extend to the usage of artificial intelligence on distribution system and even more largely on supply chain performance of medical items. Equally important, since the three major dynamics studied were found significant, future study should be sequential quali-quanti so as to explore more dynamic factors that ultimately influence distribution performance of pharmaceuticals.

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