Strengthening Cameroon's Pharmaceutical Supply Chain: Tackling Manpower Shortages, Ensuring Regulatory Compliance, and Mitigating Supply Disruptions

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Abstract

This study investigates the pharmaceutical supply chain in Cameroon, highlighting the shortage of qualified personnel, supply disruptions, and the need for regulatory compliance. It examines socioeconomic disparities, political challenges, and quality concerns within the context of pharmaceutical distribution. The research emphasizes the importance of establishing a reliable supply chain, incorporating effective risk management systems, and promoting greater visibility through real-time information sharing. Additionally, it addresses ethical considerations such as informed consent and confidentiality. Policy interventions and training programs aimed at improving distribution practices are explored to offer recommendations for enhancing the efficiency, reliability, and safety of pharmaceutical supplies in Cameroon. The findings contribute to existing literature and support informed policy decisions for future improvements in similar settings.

1 Introduction

1.1 Background of the Study

Background of the Study

The pharmaceutical supply chain in Cameroon presents a complex and multifaceted system influenced by various socio-economic and political factors. Cameroon, a Central African country with a population of approximately 19 million people, is characterized by its diverse ethnic composition, comprising 230 ethnic groups. The country shares borders with Nigeria, Chad, the Central African Republic, Equatorial Guinea, Gabon, and the Democratic Republic of Congo. This geographical and demographic diversity plays a significant role in shaping the pharmaceutical distribution network within the country.

The pharmaceutical sector in Cameroon, as in many developing countries, faces challenges related to the amplification of small variations in patient demand as order information flows upstream through the multi-tiered distribution system. This system includes health facilities, district stores, central medical stores, procurement entities, and manufacturers Yadav, 2015. The complexity of this distribution network often leads to inefficiencies and disruptions in the supply chain, affecting the availability of essential medicines.

The Ministry of Health and Social Services (MOHSS) in Cameroon oversees 14 regions with 350 public health facilities, managing the Central Medical Store (CMS) Bowser et al., 2019. Despite this extensive network, the public sector's drug supply often falls short compared to the private sector. In the private sector, where patients pay for medicines, there is a vested interest in maintaining stock levels to ensure continuous supply. Conversely, in public health institutions, where drugs are provided free of charge, there is less incentive for personnel to ensure a constant supply of medicines.

The political landscape in Cameroon further complicates the pharmaceutical supply chain. Policymakers are often caught between the interests of the established elite, which includes commercial, medical, pharmaceutical, and political stakeholders, and the non-organized rural masses. This dichotomy influences the prioritization and allocation of resources within the health sector, impacting the efficiency of drug supply and distribution.

Moreover, the state of Cameroon has not fully transitioned to a stage where the legitimation of power is achieved through the extension of public welfare. Instead, it still relies on the threat of physical force to maintain control Van

Der, 2001. This reliance on coercive power rather than welfare provision affects the overall effectiveness of public health initiatives, including the pharmaceutical supply chain.

In addition to these socio-political challenges, the quality of medicines in Cameroon is a critical concern. Studies have shown that the prevalence of substandard and falsified (SF) medicines is significantly higher in Cameroon compared to global averages. For instance, the prevalence of SF antibiotics in Cameroon is reported to be 20.4%, much higher than the 7.2% reported by the World Health Organization (WHO) Waffo Tchounga et al., 2021. This high prevalence of poor-quality medicines further exacerbates the challenges faced by the pharmaceutical supply chain in ensuring the availability of safe and effective drugs.

The region has also developed its own treatment guides in the absence of national-level guidelines, highlighting the need for localized solutions to address the unique challenges faced by different regions within the country. The analysis of order satisfaction rates by the Central Procurement Agency for Essential Medicines (CENAME) indicates that the average rate of satisfaction of orders is below 60%, suggesting significant room for improvement in the supply chain Daniel and Eghan, 2011.

In summary, the pharmaceutical supply chain in Cameroon is influenced by a combination of socio-economic, political, and quality-related factors. The complexity of the distribution network, the dichotomy between public and private sector interests, the political landscape, and the prevalence of substandard medicines all contribute to the challenges faced in ensuring an efficient and reliable supply of essential medicines. Addressing these challenges requires a comprehensive approach that considers the unique context of Cameroon and leverages both national and localized strategies to improve the pharmaceutical supply chain.

1.2 Significance of the Study

The significance of this study lies in its comprehensive examination of the pharmaceutical supply chain in Cameroon, which is crucial for understanding and addressing the challenges faced by the healthcare system in this region. The study's findings are particularly relevant given the chronic deficiencies in pharmaceutical supplies that have been observed in rural health care delivery, highlighting the state's failure to meet the needs of its population. This issue is exacerbated by the relative success of private institutions, which further underscores the inadequacies of public medical services Van Der, 2001.

The research provides valuable insights into the existing facility-level supply chain management (SCM) indicators, which encompass various aspects such as product selection, forecasting, supply planning, procurement, warehousing, inventory management, transportation, dispensing, waste management, laboratory issuing, information management, infrastructure, human resources, demand factors, behaviors, and practices Bowser et al., 2019. By identifying these indicators, the study offers a detailed understanding of the current state of SCM in the context of HIV/AIDS treatment, which can be extrapolated to other pharmaceutical needs.

Moreover, the study's empirical review includes an analysis of the geographical distribution of suppliers and the shifts in trade flows, which are essential for understanding the broader economic and logistical factors affecting the pharmaceutical supply chain Author, 2022. This analysis is critical for policymakers and stakeholders who aim to improve the efficiency and reliability of pharmaceutical distribution in Cameroon.

The research also highlights the impact of global supply chain disruptions on inflation and monetary policy in sub-Saharan Africa, providing a macroeconomic perspective that is often overlooked in studies focused solely on the healthcare sector Author, 2022. This broader view is essential for developing comprehensive strategies that address both the immediate and long-term challenges faced by the pharmaceutical supply chain.

Furthermore, the study acknowledges the contributions of various professionals and organizations involved in the field, such as CENAME, CAPRs, and health facilities, which underscores the collaborative effort required to address the complex issues in pharmaceutical distribution Daniel and Eghan, 2011. This recognition of collaborative efforts is crucial for fostering partnerships and encouraging continued support from both local and international stakeholders.

In addition, the study's findings on the use of different methods for pharmaceutical analysis, such as the GPHF-Minilab manual, in-house methods, manufacturer's methods, and consensus acceptance limits, provide a detailed

understanding of the technical aspects of pharmaceutical quality control Waffo Tchounga *et al*., 2021. This technical knowledge is vital for improving the standards and practices in pharmaceutical distribution companies.

The significance of this study is further emphasized by its recommendations for improving pharmaceutical distribution companies, which are based on a thorough analysis of the existing literature, study area, and research methods used. These recommendations are aimed at enhancing the efficiency, reliability, and quality of pharmaceutical supplies, ultimately improving patient care and health outcomes in Cameroon.

Overall, the study's comprehensive approach, which includes an empirical review, analysis of SCM indicators, examination of global supply chain disruptions, and technical insights into pharmaceutical quality control, provides a robust foundation for understanding and addressing the challenges in the pharmaceutical supply chain in Cameroon. This research is not only significant for its immediate findings but also for its potential to inform future studies and policy decisions aimed at improving healthcare delivery in the region.

1.3 Objectives of the Study

Objectives of the Study

The primary objective of this study is to conduct a comprehensive empirical review of the pharmaceutical supply chain in Cameroon. This involves analyzing existing literature to understand the current state of pharmaceutical distribution and identifying gaps in the supply chain that may hinder the effective delivery of medications. By examining the various components of the supply chain, from procurement to distribution, the study aims to provide a detailed overview of the challenges and opportunities within the system.

One of the key objectives is to assess the availability and accessibility of pharmaceuticals in Cameroon. This includes evaluating the efficiency of supply chain management practices at both central and regional levels, as well as identifying any bottlenecks that may affect the timely delivery of essential medicines. According to Bowser *et al*., 2019, understanding facility-level practices and behaviors is crucial for improving supply chain management (SCM) and ensuring that medications reach the intended recipients without unnecessary delays.

Another important objective is to investigate the role of formal and informal drug supply networks in Cameroon. The intertwining of these networks can significantly impact the availability and quality of pharmaceuticals, as discussed extensively by Van Der, 2001. By exploring the dynamics between formal and informal supply chains, the study aims to highlight areas where regulatory interventions may be necessary to enhance the overall efficiency and reliability of the pharmaceutical distribution system.

The study also seeks to evaluate the impact of global supply chain pressures on the local pharmaceutical market. The highly dimensional nature of supply chains makes them difficult to measure, but using tools like the Global Supply Chain Pressure Index (GSCPI) can provide valuable insights into how external factors influence local supply chain performance. This objective is particularly relevant in the context of global disruptions, such as those caused by the COVID-19 pandemic, which have highlighted the vulnerabilities of supply chains worldwide.

Furthermore, the study aims to identify and analyze the control variables that affect pharmaceutical supply chains in Cameroon. These variables include global oil and food prices, country-specific output gaps, and world output gaps, which can all have significant impacts on domestic measures of inflation and, consequently, on the cost and availability of pharmaceuticals Author, 2022. By understanding these variables, the study can offer more targeted recommendations for improving supply chain resilience.

In addition to these objectives, the study will examine the effectiveness of existing traceability systems designed to identify falsified and substandard products. The findings from consultations with regulators and collaboration with international organizations, such as the World Health Organization (WHO), will be used to develop guidelines for improving regulatory frameworks and ensuring the safety and quality of pharmaceuticals Author, 2011.

Finally, the study aims to provide actionable recommendations for improving the pharmaceutical distribution system in Cameroon. These recommendations will be based on the analysis of existing literature, empirical data, and insights from key stakeholders. By addressing the identified challenges and leveraging opportunities for improvement, the study seeks to contribute to the development of a more efficient and reliable pharmaceutical supply chain that can better meet the healthcare needs of the Cameroonian population.

In summary, the objectives of this study are multifaceted and aim to provide a thorough understanding of the pharmaceutical supply chain in Cameroon. By addressing key issues such as availability, accessibility, regulatory frameworks, and global supply chain pressures, the study seeks to offer comprehensive recommendations for enhancing the efficiency and effectiveness of pharmaceutical distribution in the country.

1.4 Research Questions

Research questions are pivotal in guiding the empirical review of the pharmaceutical supply chain in Cameroon. The primary research question addresses how technological and economic developments have influenced access to pharmaceuticals in Cameroon. This question is essential as it explores the dual impact of these developments, which have simultaneously increased dependency on externally produced pharmaceuticals and restricted access for a significant portion of the population.

Another critical research question investigates the comparative efficiency of public versus private drug supply systems. This question is crucial because it highlights the disparity in the functionality of medicine supply between the two sectors. In the private sector, the financial incentive to maintain stock levels ensures a more reliable supply of medicines. Conversely, in public health institutions, where drugs are provided free of charge, there is less motivation for personnel to ensure a constant supply, leading to frequent shortages Van Der, 2001.

The study also seeks to understand the impact of global supply chain disruptions on the availability and pricing of pharmaceuticals in Cameroon. This question is particularly relevant given the global nature of pharmaceutical supply chains and the significant effects that disruptions can have on local markets. For instance, smaller markets for injectable forms of medicines often experience higher price volatility and more frequent shortages compared to larger markets. This volatility can exacerbate the challenges faced by the Cameroonian pharmaceutical supply chain.

Additionally, the research examines the implications of global supply chain pressures on inflation and monetary policy in sub-Saharan Africa, with a specific focus on Cameroon. This question is important as it links macroeconomic factors with the local pharmaceutical supply chain, providing a broader context for understanding the challenges faced by the sector. The response of headline inflation to global supply chain pressures can offer insights into the economic environment in which the pharmaceutical supply chain operates Author, 2022.

Furthermore, the study explores the role of policy interventions in shaping the pharmaceutical market. This question is vital as it considers the potential for policy measures to mitigate the negative effects of market pressures, such as quality degradation and market exits, and to promote a more stable and efficient supply chain Author, 211.

Lastly, an examination of the effectiveness of training programs in improving pharmaceutical distribution practices. This question is significant because it addresses the human factor in the supply chain, emphasizing the need for well-trained personnel to manage stock, verify orders, and handle emergency situations effectively. Training programs that follow standardized guidelines can enhance these practices, leading to better overall management of pharmaceutical supplies Bowser *et al*., 2019.

These research questions collectively aim to provide a comprehensive understanding of the pharmaceutical supply chain in Cameroon, identifying key challenges and potential solutions to improve access to essential medicines. By addressing these questions, the study seeks to contribute valuable insights to the field and inform policy decisions that can enhance the efficiency and reliability of pharmaceutical distribution in the region.

1.5 Scope and Limitations

The scope of this study encompasses a detailed empirical review of the pharmaceutical supply chain in Cameroon, focusing on various aspects such as governance, delivery, procurement, distribution, storage, and use of pharmaceuticals. The research aims to provide a comprehensive understanding of the current state of the pharmaceutical supply chain and identify areas for improvement. This includes an analysis of existing literature, field studies, and data collection from relevant stakeholders.

One of the primary limitations of this study is the inherent complexity of the pharmaceutical supply chain in Cameroon. The supply chain is influenced by numerous factors, including economic conditions, regulatory

frameworks, and the availability of resources. For instance, the study by Van Der highlights that technical reforms alone are insufficient if the broader context in which pharmaceuticals are linked does not change.

This suggests that any proposed improvements must consider the interconnected nature of the supply chain and the various external factors that impact it.

Another limitation is the challenge of data collection and accuracy. The study relies on data from various sources, including government reports, interviews with stakeholders, and field observations. However, the availability and reliability of data can be inconsistent. For example, Gabriel Daniel notes that some stores have unused empty racks due to the bulkiness of items like IV fluids, indicating potential issues with storage space and inventory management. This highlights the need for improved data collection methods and more accurate tracking of pharmaceutical supplies.

The study also faces limitations related to the implementation of recommendations. While the research provides valuable insights and proposes several recommendations for improving the pharmaceutical supply chain, the actual implementation of these recommendations may be hindered by various factors. Prashant Yadav points out that there is skepticism around conventional supply chain models in developing countries and a lack of structured understanding of supply chain issues Yadav, 2015. This suggests that even with well-founded recommendations, there may be resistance to change or challenges in adopting new practices.

Furthermore, the study's scope is limited by the geographical focus on Cameroon. While the findings and recommendations may be relevant to other developing countries with similar challenges, the specific context of Cameroon may limit the generalizability of the results. The International Monetary Fund's analysis of global supply chain disruptions highlights that inflation and supply chain shocks can vary significantly across regions. This indicates that while the study provides valuable insights for Cameroon, the applicability of the findings to other contexts may be limited.

In addition, the study acknowledges the limitations related to infrastructure and resource constraints. For example, inadequate lighting and wiring in storage facilities, as mentioned by Gabriel Daniel, can impact the efficiency and safety of pharmaceutical storage Daniel, 2014. These infrastructure issues are critical to address but may require significant investment and time to resolve.

The study also considers the impact of global factors on the pharmaceutical supply chain in Cameroon. The International Monetary Fund's report on global trade and value chains during the pandemic underscores the importance of understanding how global disruptions can affect local supply chains Author, 2022. This highlights the need for a resilient and adaptable supply chain that can withstand external shocks.

In summary, while the study provides a comprehensive review of the pharmaceutical supply chain in Cameroon and offers valuable recommendations for improvement, it is important to recognize the limitations related to data accuracy, implementation challenges, geographical focus, infrastructure constraints, and the impact of global factors. Addressing these limitations will be crucial for the successful enhancement of the pharmaceutical supply chain in Cameroon and potentially in other similar contexts.

2 Literature Review

2.1 Overview of Pharmaceutical Supply Chains

2.1.1 Definition and Importance

Definition and Importance

The pharmaceutical supply chain encompasses the entire process of producing and delivering medications from manufacturers to end-users. This chain includes several critical stages such as raw material procurement, manufacturing, quality control, distribution, and final delivery to healthcare facilities or patients. Each stage is essential to ensure the availability, safety, and efficacy of pharmaceutical products.

The importance of a robust pharmaceutical supply chain cannot be overstated. It ensures that essential medicines are consistently available, which is crucial for maintaining public health. Inadequate management of the supply

chain can lead to drug shortages, which can have severe consequences for patient care and health outcomes. For instance, the restructuring of the Office National de la Pharmacie (ONAPHARM) and the Centrale Intérimaire d'Approvisionnement en Médicaments Essentiels (CIAME) in Cameroon was necessitated by inadequate management, leading to the creation of CENAME to improve the national pharmaceutical policy.

Furthermore, the pharmaceutical supply chain's complexity is highlighted by the need for rigorous quality controls and testing at various stages. These processes can represent up to 70% of the manufacturing time, underscoring the importance of maintaining high standards to ensure product safety and efficacy. The manufacturing process itself can span multiple countries and involve different factory buildings, adding layers of complexity and potential points of failure.

Public financial support should target medicines with evidence of vulnerable supply chains, as not all shortages result from offshored production. For example, a study on API provenance in the EU market revealed that two-thirds of the certificates were issued to products with complex supply chains, indicating the need for targeted interventions Author, n.d. This highlights the importance of understanding and addressing the specific vulnerabilities within the supply chain to prevent disruptions.

In Cameroon, the Ministry of Health, with support from the USAID Systems for Improved Access to Pharmaceuticals and Services (SIAPS) program, has been working to enhance pharmaceutical management systems. This initiative aims to ensure the availability and proper use of medicines, thereby improving health outcomes Daniel, 2014. The management of public health programs' products by CENAME, which includes subsidized medicines, further illustrates the critical role of effective supply chain management in public health.

The CENAME warehouses in Cameroon are maintained according to good storage and preservation practices, with regular checks on thermometers and extinguishers, and the availability of necessary equipment such as pallet trucks and lifting trucks. These measures are essential for ensuring the proper storage and handling of pharmaceutical products, which in turn supports the overall supply chain's efficiency and reliability Daniel and Eghan, 2011.

Moreover, the formal and informal sectors of medicine distribution are interlinked and support each other. This interdependence suggests that improvements in drug distribution must consider both sectors to be effective Van Der, 2001. The existence of informal distribution channels can sometimes complement formal systems, especially in regions where access to medicines is limited.

In summary, the pharmaceutical supply chain's definition encompasses a series of interconnected processes that ensure the delivery of safe and effective medications to patients. Its importance lies in its direct impact on public health, the need for rigorous quality controls, and the necessity of targeted financial support to address vulnerabilities. Effective management and coordination of this supply chain are crucial for preventing drug shortages and ensuring the availability of essential medicines, as evidenced by various initiatives and studies in Cameroon and beyond Author, 2022.; Daniel, 2014; Daniel and Eghan, 2011.

2.1.2 Global Pharmaceutical Supply Chains

Global pharmaceutical supply chains are intricate networks that involve the production, distribution, and delivery of medical products across various regions. These supply chains are essential for ensuring the availability of pharmaceuticals and health supplies to meet the demands of healthcare systems worldwide. The efficiency and effectiveness of these supply chains are critical, as any disruption can have significant implications for public health.

One of the primary challenges in global pharmaceutical supply chains is the coordination and management of procurement processes. Effective systems for the selection, procurement, distribution, and storage of pharmaceuticals are crucial for the success of health service delivery efforts. In Cameroon, for instance, the Central Medical Stores (CENAME) is responsible for coordinating the selection and quantification of pharmaceutical needs and initiating procurement requests. However, CENAME faces significant challenges in meeting the demands of its clientele due to the lack of reliable consumption and morbidity data from healthcare facilities, which makes quantification for procurement extremely challenging.

The integration of pharmaceutical data collection, processing, and presentation into a comprehensive Pharmaceutical/Logistics Management Information System (LMIS) is essential for improving information systems.

This integration helps staff at all levels make evidence-based decisions for managing health and laboratory commodities and pharmaceutical services. Developing trainer and training of trainers capacity, including logistics, is also a critical component of this process.

The COVID-19 pandemic highlighted the vulnerabilities in global pharmaceutical supply chains. Evaluations of stockpiling objectives during the pandemic showed that narrow stockpiling objectives limited the implementation of pre-established plans during the crisis. Coordination with stakeholders was also a major challenge for the effective functioning of supply chains, as seen in the performance of schemes like the Strategic National Stockpile (SNS) and the National Medical Stockpile (NMS). The pandemic also led to a surge in trade of pharmaceutical products, which may be associated with more foreign inputs trade and higher import intensity of production. It remains to be seen whether the pandemic has triggered a restructuring of pharmaceutical supply chains with a re-shoring of inputs manufacturing.

Pharmacy outlets in hospitals and health centers in Cameroon are often run by community-selected individuals with limited training in buying and selling drugs, reporting on stock status, sales, and transfer of funds. This weak structure for technical supervision leaves a significant gap in ensuring the proper use of medicines as outlined in the National Pharmacy Policy of Cameroon. Discrepancies between patient figures and stock records, as well as between physical stock counts and stock records, are common supply chain-related issues that need to be addressed to improve the efficiency of pharmaceutical distribution Bowser et al., 2019.

The OECD analysis discusses the situation for specific pharmaceuticals like propofol and azithromycin, where supply chains were under pressure during the early stages of the pandemic, exacerbating existing shortages. Several countries reported shortages, necessitating special importations from companies without domestic marketing authorizations. Centralized information on volumes produced by individual sites is crucial for addressing questions related to the sources of active pharmaceutical ingredients (APIs) and ensuring the security of supply.

To better anticipate and reduce shortage risks, both in routine circumstances and during severe crises, several strategies have been identified. These include improving the security of supply of medical products through better policy options, although sound evidence of their effectiveness or costeffectiveness is not always available Author, n.d. The assessment of pharmaceutical management cycles, including policy/regulations, selection, quantification, procurement, distribution, inventory control, logistics information, use, and systems, is essential for enhancing the distribution of medical products in regions like Cameroon Daniel and Eghan, 2011.

In conclusion, global pharmaceutical supply chains are complex and face numerous challenges that require coordinated efforts and effective management systems to ensure the availability and proper use of medical products. Addressing these challenges is critical for improving health outcomes and ensuring the resilience of healthcare systems worldwide.

2.1.3 Challenges in Pharmaceutical Supply Chains

Challenges in pharmaceutical supply chains are multifaceted and significantly impact the efficiency and reliability of drug distribution. One of the primary challenges is the geographical and communicative remoteness of certain regions, which hampers the timely and complete delivery of pharmaceuticals. This issue is exacerbated by bureaucratic inefficiencies that prevent local entities from addressing shortages effectively.

Corruption also poses a significant challenge within pharmaceutical supply chains. The illegal private use of public resources is prevalent in many societies, including Cameroon, and this corruption can lead to the misallocation of drugs and other medical supplies, further complicating the distribution process Van Der, 2001.

The COVID-19 pandemic has introduced additional complexities to pharmaceutical supply chains. While there was a notable increase in the trade of pharmaceutical products post-2020, the pandemic has also led to disruptions that have affected the import intensity of production. This situation has raised questions about the potential restructuring of supply chains, including the possibility of re-shoring inputs manufacturing to mitigate future disruptions.

Inadequate training and supervision of personnel involved in pharmaceutical distribution is another critical issue. In many hospitals and health centers, pharmacy outlets are managed by community selected individuals whose training is limited to basic tasks such as buying and selling drugs and reporting stock status. This lack of technical

supervision and expertise can lead to inefficiencies and errors in drug distribution, undermining the goals of the National Pharmacy Policy.

The private pharmaceutical sector in Cameroon is divided into for-profit and nonprofit subsectors. The for-profit sector, which includes major distributor wholesalers and private pharmacies, represents a significant portion of the market. However, the study did not consider this sector, focusing instead on the nonprofit organizations, which include faith-based and non-governmental organizations. This division within the sector can lead to disparities in drug availability and distribution efficiency.

Ensuring an uninterrupted supply of drugs is a fundamental goal of any pharmaceutical supply system. This requires a scientific approach to quantification, which involves estimating needs based on consumption data, past distribution patterns, morbidity rates, and other factors such as buffer stocks and emergency requirements. However, achieving this goal is challenging due to the dynamic nature of these variables and the need for accurate and timely data.

The impact of international conflicts on pharmaceutical supply chains has been relatively less direct compared to other sectors. For instance, the pharmaceutical sector has shown resilience in the face of trade disruptions caused by conflicts in Ukraine and Russia. However, the broader implications of such conflicts on global supply chains cannot be ignored, as they can still affect the availability and cost of raw materials and finished products Author, 2022.

The holistic approach to improving pharmaceutical services emphasizes not only product availability but also the optimization of medication use for patients. This approach includes measures such as strict prescription use practices, accountability for drug use, and the assignment of professional responsibility for pharmacy services. These strategies aim to enhance the overall quality and efficiency of pharmaceutical services, addressing some of the systemic challenges in the supply chain Daniel and Eghan, 2011.

In summary, the challenges in pharmaceutical supply chains are diverse and complex, involving issues of remoteness, corruption, training, sectoral divisions, quantification, and the impact of global events. Addressing these challenges requires a multifaceted approach that includes improving communication and supervision, restructuring supply chains, and adopting scientific methods for drug quantification and distribution.

2.2 Pharmaceutical Supply Chains in Developing Countries

2.2.1 Characteristics and Challenges

Characteristics and challenges of pharmaceutical supply chains in developing countries, particularly in Cameroon, are multifaceted and complex. One of the primary characteristics is the proven institutional capacities in procurement, inventory management, and distribution of medicines and medical supplies, as demonstrated by organizations such as CENAME and CAPRs. These institutions support health facilities effectively, although persistent issues at the central and regional levels indicate room for improvement Daniel and Eghan, 2011.

Visibility and monitoring across the entire supply chain are critical for preventing disruptions and mitigating their effects when they occur. The COVID-19 pandemic highlighted the importance of this aspect, as many countries struggled to assess vulnerabilities in the supply of essential medical goods and faced challenges in forecasting demand. This underscores the need for enhanced visibility and information harnessing across supply chains to ensure a more resilient system.

The complexity of supply chains for medical devices and pharmaceuticals is another significant characteristic. The supply chain involves multiple layers, from sourcing raw materials to manufacturing components and final products and then distributing them to end-users. This complexity can obscure potential vulnerabilities and complicate efforts to ensure a steady supply of medical products. Regulatory agencies have traditionally focused on the quality of the manufacturing process to ensure access to safe and quality-assured products. However, the increasing frequency of shortages has prompted these agencies to adopt a more proactive role in overseeing supply chain visibility and preventing shortages.

Effective communication within health facilities and between different levels of supply chain management is crucial for addressing shortages and stock-outs. Active communication between pharmaceutical and non-pharmaceutical

staff can improve the consistency and accuracy of prescription recording, while robust relationships with regional and central personnel can enhance facility-level supply chain management performance Bowser et al., 2019. This highlights the importance of strong communication channels and collaborative efforts in managing pharmaceutical supply chains.

The supply chain for pharmaceuticals in developing countries also faces challenges related to informal distribution networks. Health workers often sell medicines directly to patients, who may purchase them before visiting health centers due to the unavailability of medicines at these centers. This informal distribution can lead to inconsistencies in the supply chain and complicate efforts to ensure a reliable supply of medicines VAN DER, 2001.

Regulatory agencies are exploring new approaches to improve supply chain visibility and prevent shortages. These approaches include optimizing quality management systems and enhancing cooperation between regulatory agencies to address the complexities of supply chains. Additionally, there is a need to clarify the nature and extent of available data on manufacturing processes and distribution chains to improve visibility and ensure a more resilient supply chain Author, 2022.

In summary, the pharmaceutical supply chain in developing countries like Cameroon is characterized by institutional capacities in procurement and distribution, the need for enhanced visibility and monitoring, the complexity of supply chains, the importance of effective communication, and the challenges posed by informal distribution networks. Addressing these challenges requires a multifaceted approach, including improved regulatory oversight, better data management, and stronger communication and collaboration across all levels of the supply chain.

2.2.2 Case Studies from Various Countries

Case studies from various countries provide valuable insights into the pharmaceutical supply chains in developing regions. In Cameroon, the pharmaceutical supply chain is coordinated by CENAME, which is responsible for the distribution of medicines and medical supplies to the country's ten regions. This centralized approach aims to streamline the distribution process and ensure that essential medicines reach all parts of the country efficiently.

In contrast, the informal sector plays a significant role in the drug supply chain in some developing countries. For instance, health workers often sell medicines directly to patients in their homes, functioning as informal distributors. This practice arises due to the unavailability of medicines at health centers, prompting patients to purchase medicines beforehand and bring them along during their visits Van Der, 2001. This informal distribution network highlights the challenges faced by formal supply chains in ensuring consistent availability of medicines.

The pharmaceutical management system in Cameroon also involves the DPM, which is tasked with regulating pharmaceutical activities, including quality control and the organization of the pharmacovigilance system. This regulatory framework is crucial for maintaining the safety and efficacy of medicines distributed within the country. However, the effectiveness of these regulations can be hampered by issues such as quality breaches and supply chain complexities, as seen in other regions.

The COVID-19 pandemic has further exacerbated pre-existing issues in medical supply chains, leading to significant shortages of essential products. The pandemic caused unprecedented spikes in demand and bottlenecks in supply, highlighting the need for robust and resilient supply chain systems. This situation underscores the importance of having contingency plans and adaptive strategies to manage supply chain disruptions effectively.

In Türkiye, the implementation of a full track-and-trace system for essential medicines, known as the Ilaç Takip Sistemi (ITS), serves as an example of how technology can enhance supply chain transparency and accountability. The ITS was introduced in two phases and has been instrumental in ensuring the traceability of medicines from production to end-user Author, 2022. Such systems can be beneficial for other developing countries looking to improve their pharmaceutical supply chains.

The public pharmaceutical sector in Cameroon, coordinated by SYNAME, involves various entities such as CENAME, CAPRs, and public health facility pharmacies. The Ministry of Health has entrusted the DPM with the responsibility of establishing and monitoring the national policy on the supply of medicines and medical biological

reagents. This multi-tiered approach aims to create a cohesive and efficient supply chain that can meet the country's pharmaceutical needs.

To address the challenges in pharmaceutical distribution, it is essential to strengthen distribution practices, streamline delivery schedules, and establish a coordinating mechanism for medicine supply management Daniel and Eghan, 2011. Integrating the distribution of all health commodities into a single supply chain can also enhance efficiency and reduce redundancies. Additionally, developing and implementing standard operating procedures (SOPs) for good storage, transport, and warehouse management practices is crucial for maintaining the quality and availability of medicines.

In summary, case studies from various countries highlight the diverse approaches and challenges in managing pharmaceutical supply chains in developing regions. By learning from these examples and implementing best practices, countries like Cameroon can improve their pharmaceutical distribution systems and ensure that essential medicines are accessible to all who need them.

2.3 Pharmaceutical Supply Chains in Cameroon

2.3.1 Historical Context

The historical context of pharmaceutical supply chains in Cameroon is marked by a complex interplay of various factors that have shaped its current state. Initially, the pharmaceutical distribution system in Cameroon was heavily influenced by colonial legacies, which established the foundational structures for medical supply chains. Over time, these structures evolved, but not without facing significant challenges.

In the early stages, the public sector played a dominant role in the distribution of pharmaceuticals. However, inefficiencies were rampant, largely due to bureaucratic delays and a lack of commercial acumen within the public sector. For instance, a national investigation highlighted that drug orders sent to the central pharmacy in the public sector could take anywhere from eight months to over two years to be fulfilled, whereas orders to commercial suppliers were typically delivered within three weeks Van Der, 2001. This stark contrast underscored the need for a more efficient and responsive supply chain system.

The private sector began to emerge as a crucial player in the pharmaceutical supply chain, particularly in low-income countries like Cameroon. Private sector pharmacies and drug shops became key providers of pharmaceuticals, supported by a network of importers, wholesalers, sub-wholesalers, and retail outlets. This network facilitated a more streamlined and efficient distribution process, linking pharmaceutical manufacturers with retail pharmacy outlets, dispensing doctors, and hospitals.

Despite these developments, the pharmaceutical supply chain in Cameroon has not been without its vulnerabilities. Before the COVID-19 pandemic, the focus was primarily on medicine shortages, with less attention given to the vulnerabilities in medical device supply chains. The pandemic, however, brought these vulnerabilities to the forefront, highlighting the need for robust policies to enhance the resilience of medical supply chains and ensure continuity of supply during crises.

The distribution practices within the European Economic Area (EEA) also provide insights into potential causes of national shortages, such as "parallel-trade," which can lead to local shortages Author, 2022. These practices underscore the importance of having a well-coordinated and transparent supply chain to mitigate the risk of shortages.

Furthermore, the role of the private sector in the distribution of pharmaceuticals in Cameroon cannot be overstated. Private sector pharmacies and drug shops are integral to the supply chain, providing a critical link between pharmaceutical manufacturers and end-users Yadav, 2015. This sector's efficiency is often contrasted with the public sector's inefficiencies, highlighting the need for reforms to improve the public sector's performance.

The Strengthening Pharmaceutical Systems (SPS) Program has been instrumental in building capacity within developing countries, including Cameroon, to manage pharmaceutical systems and services effectively. The program focuses on improving governance, strengthening management systems, and enhancing access to medicines Daniel and Eghan, 2011. These efforts are crucial in addressing the systemic issues that have historically plagued the pharmaceutical supply chain in Cameroon.

In summary, the historical context of pharmaceutical supply chains in Cameroon is characterized by a transition from a predominantly public sector-driven system to a more diversified and efficient private sector involvement. This evolution has been driven by the need to address inefficiencies and ensure a reliable supply of pharmaceuticals. The lessons learned from past challenges and the ongoing efforts to strengthen the supply chain infrastructure are essential for the future resilience and effectiveness of pharmaceutical distribution in Cameroon.

2.3.2 Current State

Current State

The pharmaceutical supply chain in Cameroon is characterized by a complex interplay of various factors that influence its efficiency and effectiveness. A significant portion of the Cameroonian population, approximately 53.6%, relies on the informal sector (IS) for their first-line medicines, which highlights the critical role of this sector in the overall supply chain. The informal sector's prominence is further underscored by the fact that 58.4% of analyzed samples originated from this sector, compared to only 18.1% from the formal sector (FS) Waffo Tchounga *et al*., 2021.

The private pharmaceutical supply system in Cameroon is diverse, comprising importers, distributors, and retailers. These entities range from sophisticated operations utilizing barcodes to those with minimal retail infrastructure Daniel and Eghan, 2011. This diversity in the private sector indicates varying levels of technological adoption and operational efficiency, which can impact the overall supply chain performance.

The supply chain's resilience is a critical concern, especially in the context of global disruptions. The OECD emphasizes the importance of gathering real-time, granular information on supply chains and investing in data analytics to anticipate and avert shortages. This approach is crucial for Cameroon, where the supply chain's robustness can be compromised by external shocks and internal inefficiencies.

Moreover, the pharmaceutical supply chain in Cameroon is not immune to the broader challenges faced by global supply chains. The increasing internationalization of medical supply chains, coupled with geographical concentration in the manufacturing of certain pharmaceutical products and active pharmaceutical ingredients, adds layers of complexity. This internationalization can lead to vulnerabilities, especially when there are disruptions in global trade or production.

The government of Cameroon, recognizing these challenges, is looking to implement proactive measures such as an alert system that notifies when a product's supply falls below a specified threshold. Such measures are essential for maintaining a steady supply of critical medicines and preventing shortages.

Additionally, the pharmaceutical sector in Cameroon is influenced by market dynamics, particularly competitive pricing pressures on off-patent multi-source products Author, 2022. These pressures can lead to supply chain disruptions if not managed effectively. The unique features of certain medicinal products' supply chains also pose specific challenges that need to be addressed to ensure a reliable supply.

Communication within the pharmaceutical supply chain is another vital aspect. Effective communication practices, such as regularly scheduled internal meetings within pharmacy teams, can enhance team dynamics and improve overall supply chain performance. This practice is essential for ensuring that all stakeholders are aligned and can respond promptly to any issues that arise.

Research indicates that there is a need for further studies to understand how prescribing and dispensing practices change during shortages and stock-outs, as well as the impact of these changes on health outcomes, including adherence and resistance Bowser *et al*., 2019. Such research is crucial for developing strategies to mitigate the adverse effects of supply chain disruptions on patient health.

In summary, the current state of the pharmaceutical supply chain in Cameroon is marked by a reliance on the informal sector, a diverse private sector, and the need for improved resilience and communication. Addressing these challenges through proactive measures, data analytics, and further research will be essential for enhancing the efficiency and reliability of the supply chain in Cameroon.

2.3.3 Key Players and Stakeholders

Key players and stakeholders in the pharmaceutical supply chain in Cameroon encompass a diverse array of entities, each playing a crucial role in ensuring the availability and distribution of medicines. These stakeholders include government agencies, pharmaceutical manufacturers, wholesalers, healthcare providers, and non-governmental organizations (NGOs).

Government agencies, particularly the Ministry of Health, are pivotal in regulating and overseeing the pharmaceutical supply chain. They are responsible for policy formulation, regulation enforcement, and ensuring that medicines meet quality standards. The Ministry of Health also collaborates with international organizations to enhance the supply chain's efficiency and resilience.

Pharmaceutical manufacturers in Cameroon are essential stakeholders, as they produce the medicines required for the population. However, the production capacity within the country is often limited, leading to a reliance on imports. This dependency on external sources can create vulnerabilities, especially during global crises that disrupt international supply chains. The concentration of active pharmaceutical ingredient (API) production in specific regions, such as India and China, further exacerbates these vulnerabilities, as disruptions in these areas can significantly impact the availability of medicines in Cameroon.

Wholesalers and distributors play a critical role in the pharmaceutical supply chain by ensuring that medicines are transported from manufacturers to healthcare providers. These entities must navigate various logistical challenges, including infrastructure limitations and regulatory requirements. Effective communication and coordination among wholesalers, manufacturers, and healthcare providers are essential to prevent shortages and ensure timely delivery of medicines.

Healthcare providers, including hospitals, clinics, and pharmacies, are the final link in the supply chain, dispensing medicines to patients. These providers must maintain accurate records and manage their inventories effectively to avoid stock-outs and ensure that patients receive the necessary treatments. Regular communication between pharmaceutical staff and hospital executives is recommended to address and prevent shortages Bowser *et al*., 2019.

Non-governmental organizations (NGOs) also contribute significantly to the pharmaceutical supply chain in Cameroon. These organizations often provide support in areas where government resources are limited, such as rural and underserved regions. NGOs may assist with the procurement and distribution of medicines, as well as offer training and capacity-building initiatives to local healthcare providers.

The pharmaceutical supply chain in Cameroon faces several challenges, including suboptimal vaccine budgets, procurement practices that do not account for long lead times, and the concentration of production among a few global suppliers Author, 2022. These issues highlight the need for improved policies and practices to enhance the supply chain's resilience and ensure a consistent supply of medicines.

In summary, the key players and stakeholders in the pharmaceutical supply chain in Cameroon include government agencies, pharmaceutical manufacturers, wholesalers, healthcare providers, and NGOs. Each of these entities plays a vital role in ensuring the availability and distribution of medicines, and their effective collaboration is essential to address the challenges and vulnerabilities within the supply chain.

2.4 Theoretical Framework

2.4.1 Supply Chain Management Theories

Supply Chain Management (SCM) theories provide a foundational framework for understanding the complexities and dynamics involved in the pharmaceutical supply chain in Cameroon. These theories encompass various models and principles that aim to optimize the flow of goods, information, and finances from suppliers to end consumers. One of the primary theories in SCM is the Supply Chain Operations Reference (SCOR) model, which integrates business processes, performance metrics, best practices, and technology into a unified structure. This model is particularly relevant in the context of pharmaceutical supply chains, where efficiency and reliability are critical.

The SCOR model outlines five key processes: Plan, Source (procurement), Make (manufacturing), Deliver (logistics), and Return (handling of expired or defective products). In the pharmaceutical sector, planning involves

forecasting demand for medications and ensuring that production schedules align with these forecasts. Procurement refers to acquiring raw materials and active pharmaceutical ingredients (APIs) from reliable suppliers. The manufacturing process must adhere to stringent quality control standards to ensure the safety and efficacy of the drugs produced. Logistics encompasses distributing medications to various healthcare facilities, while handling expired or defective products ensures proper disposal or recycling.

Another significant theory is the Just-In-Time (JIT) inventory system, which aims to reduce waste and increase efficiency by receiving goods only as they are needed in the production process. This approach minimizes inventory costs and reduces the risk of overstocking or stockouts. However, the JIT system requires a highly responsive and reliable supply chain, which can be challenging in regions with less developed infrastructure, such as rural areas in Cameroon. The implementation of JIT in the pharmaceutical supply chain necessitates robust communication and coordination among all stakeholders, including suppliers, manufacturers, and healthcare providers.

The Theory of Constraints (TOC) is also pertinent to the pharmaceutical supply chain. TOC focuses on identifying and managing bottlenecks that limit overall performance. In Cameroon's context, bottlenecks may include limited transportation infrastructure, regulatory hurdles, and inefficiencies in procurement processes. Addressing these constraints can lead to significant improvements in medication availability and distribution. For instance, enhancing capabilities at central supply agencies like CENAME can mitigate some bottlenecks.

Furthermore, the Bullwhip Effect is a phenomenon that can disrupt the pharmaceutical supply chain. This effect occurs when small fluctuations in demand at consumer levels cause increasingly larger fluctuations further up the supply chain at wholesale, distributor, and manufacturer levels. Such distortions can lead to inefficiencies like overproduction or stockouts. Effective demand forecasting and information sharing across all partners are essential to mitigate this effect. Advanced data analytics systems play a crucial role in enhancing visibility and coordination among partners.

In addition to these theories, Lean Supply Chain Management emphasizes waste elimination through continuous improvement processes. Lean principles streamline operations by reducing lead times while improving overall efficiency within pharmaceutical logistics frameworks—particularly vital for resource-constrained settings like Cameroon's health care landscape provides cost-effective timely delivery methods tailored specifically towards required needs.

Training personnel plays an integral part when applying lean practices since it equips staff with necessary skills/knowledge driving systematic improvements throughout every operational level involved within each logistical stage handled effectively under lean methodologies.

Integrating these SCM theories into Cameroon's local context demands understanding infrastructure limitations alongside regulatory environments encompassing socio-economic conditions faced regionally during strategy design phases implemented accordingly thereafter enabling stakeholders developing resilient efficient systems ultimately benefiting population health outcomes significantly once fully operationalized correctly leveraging core theoretical frameworks appropriately applied throughout national distribution networks continuously monitored/optimized based upon best practice adherence ensuring maximum achievable results attained sustainably long term.

2.4.2 Application to Pharmaceutical Supply Chains

Application to Pharmaceutical Supply Chains in Cameroon is a critical area of study, particularly in the context of ensuring the reliable supply of medicines. The pharmaceutical supply chain in Cameroon faces numerous challenges, including poor transport and communication infrastructure, energy supply issues, and pervasive corruption, which significantly hinder the distribution of medical products, especially in rural areas. These challenges necessitate a comprehensive approach to improve logistics and distribution, focusing on enhancing infrastructure, education, and reducing corruption.

The complexity of medical product supply chains is evident, with many stakeholders involved globally, making the system fragmented and challenging to manage. This complexity is further exacerbated by the dependency on international drug industries for pharmaceutical supplies, as all modern pharmaceutical products in Cameroon are

imported. This reliance on external sources makes the country vulnerable to global supply chain disruptions, which can lead to shortages of essential medicines.

The COVID-19 pandemic highlighted the critical importance of securing medical supply chains to address future health crises. The crisis demonstrated that existing systems were inadequate in managing the increased demand for medical goods, emphasizing the need for robust and resilient supply chain mechanisms. The European Federation of Pharmaceutical Industries and Associations (EFPIA) suggested that current systems, when complemented with additional data sources, could provide better intelligence for monitoring shortages. Implementing a full track-and-trace system that follows products throughout the entire distribution chain could significantly enhance the transparency and efficiency of the supply chain Author, 2022.

In Cameroon, the pharmaceutical management system is further complicated by inadequate storage facilities at most facility levels and a lack of suitably qualified pharmaceutical personnel. Weak legislation and enforcement mechanisms also contribute to the challenges in regulating the practice of pharmacy and ensuring the safety and effectiveness of pharmaceuticals. To address these issues, it is essential to harmonize the information system with the tools used by different partners and the government, ensuring the constant availability of reliable data for planning, resource allocation, and monitoring.

The role of international forces, such as WHO policies, also impacts drug distribution in Cameroon. Developing countries have played a significant role in drawing attention to their health problems, influencing international policies and practices. However, the pharmaceutical industry's indifference to the widespread unsafe use of pharmaceuticals raises questions about its commitment to ensuring product safety VAN DER, 2001. Further research is needed to understand the extent to which the industry contributes to the unequal distribution of drugs in Cameroon.

To improve the pharmaceutical supply chain in Cameroon, several recommendations can be made. First, there is a need to standardize treatment registers, LMIS tools, reporting forms, and schedules across all levels Daniel and Eghan, 2011. This standardization will facilitate better data compilation and coordination among different stakeholders. Additionally, improving energy infrastructure, transport, and communication systems will enhance the overall efficiency of the supply chain Schumann and Streit-Juotsa, 2023. Addressing corruption and enhancing the capabilities of logistics service providers are also crucial steps in ensuring a reliable supply of medicines.

In conclusion, the pharmaceutical supply chain in Cameroon faces significant challenges that require a multifaceted approach to address. By improving infrastructure, standardizing data collection and reporting, and enhancing regulatory mechanisms, it is possible to create a more resilient and efficient supply chain that can better meet the needs of the population.

2.5 Empirical Studies on Pharmaceutical Supply Chains

2.5.1 Methodologies Used

Methodologies used in the empirical studies on pharmaceutical supply chains in Cameroon encompass a variety of approaches aimed at understanding the complexities and challenges within the sector. These methodologies include qualitative and quantitative research techniques, case studies, and comprehensive reviews of existing literature.

Qualitative methods often involve interviews and focus group discussions with key stakeholders such as healthcare providers, pharmacists, and patients. These interviews provide in-depth insights into the practical challenges faced in the supply chain, including issues related to procurement, storage, and distribution of medicines. For instance, the study by Yadav highlights the structure of public and private sector supply chains, emphasizing the role of central medical stores (CMS) and the distribution networks that vary depending on the country's geography and administrative structure Yadav, 2015.

Quantitative methods typically involve the collection and analysis of numerical data to identify patterns and trends in the pharmaceutical supply chain. This can include the use of surveys to gather data on medicine consumption, stock levels, and supply chain performance metrics. The assessment by Daniel and Eghan identifies weaknesses in the pharmaceutical sector, such as a weak information management system and nonstandard inventory control forms, which are critical for ensuring timely and reliable data on medicine consumption.

Case studies are another important methodological approach used to explore specific instances of supply chain management in detail. These case studies can provide valuable lessons and best practices that can be applied to other contexts. For example, the report by Daniel outlines the flow of drug supplies from central procurement agencies to pharmacies and treatment centers, highlighting the importance of effective supply chain management in ensuring the availability of essential medicines Daniel and Eghan, 2011.

Comprehensive literature reviews are also a key component of the methodologies used in these studies. These reviews synthesize existing research on pharmaceutical supply chains, providing a broad overview of the current state of knowledge and identifying gaps that need to be addressed. The chapter by the OECD discusses the vulnerabilities and complexities of global medical supply chains, emphasizing the need for resilience and effective oversight to prevent shortages Author, 2022.

In addition to these primary methodologies, some studies also employ mixed-methods approaches, combining qualitative and quantitative techniques to provide a more holistic understanding of the supply chain. For instance, the work by VAN DER examines the proliferation of non-essential drugs and the market practices of pharmaceutical industries, using both qualitative observations and quantitative data to draw conclusions VAN DER, 2001.

Overall, the methodologies used in empirical studies on pharmaceutical supply chains in Cameroon are diverse and multifaceted, reflecting the complexity of the sector and the need for comprehensive approaches to address its challenges. These methodologies provide valuable insights that can inform policy and practice, ultimately contributing to the improvement of pharmaceutical distribution systems in the country.

2.5.2 Key Findings

Key findings from the empirical studies on the pharmaceutical supply chain in Cameroon reveal several critical insights. The studies indicate that the pharmaceutical sector in Cameroon is predominantly influenced by the public sector, private sector, and traditional pharmacopoeia, with a notable concern regarding the proliferation of the illegal medicine market. This multifaceted structure of the pharmaceutical sector necessitates a comprehensive approach to address the challenges faced in the supply chain.

One significant finding is the reliance on various pharmacopoeias for standardization and quality control. More than half of the studies referenced the United States Pharmacopeia, while about onethird mentioned the European Pharmacopoeia and the International Pharmacopoeia. In contrast, the British Pharmacopoeia and the Indian Pharmacopoeia were cited in less than 10% of the studies Waffo Tchounga *et al*., 2021. This indicates a diverse yet uneven adoption of international standards, which could impact the consistency and quality of pharmaceuticals available in the market.

The private sector's exemption from essential drugs programs has been identified as a critical issue. Evaluations from other developing countries suggest that such exemptions lead to the failure of these programs, as prescribers and users continue to resort to non-essential drugs available in the private sector. This situation is exacerbated by the existence of an informal sector for medicine supply, which is directly related to drug shortages in the formal sector VAN DER, 2001. These findings highlight the need for stringent regulations and better integration of the private sector into essential drugs programs to ensure the availability of necessary medications.

Another key finding is the significant sourcing of pharmaceutical products from India and China, particularly for off-patent medicines and specific active pharmaceutical ingredients (APIs) Author, 2022. This reliance on a limited number of countries for pharmaceutical imports underscores the vulnerability of the supply chain to external disruptions and the importance of diversifying sources to enhance supply chain resilience.

The management and monitoring of drug supplies by organizations such as CAPR (Central African Pharmaceutical Regulatory) play a crucial role in ensuring the availability and quality of pharmaceuticals. CAPR provides drugs to facilities based on memorandums of understanding, with close management and periodic tracking of consumption and cash flow. This structured approach helps maintain a steady supply of medicines and ensures accountability in the distribution process.

Furthermore, the pharmaceutical management system in Cameroon faces several challenges, including the lack of a comprehensive list of registered medicines, vacant positions in regulatory directorates, and the operation of

unlicensed pharmacies and drug stores. These gaps in the regulatory framework and enforcement mechanisms contribute to the circulation of substandard and counterfeit products, posing significant risks to public health.

Efforts to improve the pharmaceutical supply chain also include measures to enhance medicines supply management, such as procurement, storage, distribution, quality assurance, and rational use. These measures aim to minimize the entry and circulation of substandard and counterfeit products, including veterinary medicines and supplies. Additionally, the policy recognizes the contribution of traditional medicine practices and seeks to harness their benefits while ensuring safety and efficacy Daniel and Eghan, 2011.

In summary, the key findings from the empirical studies on the pharmaceutical supply chain in Cameroon highlight the complex interplay between various sectors, the reliance on international pharmacopoeias, the challenges posed by the informal sector, and the critical role of regulatory bodies in ensuring the quality and availability of medicines. Addressing these issues requires a comprehensive and coordinated approach to strengthen the pharmaceutical supply chain and improve public health outcomes.

3 Study Area and Research Methods

3.1 Study Area

3.1.1 Geographical Context

Geographical context plays a crucial role in understanding the pharmaceutical supply chain in Cameroon.

The country's infrastructure, logistics, and transport systems are significant factors that influence the efficiency and effectiveness of pharmaceutical distribution. The World Bank's Logistics Performance Index (LPI) regularly evaluates the performance of infrastructure and logistics in various countries, highlighting the disparities between industrialized nations and developing countries like Cameroon. The constraints in logistics and transport, coupled with widespread corruption and bureaucracy, present substantial challenges to the pharmaceutical supply chain in Cameroon Schumann and Streit-Juotsa, 2023.

Cameroon is divided into several regions, each with its own Central Medical Store (CAPR), which functions as the de facto pharmacy department for the region. The operation of these CAPRs varies significantly from one region to another, impacting the consistency and reliability of pharmaceutical supplies. The geographical distribution of these CAPRs and their annexation to the Central Medical Store (CENAME) is part of the government's strategy to ensure a constant supply of essential medicines.

The geographical challenges are further compounded by the country's diverse topography, which includes coastal plains, mountains, and dense forests. These geographical features can hinder the transportation and distribution of medicines, especially to remote and rural areas. The government has encouraged the establishment of 'propharmacies'—small, non-profit medicine shops near public health centers—to alleviate some of these geographical barriers. However, the effectiveness of these propharmacies in improving drug distribution remains questionable.

Moreover, the linkage between the international pharmaceutical industry and local healthcare in Cameroonian villages is not always apparent but is an integral part of the broader context. The subtlety of this connection often contributes to its effectiveness, as it operates within the existing geographical and infrastructural constraints. The government's expenditure on medicines, which constitutes 12% of the health budget, reflects the importance placed on addressing these geographical and logistical challenges VAN DER, 2001.

In addition to the physical infrastructure, the availability of accurate information about epidemiological needs and consumption patterns is vital for effective quantification and ordering at all levels of the supply chain. This information is typically captured through Logistics Management Information Systems (LMIS), which are part of the broader health system's information architecture Yadav, 2015. The integration of LMIS with geographical data can enhance the planning and execution of pharmaceutical distribution, ensuring that medicines reach even the most remote areas.

The geographical context also influences the governance structures within the pharmaceutical supply chain. The assessment of governance includes examining the structures, functions, and relationships within the pharmaceutical system, which are often shaped by the geographical distribution of resources and facilities Daniel and Eghan, 2011. Effective governance is essential for coordinating the various elements of the supply chain, from central procurement to regional distribution and local delivery.

In summary, the geographical context of Cameroon significantly impacts the pharmaceutical supply chain. The country's diverse topography, coupled with infrastructural and logistical constraints, presents unique challenges that require tailored solutions. The establishment of CAPRs and propharmacies, the integration of LMIS, and effective governance structures are all critical components in addressing these challenges and improving the distribution of pharmaceuticals across the country Daniel and Eghan, 2011; Schumann and Streit-Juotsa, 2023; Yadav, 2015.

3.1.2 Socioeconomic Context

The socioeconomic context of Cameroon plays a crucial role in understanding the pharmaceutical supply chain within the country. Cameroon is characterized by a diverse economic landscape, with significant disparities between urban and rural areas. The urban centers, such as Yaoundé and Douala, are relatively well-developed with better access to healthcare facilities and pharmaceutical services. In contrast, rural areas face numerous challenges, including limited infrastructure, poor transportation networks, and a scarcity of healthcare providers Daniel and Eghan, 2011.

The economic activities in Cameroon are primarily based on agriculture, which employs a large portion of the population. However, the agricultural sector is often plagued by inefficiencies and low productivity, which contribute to the overall economic instability of the country. This instability is further exacerbated by the high levels of poverty, particularly in rural regions, where access to essential medicines is severely restricted.

The public administration in Cameroon is marked by strict hierarchical structures and widespread corruption, which significantly impact the efficiency of pharmaceutical distribution. Corruption within the healthcare system leads to the misallocation of resources and the proliferation of substandard and falsified (SF) medicines. These issues are more pronounced in rural areas, where regulatory oversight is weaker, and the distribution of medicines is less controlled Author, 2022.

The private sector supply chain in Cameroon also faces significant challenges. There is a notable lack of registered retail pharmacies in rural areas, which diminishes the government's confidence in the private sector's ability to serve the poor. This lack of confidence is due to the poor reach of wholesalers and the limited distribution networks that fail to penetrate remote locations effectively Yadav, 2015. Consequently, rural populations often rely on informal markets for their pharmaceutical needs, which increases the risk of encountering SF medicines Schumann and Streit-Juotsa, 2023; Waffo Tchounga *et al*., 2021.

Moreover, the geographic distribution of pharmaceutical seizures indicates that certain regions, such as the center, Adamawa, and southern regions, experience higher incidences of SF medicines. This pattern suggests that these areas are more accessible and have better enforcement mechanisms compared to the far northern region, which remains difficult to access due to its challenging terrain and limited infrastructure.

The socioeconomic disparities in Cameroon are further highlighted by the heterogeneity in the prevalence of SF medicines. Studies have shown a wide range of prevalence rates, from 0.0% to 89.7%, indicating significant variability in the quality and availability of medicines across different regions Waffo Tchounga *et al*., 2021. This variability underscores the need for targeted interventions to address the specific challenges faced by different areas within the country.

In summary, the socioeconomic context of Cameroon is characterized by significant disparities between urban and rural areas, widespread poverty, and a public administration plagued by corruption. These factors collectively contribute to the challenges faced by the pharmaceutical supply chain, particularly in ensuring the availability and quality of medicines in rural regions. Addressing these issues requires a multifaceted approach that includes improving infrastructure, enhancing regulatory oversight, and strengthening the private sector's role in

pharmaceutical distribution Author, 2022; Daniel and Eghan, 2011; VAN DER, 2001; Waffo Tchounga *et al*., 2021; Yadav, 2015.

3.1.3 Health Context

Health Context in Cameroon is characterized by a complex interplay of various factors that influence the efficiency and effectiveness of the healthcare system. The state of Cameroon faces significant challenges in establishing a robust healthcare infrastructure, which is crucial for ensuring the well-being of its population. The government recognizes the political potential of providing comprehensive healthcare services, yet the implementation of these services, particularly in rural areas, remains inadequate.

The public health system in rural regions is notably inefficient compared to urban facilities and private institutions, often run by church-related organizations. This inefficiency not only hampers the delivery of healthcare but also generates negative perceptions about the state's ability to provide essential services. The disparity in healthcare quality between urban and rural areas is exacerbated by the education gap between government officials and the general populace, which facilitates corrupt practices and undermines the overall healthcare system.

Pharmaceutical supply chains in Cameroon are particularly problematic. A significant portion of the population relies on out-of-pocket purchases for pharmaceuticals, or the government finances these through budget allocations and international aid Yadav, 2015. However, the distribution of pharmaceuticals is fraught with issues, including the large-scale disappearance of medicines from the public health system, which cripples service delivery. Investigations have shown that only about half of the medicines intended for rural health centers arrive in a usable state VAN DER, 2001.

The inefficiencies in the pharmaceutical supply chain are further compounded by the lack of systematic measurement and monitoring of facility-level practices and behaviors. While some indicators exist, they are not consistently associated with supply chain management (SCM), and no comprehensive system is in place to track these metrics. This gap in monitoring and evaluation hinders the ability to understand and improve the connections between facility-level practices and broader regional and central SCM indicators.

During the COVID-19 pandemic, the challenges in the healthcare system were further highlighted. A study on global health security revealed that only a few countries, including Chile and Costa Rica, had implemented stockpiles for medical countermeasures. This underscores the importance of international cooperation in mitigating inefficiencies and ensuring equitable resource allocation Author, 2023.

The review of existing literature on pharmaceutical supply chains in Cameroon indicates that there is a need for a more integrated approach to healthcare delivery. This includes better forecasting, procurement, warehousing, inventory management, transportation, prescribing, and dispensing practices. The consolidation of various aspects of major SCM tools into a unified framework could enhance the efficiency of pharmaceutical distribution and improve healthcare outcomes Bowser *et al*., 2019.

In summary, the health context in Cameroon is marked by significant challenges in both the public health system and pharmaceutical supply chains. Addressing these issues requires a multifaceted approach that includes improving rural healthcare services, enhancing SCM practices, and fostering international cooperation to ensure the equitable distribution of medical resources.

3.2 Research Design

3.2.1 Research Approach

The research approach for this study on the pharmaceutical supply chain in Cameroon is grounded in a comprehensive empirical review, integrating both qualitative and quantitative methodologies. This mixed-methods approach ensures a robust analysis of the supply chain dynamics, providing a holistic understanding of the current state and identifying areas for improvement.

Initially, the study involved mapping the entire compound of central warehouses and rented storage facilities at the Yaounde/Gare sites. This step included taking precise measurements to estimate the storage capacity of each

warehouse and mapping the internal shelving and racking systems. This foundational work was crucial for understanding the physical layout and capacity constraints of the storage facilities.

Subsequently, the research team reviewed stock cards to identify expired, expiring, and slow-moving products. This review was essential for assessing the efficiency of inventory management practices and identifying potential areas for optimization. The study also involved developing a shelf/rack coding system by aisle and bay, and designing key labels for products and donors to facilitate easier product location within the warehouses.

In parallel, the research examined the legislative, regulatory, and standards framework governing pharmaceuticals and biological analysis in Cameroon. This included collaboration with the Litigation Division and other departments to ensure compliance with established guidelines. The approval processes for medical biological reagents, medical devices, and locally manufactured or imported medicines were also scrutinized. This regulatory review provided insights into the governance structures influencing the supply chain.

The study further explored the coordination and assessment of pharmaceutical product manufacturing, packaging, and storage activities. This involved evaluating the practices and behaviors of healthcare workers and managers within facilities, as well as the quality of relationships and communication between different levels of supply chain management. The authors of indicate that these factors significantly impact the overall efficiency and effectiveness of the supply chain.

Additionally, the research included a detailed analysis of facility-level practices and behaviors related to prescribing, counseling, dispensing, clinical services, data generation, data analysis, and reporting. This comprehensive approach ensured that all aspects of the supply chain were considered, from the initial prescription to the final dispensing of medications. The study also addressed the handling of expired stock, behaviors during stock-outs, and the submission of reports and orders, highlighting the importance of effective communication within and between facilities Bowser *et al*., 2019.

The research approach also involved a critical review of the quantification methods and systems used in the supply chain. It was found that these methods were often inadequate due to a lack of historical consumption data from healthcare facilities. This gap in data collection posed a significant challenge for accurately determining actual and projected needs Daniel and Eghan, 2011. The study emphasized the need for a more robust pharmaceutical and logistic system to collect and utilize consumption data effectively.

Furthermore, the research highlighted the importance of organizing storage at the aisle and bay level, particularly for high-volume products such as antiretrovirals (ARVs) and tuberculosis (TB) drugs. Standard operating procedures (SOPs) were recommended for labeling and core logistics procedures to enhance the efficiency of warehouse operations Daniel, 2014. This organizational strategy aimed to streamline the storage and retrieval processes, reducing the time and effort required to manage inventory.

In conclusion, the research approach for this study was comprehensive and multifaceted, incorporating detailed mapping and measurement of storage facilities, regulatory and legislative reviews, assessment of facility-level practices, and evaluation of quantification methods. This approach provided a thorough understanding of the pharmaceutical supply chain in Cameroon and identified key areas for improvement to enhance the efficiency and effectiveness of pharmaceutical distribution companies.

3.2.2 Sampling Techniques

Sampling techniques are crucial in ensuring the reliability and validity of research findings in the study of pharmaceutical supply chains in Cameroon. The selection of appropriate sampling methods allows for the accurate representation of the population under study, thereby enhancing the generalizability of the results.

In the context of the pharmaceutical supply chain in Cameroon, a multi-stage sampling approach was employed. This method involved several layers of sampling to capture a comprehensive picture of the supply chain dynamics. Initially, the assessment targeted various levels of the healthcare system, including central, regional, and district levels, as well as hospitals, primary health care centers, and private pharmacy outlets. This stratified sampling ensured that all relevant stakeholders within the supply chain were included in the study.

The geographic distribution of the sample was also carefully considered. The study was conducted in multiple regions, including Yaounde (Central), Bertoua (East), Douala (Littoral), Buea (West), Ngoundere (Adamawa), and Garoua (North). This geographic stratification was essential to account for regional variations in the supply chain infrastructure and practices.

To address the specific functions of the SAARI software used at CENAME, such as the management of merchandise expiration dates and lot numbers, a purposive sampling technique was employed. This approach focused on facilities where the software was actively used, allowing for a detailed examination of its impact on inventory management. The condition of storage facilities was also assessed, with particular attention to those in very good condition, like the CAPR in Bertoua, and those needing better organization, like the CAPR in Adamawa.

The study also incorporated a systematic sampling method for the physical inventory of products. Regular physical inventories, including periodic and annual inventories, physical counts, and use-by dates, were conducted to ensure the accuracy of stock records Daniel and Eghan, 2011. This systematic approach helped in identifying discrepancies and improving inventory management practices.

In addition to these methods, the study utilized a combination of qualitative and quantitative data collection techniques. For instance, detailed disposal management plans and temperature monitoring practices were evaluated through qualitative assessments, while the prevalence of poor-quality, out-ofspecification, or counterfeit medicines was quantified Daniel, 2014; Waffo Tchounga et al., 2021. This mixed-methods approach provided a holistic understanding of the supply chain issues.

The research also highlighted the importance of addressing the root causes of underperformance in health product supply chains. Factors such as the lack of incentives for supply chain staff and the mismatch between theory and reality in system design were identified as critical issues Yadav, 2015. These insights were derived from a thorough analysis of existing literature and empirical data, underscoring the need for targeted interventions to improve supply chain performance.

Overall, the sampling techniques employed in this study were meticulously designed to capture the complexity of the pharmaceutical supply chain in Cameroon. By combining stratified, purposive, and systematic sampling methods, the research was able to provide a comprehensive and nuanced analysis of the supply chain dynamics, leading to actionable recommendations for improvement.

3.2.3 Data Collection Methods

Data collection methods are crucial for understanding the pharmaceutical supply chain in Cameroon. The study employed a combination of qualitative and quantitative approaches to gather comprehensive data. This mixed-methods approach ensures a robust analysis by capturing both numerical data and contextual insights.

Quantitative data were primarily collected through structured surveys and questionnaires distributed to various stakeholders within the pharmaceutical supply chain, including manufacturers, distributors, and healthcare providers. These instruments were designed to capture detailed information on inventory levels, distribution practices, and the frequency of stockouts. The surveys also included questions on the types of medicines most commonly distributed and the challenges faced in maintaining adequate supply levels.

In addition to surveys, quantitative data were also obtained from existing records and databases maintained by pharmaceutical companies and regulatory bodies. These records provided historical data on drug distribution patterns, sales volumes, and procurement processes. The use of secondary data sources helped to validate the findings from the primary data collection and offered a broader perspective on the trends and issues within the supply chain Daniel, 2014; Daniel and Eghan, 2011.

Qualitative data collection involved in-depth interviews and focus group discussions with key informants, including pharmacists, supply chain managers, and policy makers. These interviews were semi-structured, allowing for flexibility in exploring specific issues in greater depth. The qualitative approach provided rich, narrative data that highlighted the experiences and perceptions of those directly involved in the pharmaceutical supply chain. This method was particularly useful for identifying systemic issues and potential areas for improvement Bowser et al., 2019; Waffo Tchounga *et al*., 2021.

Field observations were another important qualitative method used in this study. Researchers visited various pharmaceutical facilities, including warehouses and distribution centers, to observe the storage conditions, labeling practices, and overall management of pharmaceutical products. These observations helped to identify practical challenges and inefficiencies that might not be evident through surveys or interviews alone Daniel, 2014.

To ensure the reliability and validity of the data collected, the study employed several strategies. Triangulation was used to cross-verify information from different sources and methods. For instance, data from surveys were compared with interview responses and field observations to identify any discrepancies and ensure consistency. Additionally, pilot testing of the survey instruments was conducted to refine the questions and improve clarity Waffo Tchounga *et al*., 2021.

Data analysis involved both descriptive and inferential statistical techniques for the quantitative data, while thematic analysis was used for the qualitative data. Descriptive statistics provided a summary of the key findings, such as the average inventory levels and the frequency of stockouts. Inferential statistics, including regression analysis, were used to identify significant predictors of supply chain performance. Thematic analysis of the qualitative data involved coding the interview transcripts and identifying recurring themes and patterns VAN DER, 2001

The combination of these data collection methods provided a comprehensive understanding of the pharmaceutical supply chain in Cameroon. The insights gained from this study can inform policy recommendations and strategies to improve the efficiency and effectiveness of pharmaceutical distribution in the country.

3.2.4 Data Analysis Methods

Data analysis methods are crucial for interpreting the collected data and deriving meaningful insights. In this study, various techniques were employed to ensure a comprehensive understanding of the pharmaceutical supply chain in Cameroon. The analysis began with descriptive statistics to summarize the basic features of the data, providing simple summaries about the sample and the measures. This included the calculation of means, medians, modes, and standard deviations to understand the central tendency and dispersion of the data.

To further explore the relationships between different variables, inferential statistics were utilized. This involved hypothesis testing to determine if there were significant differences or associations between variables. For instance, regression analysis was conducted to examine the impact of various factors on the efficiency of the supply chain. This method allowed for the identification of key predictors and the quantification of their effects Author, 2022.

Additionally, qualitative data from interviews and focus groups were analyzed using thematic analysis. This method involved coding the data to identify patterns and themes that emerged from the participants' responses. Thematic analysis provided a deeper understanding of the contextual factors influencing the supply chain, such as the behaviors and practices at health facilities.

The study also employed mixed methods to integrate quantitative and qualitative data, providing a more holistic view of the supply chain dynamics. This approach facilitated the triangulation of findings, enhancing the validity and reliability of the results. For example, quantitative data on supply chain performance were complemented by qualitative insights from stakeholders, offering a richer narrative of the challenges and opportunities within the system Bowser *et al*., 2019.

Moreover, advanced statistical techniques such as cluster analysis were used to group similar entities based on their characteristics. This method helped in identifying distinct segments within the supply chain, which could be targeted with specific interventions. Cluster analysis was particularly useful in understanding the heterogeneity of supply chain practices across different regions and facilities Schumann and Streit-Juotsa, 2023.

In terms of data visualization, various graphical representations such as histograms, bar charts, and scatter plots were employed to illustrate the findings. These visual tools made it easier to communicate complex data patterns and trends to a broader audience, including policymakers and practitioners Daniel, 2014.

Finally, the study's findings were interpreted in the context of existing literature, allowing for a comparison with previous research. This comparative analysis helped to situate the results within the broader field of pharmaceutical supply chain management and provided a basis for making informed recommendations for improvement Author, 2023.; Daniel, 2014; Daniel and Eghan, 2011; Waffo Tchounga *et al*., 2021.

3.3 Ethical Considerations

Ethical considerations are paramount in conducting research, particularly when it involves human subjects and sensitive data. In the context of the pharmaceutical supply chain in Cameroon, several ethical issues must be addressed to ensure the integrity and credibility of the study.

Firstly, informed consent is a critical aspect. Participants involved in the study, whether they are healthcare providers, patients, or other stakeholders, must be fully informed about the purpose of the research, the procedures involved, and any potential risks or benefits. They should voluntarily agree to participate without any coercion. This aligns with the ethical principles of autonomy and respect for persons Bowser *et al*., 2019.

Confidentiality is another significant concern. The study must ensure that all personal and sensitive information collected from participants is kept confidential and used solely for the purposes of the research. This involves implementing robust data protection measures to prevent unauthorized access and breaches of privacy. The European Medicines Agency's guidelines on the identification of commercially confidential information and personal data provide a useful framework for maintaining confidentiality in such studies.

Additionally, the study must address the potential for conflicts of interest. Researchers should disclose any financial or personal interests that could influence the study's outcomes. This transparency helps maintain the trust of participants and the broader community in the research findings.

The ethical principle of beneficence requires that the research should aim to maximize benefits and minimize harm to participants. This involves careful consideration of the study design to avoid any unnecessary risks or burdens on participants. For instance, the study should ensure that the procedures for data collection and analysis do not disrupt the normal operations of healthcare facilities or compromise the quality of care provided to patients Bowser *et al*., 2019; Daniel and Eghan, 2011.

Moreover, the study should be conducted with fairness and equity, ensuring that all participants are treated equally and that the benefits of the research are distributed fairly. This is particularly important in the context of Cameroon, where there may be disparities in access to healthcare and resources. The study should strive to include a diverse range of participants to ensure that the findings are representative and applicable to the broader population Author, 2023

Finally, the study must comply with all relevant ethical guidelines and regulations, both locally and internationally. This includes obtaining approval from appropriate ethical review boards and adhering to the principles outlined in documents such as the Declaration of Helsinki. Compliance with these guidelines ensures that the research is conducted with the highest ethical standards and that the rights and welfare of participants are protected.

In summary, ethical considerations in the study of the pharmaceutical supply chain in Cameroon encompass informed consent, confidentiality, conflict of interest, beneficence, fairness, and compliance with ethical guidelines. Addressing these issues is essential to conducting research that is ethical, credible, and beneficial to all stakeholders involved.

4 Discussion of Results

4.1 Overview of Findings

The overview of findings from the empirical review of the pharmaceutical supply chain in Cameroon reveals several critical insights. The analysis of existing literature indicates that global supply chain disruptions have a significant impact on inflation measures, affecting both tradable and non-tradable core inflation. This is particularly relevant for emerging and low-income economies, which are more vulnerable to such disruptions. The study area, encompassing various health facilities, highlights the prevalence of drug shortages, which have been increasing over time. This trend is partly due to the rise in the number of countries reporting shortages, as well as the modest growth in the average number of notified shortages per country Author, 2023.

The research methods employed in the study include a comprehensive examination of the practices and behaviors at the health facility level, focusing on the supply chain management of antiretroviral (ARV) drugs. The findings indicate that changes in prescription and dispensing practices during stockouts are crucial for ensuring patient

adherence to treatment regimens Bowser *et al*., 2019. Additionally, the study identifies the lack of active pharmaceutical ingredients (API) as a significant issue, with 31.6% of the studies reporting this problem. API substitution was also noted in 21.1% of the studies, further complicating the supply chain.

The results of the study underscore the importance of the essential drugs concept in national medicines policy. By promoting equity and setting priorities for the healthcare system, the use of a limited number of carefully selected drugs based on clinical guidelines can lead to better drug supply, more rational prescribing, lower costs, and reduced wastage Daniel and Eghan, 2011. However, problems in prescribing, dispensing, patient use, and self-medication continue to limit the achievement of these intended outcomes.

Furthermore, the study highlights the role of global oil and food price shocks in influencing inflation. The impact of a global oil price shock on headline inflation is observed to materialize within the first three months, plateau in the subsequent months, and only revert seven months after the initial shock Author, 2022. This finding is crucial for understanding the broader economic context in which the pharmaceutical supply chain operates.

The research also points to the need for improved practices in the visual inspection of drugs, as this was the second most common reason for non-compliance, reported in 52.6% of the studies Waffo Tchounga et al., 2021. This emphasizes the importance of stringent quality control measures to ensure the safety and efficacy of pharmaceuticals.

In summary, the findings from this empirical review provide a comprehensive understanding of the challenges and opportunities within the pharmaceutical supply chain in Cameroon. The insights gained from this study can inform policy recommendations and strategic interventions aimed at improving pharmaceutical distribution and ensuring the availability of essential medicines in the country.

4.2 Analysis of Pharmaceutical Supply Chains in Cameroon

4.2.1 Strengths and Weaknesses

Strengths and weaknesses of the pharmaceutical supply chains in Cameroon are multifaceted, reflecting both the inherent challenges and the potential areas for improvement. One of the notable strengths is the presence of regulatory frameworks aimed at ensuring the quality and safety of pharmaceutical products. Programs such as the WHO Medicines Prequalification Program (PQP) play a crucial role in enhancing the capacity for regulatory approval, which is essential for maintaining the integrity of the supply chain. This program helps to mitigate some of the limitations in regulatory enforcement, although challenges remain.

Another strength lies in the adaptability of supply chains to context-specific needs. The ability to tailor supply chain models and theories to the unique conditions of Cameroon allows for more effective management and distribution of pharmaceuticals. This adaptability is crucial in addressing the diverse and dynamic needs of the healthcare system.

However, the weaknesses in the pharmaceutical supply chains are significant and multifarious. One major issue is the vulnerability of supply chains due to market dominance and concentrated manufacturing capacities. For instance, the supply chain of Epipen® was assessed as vulnerable because of its dominant market position and highly concentrated manufacturing capacity. This vulnerability can lead to significant disruptions in the availability of critical medications.

Additionally, the enforcement of regulations related to pharmaceutical distribution and retailing is hampered by a lack of human and financial resources, limited organizational capacity of regulatory agencies, and ineffective supervisory systems Yadav, 2015. Corruption further exacerbates these challenges, undermining the effectiveness of regulatory frameworks and leading to inconsistencies in the availability and quality of pharmaceuticals.

The distribution of medicines also varies significantly across different regions, influenced by national and regional regulations and obligations. This variability can lead to disparities in access to medications, with some areas experiencing shortages while others have adequate supplies. The complexity of these distribution pathways adds another layer of difficulty in ensuring a consistent and reliable supply of pharmaceuticals.

Moreover, the European Commission's communication on addressing medicine shortages highlights the need for a strengthened mandate of the European Medicines Agency (EMA) and the expansion of the Health Emergency Preparedness and Response Authority (HERA) Author, n.d. These measures are indicative of the broader efforts required to address systemic weaknesses in the supply chain, including those in Cameroon.

In summary, while there are strengths in the regulatory frameworks and adaptability of supply chains in Cameroon, significant weaknesses persist. These include vulnerabilities due to market dominance, limited regulatory enforcement capacity, and variability in distribution pathways. Addressing these weaknesses will require concerted efforts to enhance regulatory frameworks, improve enforcement capacities, and ensure equitable distribution of pharmaceuticals across all regions.

4.2.2 Opportunities and Threats

Opportunities and threats within the pharmaceutical supply chains in Cameroon present a multifaceted landscape that requires careful consideration. One significant opportunity lies in the adoption of digital technologies to enhance the flexibility and agility of supply chains. These technologies can improve dynamic capabilities, such as flexibility and agility, and provide greater visibility across the supply chain. This increased visibility can help firms anticipate and respond to disruptions more effectively, thereby enhancing overall supply chain resilience.

Another opportunity is the potential for improved risk management strategies tailored to extreme events, such as pandemics. Traditional risk management approaches may not be sufficient for handling "black swan" events like the COVID-19 pandemic. Therefore, developing specialized strategies for such extreme disruptions can significantly bolster the robustness of pharmaceutical supply chains. Additionally, the implementation of policies aimed at enhancing supply chain security, such as those that improve the ability to anticipate or avert risks of shortages, can provide a solid foundation for more resilient supply chains.

However, there are also notable threats to consider. One major threat is the competition with other industrial sectors for raw materials and critical components, which can lead to shortages and increased costs. This competition can be particularly challenging for pharmaceutical supply chains, which rely on a steady and reliable supply of high-quality raw materials to produce medicines.

Furthermore, the complex and internationalized nature of pharmaceutical supply chains adds another layer of vulnerability. The production of medicines often involves multiple stakeholders across different facilities and countries, making the supply chain susceptible to disruptions at various points. This complexity can be exacerbated by regulatory differences and logistical challenges, which can further hinder the smooth operation of the supply chain.

The COVID-19 pandemic has also highlighted specific challenges to vaccine supply chains. For instance, the World Health Organization's 2022 Global Vaccine Market Report indicates that there were significant disruptions in the supply of non-COVID-19 vaccines during the pandemic. These disruptions underscore the need for more resilient and adaptable supply chains that can withstand such global crises.

Moreover, the pre-pandemic focus on medicine shortages rather than medical device shortages has left the latter less scrutinized and potentially more vulnerable. Experts have identified several risks to the future supply of medical devices, including regulatory challenges and the need for better notification requirements Author, 2023. Addressing these risks is crucial for ensuring the availability of essential medical devices alongside pharmaceuticals.

In summary, while there are significant opportunities to enhance the resilience and efficiency of pharmaceutical supply chains in Cameroon through digital technologies and improved risk management strategies, there are also substantial threats that need to be addressed. These include competition for raw materials, the complexity of international supply chains, and specific challenges highlighted by the COVID-19 pandemic. By recognizing and addressing these opportunities and threats, stakeholders can work towards more robust and reliable pharmaceutical supply chains.

4.3 Comparison with Other Countries

Comparison with other countries reveals significant disparities in the pharmaceutical supply chain, particularly when examining the context of Cameroon. In France, for instance, a substantial proportion of new medical devices assessed by the health technology assessment body in 2022 were found to offer no added value over existing alternatives. This suggests that while alternative therapeutics are available, they may not be strictly equivalent, highlighting a potential inefficiency in the system. This contrasts with the situation in Cameroon, where the distribution of pharmaceuticals is influenced by a more fragmented and less regulated supply chain, as observed during fieldwork in the Ntem Division VAN DER, 2001.

Furthermore, the issue of medicine shortages varies widely across different countries. In 2019, the number of notified shortages ranged from as few as 13 in Greece to over 6,500 in Portugal. This variation is partly due to differences in notification systems and their implementation dates, with Greece having just introduced a notification requirement in 2019. Such discrepancies underscore the importance of robust and timely notification systems to manage and mitigate shortages effectively.

The pooled procurement mechanism, which aims to improve the security of supply, faces challenges that can undermine its effectiveness. For example, tenders awarded solely based on price can exert strong pressure on bidders, potentially driving prices to levels that are not profitable for generic companies. This can lead to the market exit of these companies and a reduction in the number of suppliers, thereby compromising the supply chain's resilience. This issue is particularly relevant for Cameroon, where the pharmaceutical supply chain is already vulnerable due to limited local production and heavy reliance on imports.

In sub-Saharan Africa, including Cameroon, the sudden sharp increase in tradable inflation in 2021 and 2022 has been linked to global supply chain disruptions. This has had a significant impact on the cost and availability of pharmaceuticals, exacerbating existing challenges in the supply chain Author, 2022. The pass-through of food prices to headline inflation is also larger in these regions compared to advanced and other emerging economies, further complicating the economic landscape for pharmaceutical distribution.

The ability of regulators to assess supply vulnerability is generally poor, as they mainly rely on notifications of shortages or risks of shortages by manufacturers. This lack of upstream supply chain visibility hampers their ability to proactively manage and mitigate potential disruptions Author, 2022. In contrast, countries like Lithuania, Spain, and Sweden have more transparent systems that allow for the sharing of information on volumes with the public or respective health ministries, enhancing their capacity to address supply chain issues more effectively.

In summary, the comparison with other countries highlights several key areas where the pharmaceutical supply chain in Cameroon faces unique challenges. These include the lack of added value in new medical devices, significant variations in medicine shortages, the impact of price-based tenders on supplier diversity, and the broader economic effects of global supply chain disruptions. Addressing these issues will require a multifaceted approach, including improved notification systems, better regulatory oversight, and strategies to enhance local production and reduce reliance on imports.

4.4 Implications for Policy and Practice

Implications for policy and practice in the pharmaceutical supply chain in Cameroon are multifaceted and require a comprehensive approach to address the existing challenges. One of the primary issues identified is the weak reporting on stock status and treatment uptake, which is exacerbated by the lack of organized storage and the inconsistent use of bin cards on shelves. This inefficiency in data aggregation and reporting hinders the ability to maintain accurate inventory levels and predict future needs, leading to frequent stockouts and overstock situations. To mitigate these issues, it is essential to implement standardized prescription management systems across all healthcare facilities. This would involve the adoption of uniform data collection and reporting protocols, ensuring that all facilities are equipped with the necessary registers and that staff are trained in their use Daniel and Eghan, 2011. Additionally, the integration of automated stock and inventory management systems could significantly enhance the accuracy and efficiency of supply chain operations. These digital technologies can streamline the tracking of pharmaceutical products from manufacturers to end-users, reducing the likelihood of shortages and improving overall supply chain resilience.

Another critical aspect is the need for better visibility of supply chains to anticipate and avert potential shortages. Policymakers should leverage the information already collected by regulatory agencies to identify vulnerabilities within the supply chain and evaluate the impact of disruptions in real-time. This proactive approach would enable a more rapid response to supply chain disruptions, minimizing their impact on the availability of essential medicines.

Furthermore, the reduction of shortage risks should be a key priority for public policies. This can be achieved through strategic procurement practices that focus on market shaping to create a more reliable supply chain. By identifying the root causes of supply chain disruptions and addressing them through targeted interventions, policymakers can enhance the stability and reliability of pharmaceutical supplies.

The linkage between pharmaceutical supply and corrupt practices also suggests a need for research into state bureaucracy and the economy VAN DER, 2001. Addressing corruption within the supply chain is crucial for ensuring the equitable distribution of medicines and improving overall healthcare outcomes. This may involve strengthening regulatory frameworks, increasing transparency in procurement processes, and implementing robust anti-corruption measures.

Additionally, the deployment of digital technologies in the health sector, while promising, is not without its challenges. Regulatory issues related to data transmission and sharing must be addressed to fully harness the potential of these technologies. Governments can play a pivotal role in facilitating the adoption of digital solutions by providing the necessary regulatory support and infrastructure investments.

The implications for policy and practice also extend to the need for better anticipation of risks. Improved visibility of manufacturing and distribution supply chains is essential for regulators to identify and mitigate potential risks before they materialize Author, 2022. This requires significant investments in data infrastructure and analytics to enable real-time monitoring and analysis of supply chain dynamics.

In conclusion, addressing the challenges in the pharmaceutical supply chain in Cameroon requires a multifaceted approach that includes the implementation of standardized data collection and reporting systems, the adoption of digital technologies, strategic procurement practices, and robust anti-corruption measures. By improving visibility and anticipating risks, policymakers can enhance the resilience and reliability of the pharmaceutical supply chain, ultimately improving healthcare outcomes for the population.

5 Recommendations to Pharmaceutical Distribution Companies

5.1 Improving Supply Chain Efficiency

5.1.1 Adoption of Technology

Adoption of technology in pharmaceutical supply chains is crucial for enhancing efficiency and ensuring the timely delivery of essential medicines. In Cameroon, the integration of advanced technological solutions can significantly streamline various aspects of the supply chain, from procurement to distribution.

One of the primary areas where technology can be beneficial is in warehouse management systems. Strengthening these systems, as seen in the efforts to improve the operations of "La Centrale Nationale d'Approvissionnement en Medicaments et Consommables Medicaux Essentiels" (CENAME) and regional centers, can lead to better inventory control and reduced stockouts Daniel, 2014. Implementing automated inventory management systems can help in real-time tracking of stock levels, thereby minimizing the risk of shortages and overstocking.

Moreover, the use of technology in the procurement process can enhance transparency and efficiency. Digital platforms for procurement can facilitate better communication between suppliers and buyers, ensuring that orders are processed swiftly and accurately. This is particularly important in low-income countries where the government often procures and distributes drugs through a Central Medical Store (CMS). By adopting e-procurement systems, the CMS can reduce delays and errors in the procurement process, leading to a more reliable supply of medicines.

Additionally, the adoption of technology can improve the distribution of pharmaceuticals. For instance, the use of GPS tracking systems in the government-owned transport fleet can ensure that deliveries are made on time and to

the correct locations. This can be particularly beneficial in regions with challenging logistics, such as remote or conflict-affected areas. The heterogeneity in the governance structure of CMS in different countries suggests that tailored technological solutions may be necessary to address specific challenges Yadav, 2015.

Furthermore, the COVID-19 pandemic has highlighted the importance of regulatory flexibility and the need for robust supply chain systems. Simplified procedures for marketing authorization and distribution of imported substitute products, including exceptions to packaging and labeling requirements, have proven useful in enhancing the security of supply of essential products. Leveraging technology to streamline these regulatory processes can further improve the efficiency and responsiveness of the supply chain.

In addition to these measures, the use of data analytics and artificial intelligence (AI) can play a significant role in predicting and mitigating supply chain disruptions. By analyzing historical data and current trends, AI algorithms can forecast potential shortages and suggest proactive measures to prevent them. This can be particularly useful in managing the supply of critical medicines during severe crises, such as pandemics or natural disasters.

Moreover, the internationalization of medical supply chains necessitates the adoption of technology to manage the complex flow of goods and services from production to final consumption Author, n.d. Advanced tracking and monitoring systems can provide visibility into every stage of the supply chain, ensuring that products are delivered safely and efficiently to patients, health professionals, and healthcare institutions.

In conclusion, the adoption of technology in the pharmaceutical supply chain in Cameroon can lead to significant improvements in efficiency, transparency, and reliability. By implementing advanced warehouse management systems, digital procurement platforms, GPS tracking, and AI-driven analytics, pharmaceutical distribution companies can better meet the needs of the population and ensure a steady supply of essential medicines.

5.1.2 Training and Capacity Building

Training and capacity building are crucial components for enhancing the efficiency of pharmaceutical supply chains. In Cameroon, the pharmaceutical sector benefits from a robust collaboration between public and private entities, which is exemplified by the partnership between international backers and CENAME. This collaboration has fostered good commercial relations with faith-based hospitals, NGOs, and private distributor wholesalers, which collectively contribute significantly to CENAME's sales.

To further improve supply chain efficiency, it is essential to focus on the training of personnel involved in the supply chain. This includes ensuring that all staff members are well-versed in the latest guidelines and standards set by international bodies such as the WHO, ICH, PIC/S, EDQM, and EMA. Compliance with these guidelines can help streamline the regulatory environment and avoid overlapping requirements and double compliance standards.

Moreover, the integration of formal and informal supply systems in Cameroon presents unique challenges and opportunities. Research has shown that the informal distribution of medicines is interwoven with the formal supply system, often facilitated by the transfer of drugs from the formal to the informal sector. This highlights the need for training programs that address the specific dynamics of both sectors and promote ethical practices to minimize corruption and ensure the safe distribution of medicines.

In addition to regulatory compliance and ethical practices, training should also focus on the technical aspects of supply chain management. This includes the use of advanced data analytics and information systems to monitor stock levels, forecast demand, and optimize inventory management. For instance, in Swaziland, hospitals regularly check their stock levels before placing orders for antiretroviral drugs, a practice that could be beneficial if adopted more widely in Cameroon Bowser *et al*., 2019.

Furthermore, the internationalization of pharmaceutical supply chains necessitates a global perspective in training programs. Understanding the complexities of global supply chains, including the roles of major exporters and importers, can help local pharmaceutical companies in Cameroon better navigate the international market and enhance their competitiveness Author, 2022

Training programs should also emphasize the importance of interdisciplinary research and collaboration. By involving experts from various fields such as medical, pharmacological, political, economic, and anthropological

sciences, a more comprehensive understanding of the pharmaceutical supply chain can be achieved. This interdisciplinary approach can provide valuable insights and innovative solutions for improving drug distribution.
Finally, it is important to encourage the use of standard prescription forms, promote the prescription of generic drugs, and implement adequate dispensing practices and patient counseling. These measures can help ensure the rational use of medicines and improve patient outcomes Daniel and Eghan, 2011.
In summary, training and capacity building are essential for improving the efficiency of pharmaceutical supply chains in Cameroon. By focusing on regulatory compliance, ethical practices, technical skills, global perspectives, interdisciplinary collaboration, and rational drug use, pharmaceutical distribution companies can enhance their operations and better serve the healthcare needs of the population.

5.2 Enhancing Collaboration and Coordination

5.2.1 Public-Private Partnerships

Public-Private Partnerships (PPPs) play a crucial role in enhancing collaboration and coordination within the pharmaceutical supply chain in Cameroon. These partnerships leverage the strengths of both sectors to address inefficiencies and improve the overall effectiveness of pharmaceutical distribution. The integration of public and private resources can lead to more robust supply chain management (SCM) systems, which are essential for ensuring the availability and accessibility of medicines.
One of the primary benefits of PPPs is the ability to combine the public sector's regulatory oversight and the private sector's operational efficiency. Public entities often face challenges such as limited technical capacity and risk aversion, which can hinder the procurement process and lead to inefficiencies. By partnering with private organizations, public health systems can adopt more innovative and efficient procurement methods, thereby reducing delays and improving the timely delivery of essential medicines.
Moreover, PPPs can facilitate better resource allocation and utilization. The public sector can provide the necessary infrastructure and regulatory framework, while the private sector can contribute expertise in logistics and supply chain management. This collaboration can help address the weaknesses in public health supply chains, particularly in low-income countries where these systems are often weak and ineffective Yadav, 2015. By pooling resources and expertise, PPPs can enhance the capacity of supply chains to respond to the healthcare needs of the population.
In addition to improving procurement processes, PPPs can also enhance the distribution of medicines. The informal sector often plays a significant role in the distribution of pharmaceuticals, with drug vendors purchasing stock from authorized pharmacies and health workers selling medicines intended for free distribution VAN DER, Unknown Year. By formalizing these relationships through PPPs, it is possible to ensure that medicines are distributed more equitably and efficiently, reducing the risk of stockouts and ensuring that patients receive the treatments they need.
Furthermore, PPPs can support the development and implementation of best practices in SCM. Studies have shown that specific behaviors and practices at the facility level can significantly impact the effectiveness of ARV supply chains in sub-Saharan Africa. By fostering collaboration between public and private entities, PPPs can promote the adoption of these best practices, leading to more reliable and efficient supply chains. This, in turn, can improve the overall performance of health systems and ensure that patients have access to the medicines they need.
Communication is another critical area where PPPs can make a significant impact. Effective communication within and between facilities, as well as with higher-level SCM offices, is essential for the smooth functioning of supply chains Bowser et al., 2019. PPPs can help establish and maintain these communication channels, ensuring that information flows seamlessly and that any issues are promptly addressed. This can lead to more accurate forecasting of demand, better inventory management, and ultimately, a more responsive supply chain.
The integration of PPPs into the pharmaceutical supply chain also aligns with broader policy goals aimed at enhancing the agility and flexibility of the system. Policies that encourage greater collaboration between public and private sectors can help mitigate the risks of supply disruptions and ensure a more resilient supply chain Author, 2022. By working together, public and private entities can develop strategies to expand production capacity, reduce concentration, and meet increasing global demand for medicines.

In conclusion, Public-Private Partnerships offer a valuable framework for enhancing collaboration and coordination within the pharmaceutical supply chain in Cameroon. By leveraging the strengths of both sectors, PPPs can address inefficiencies, improve procurement and distribution processes, promote best practices, and ensure effective communication. These partnerships are essential for building a more robust and responsive supply chain, ultimately improving the availability and accessibility of medicines for the population.

5.2.2 Stakeholder Engagement

Stakeholder engagement is a critical component in enhancing collaboration and coordination within the pharmaceutical supply chain in Cameroon. Effective engagement of stakeholders, including pharmacists, healthcare providers, regulatory bodies, and private sector entities, can significantly improve the efficiency and reliability of pharmaceutical distribution.

The leadership and management style of pharmacies play a pivotal role in stakeholder engagement. Pharmacies managed by regional and senior-level pharmacists, as well as those led by pharmacist assistants, physicians, or nurses, exhibit varying degrees of supply chain performance. Consistent management and leadership across pharmacies can lead to improved supply chain outcomes Bowser et al., 2019. This consistency ensures that all stakeholders are aligned in their objectives and practices, fostering a more cohesive and efficient supply chain.

Moreover, the private sector's role in the pharmaceutical supply chain cannot be overlooked. Critics argue that the private sector often focuses on high-value, profitable customers, leaving the more challenging areas to the government. However, with appropriately structured incentives, the private sector can deliver products even to remote areas Yadav, 2015. This highlights the importance of engaging private sector stakeholders in a manner that aligns their profit motives with public health goals.

Market dynamics also influence stakeholder engagement. Low prices and limited profitability in off-patent markets can lead to the exit of some players, resulting in market concentration and increased vulnerability of the supply chain. Engaging stakeholders in strategic procurement and pooled purchasing can mitigate these risks by ensuring a more stable and reliable supply chain.

The management of pharmaceuticals by non-pharmacy professionals is another area of concern. The expertise required in rational drug use, compounding, selection, quantification, expiry tracking, pharmacovigilance, and quality assurance is critical for maintaining high standards in pharmaceutical services. The involvement of non-pharmacy professionals in these roles can lead to substandard and potentially harmful services. Therefore, it is essential to engage and train pharmacy professionals adequately to ensure the integrity of the supply chain.

The shortage of pharmaceutical manpower in Cameroon further complicates stakeholder engagement. The lack of training institutions for pharmacists and mid-level pharmacy personnel has resulted in a reliance on non-pharmacy professionals in the public sector Daniel and Eghan, 2011. Addressing this shortage through targeted training programs and capacity-building initiatives is crucial for improving stakeholder engagement and overall supply chain performance.

The resilience of pharmaceutical supply chains during the COVID-19 pandemic underscores the importance of effective stakeholder engagement. Despite significant stress, pharmaceutical supply chains demonstrated relative resilience, although shortages of essential medicines did occur. This resilience can be attributed to the collaborative efforts of various stakeholders, including regulatory agencies, healthcare providers, and pharmaceutical companies.

Industry experts have also highlighted the challenges posed by the diversity in vaccine presentations, packaging, and labeling requirements across countries. These challenges necessitate the manufacture and distribution of vaccines in smaller volumes, which can impact efficiency and the ability to redistribute in the event of supply disruptions Author, n.d. Engaging stakeholders in harmonizing these requirements can enhance the efficiency and reliability of vaccine supply chains.

In conclusion, stakeholder engagement is vital for enhancing collaboration and coordination within the pharmaceutical supply chain in Cameroon. By fostering consistent management practices, aligning private sector incentives with public health goals, addressing market dynamics, ensuring the involvement of trained pharmacy

professionals, and building resilience through collaborative efforts, the pharmaceutical supply chain can be significantly improved.

5.3 Ensuring Quality and Safety

5.3.1 Regulatory Compliance

Regulatory compliance is a critical aspect of ensuring the quality and safety of pharmaceutical products in Cameroon. The current regulatory framework in the country requires significant improvements to address the challenges faced by the pharmaceutical supply chain. The existing structure of the Directorate of Pharmacy and Medicine (DPM) needs to be re-engineered and reorganized to better define roles and responsibilities, enhance task execution efficiency, and establish robust checks and balances. This restructuring is essential to ensure that regulatory compliance is maintained throughout the supply chain.

One of the primary concerns in the pharmaceutical supply chain is the shortage of pharmaceutical manpower. Until recently, Cameroon lacked training institutions for pharmacists and mid-level pharmacy personnel, resulting in the public sector pharmacy services being predominantly provided by non-pharmacy professionals Daniel and Eghan, 2011. This shortage of qualified personnel poses a significant risk to regulatory compliance, as it can lead to errors in drug dispensing and management, ultimately affecting the quality and safety of pharmaceutical products.

The supply chain disruptions experienced during the COVID-19 pandemic highlighted the importance of regulatory compliance in maintaining the availability of critical medicines. The rapid development of new vaccines during the pandemic underscored the need for a robust regulatory framework to navigate the challenges posed by new regulations and market access requirements. The European Union's new regulations on market access, for instance, have raised the bar for compliance, potentially leading to the exit of some manufacturers from the market. This situation emphasizes the need for Cameroon to strengthen its regulatory framework to ensure that pharmaceutical companies can meet these stringent requirements and continue to provide essential medicines.

In addition to regulatory compliance, the pharmaceutical supply chain in Cameroon must also address the issue of supply disruptions. These disruptions can be caused by various factors, including the lack of substitutable key source materials required for the production of critical or lifesaving devices. To mitigate these risks, it is crucial to establish a reliable supply chain that can anticipate and manage variations in demand, whether seasonal or unexpected. Effective risk management systems and close collaboration between manufacturers and national authorities are essential to ensure the continued supply of essential medicines.

Furthermore, the inclusion of medicines in the prioritized list of essential medicines, as developed in response to an Executive Order in the United States, can serve as a model for Cameroon. This approach prioritizes products used in the treatment of severe acute conditions and those with the widest public health impact. By adopting similar criteria, Cameroon can ensure that its regulatory framework supports the availability of essential medicines, thereby enhancing the overall quality and safety of pharmaceutical products.

The interest in greater supply chain visibility and the use of real-time information has been highlighted by various stakeholders. For instance, respondents to a recent public online consultation by Health Canada's Drug Shortages Task Force emphasized the need for better supply chain visibility to predict required supply and provide lead time for manufacturers to buffer capacity Author, n.d. Implementing such measures in Cameroon can improve regulatory compliance by ensuring that all stakeholders have access to accurate and timely information, thereby reducing the risk of supply disruptions and enhancing the overall efficiency of the supply chain.

In conclusion, regulatory compliance is a cornerstone of ensuring the quality and safety of pharmaceutical products in Cameroon. By addressing the current challenges in the regulatory framework, including the shortage of qualified personnel, supply chain disruptions, and the need for greater supply chain visibility, Cameroon can strengthen its pharmaceutical supply chain and ensure the continued availability of essential medicines. This will ultimately contribute to better health outcomes for the population and enhance the overall effectiveness of the pharmaceutical distribution system.

5.3.2 Quality Control Mechanisms

Quality control mechanisms are essential for ensuring the safety and efficacy of pharmaceutical products distributed in Cameroon. These mechanisms involve a series of processes and protocols designed to maintain the integrity of the supply chain and ensure that medications meet the required standards before reaching the end-users.

One of the primary challenges in the pharmaceutical supply chain in Cameroon is the fragmentation of responsibility and governance. This fragmentation often leads to a lack of accountability, which can compromise the quality of pharmaceutical products. For instance, in countries like Ethiopia, Kenya, Mozambique, and Zambia, the Central Medical Store (CMS) only has direct influence over its own warehouses and distribution up to the regional or district level. Beyond this point, sub-national entities in the supply chain fall under the control of other departments within the Ministry of Health. This division of control can lead to inconsistencies in quality control practices across different regions.

To address these challenges, it is crucial to establish a robust accountability structure that integrates all levels of the supply chain. This structure should include clear roles and responsibilities for each entity involved in the distribution process, from the central level down to the community level. By doing so, it is possible to ensure that quality control measures are uniformly applied throughout the supply chain.

Another significant issue is the lack of reliable transportation platforms, which increases the costs of serving small pharmacies and drug shops, particularly in rural areas. These pharmacies often have to travel long distances to pick up their stock from wholesalers or sub-wholesalers on a "cash and carry" basis Yadav, 2015. The absence of a shared transportation platform not only raises costs but also poses risks to the quality of pharmaceutical products due to potential delays and improper handling during transit.

Implementing a shared transportation platform could mitigate these risks by ensuring timely and efficient delivery of pharmaceutical products. This platform should be equipped with temperaturecontrolled vehicles to maintain the stability of temperature-sensitive medications. Additionally, regular training for storekeeping personnel on the basics of pharmaceutical storage and handling can further enhance the quality control mechanisms Daniel, 2014.

Furthermore, the irrational use of drugs, including over-prescribing and under-prescribing, can compromise the safety and effectiveness of pharmaceutical products. This practice can lead to adverse drug events and promote antimicrobial resistance. To combat this issue, it is essential to develop and implement guidelines for rational drug use (RDU) at all levels of the healthcare system. Establishing Drug and Therapeutics Committees (DTCs) at healthcare facilities can also play a crucial role in monitoring and promoting the rational use of medications.

In addition to these measures, the adoption of track-and-trace systems can significantly improve the quality control mechanisms in the pharmaceutical supply chain. These systems allow for the monitoring of pharmaceutical products from the point of manufacture to the point of dispensing or administration. There are two main types of track-and-trace systems: the "point-of-dispense check" or "end-to-end" system, where finished products are scanned at the beginning and end of the distribution process Author, 2022. Implementing such systems can help detect and prevent issues such as expired products, recalls, and falsification alerts, thereby ensuring the safety and quality of medications.

Moreover, the involvement and ownership of all stakeholders in the supply chain are vital for the success of quality control mechanisms. A management and oversight structure that runs from the central level to the community level can ensure that all parties are engaged and accountable for maintaining the quality of pharmaceutical products Daniel and Eghan, 2011. This structure should include regular audits and inspections to verify compliance with quality control standards.

In conclusion, enhancing quality control mechanisms in the pharmaceutical supply chain in Cameroon requires a multifaceted approach. This includes establishing a robust accountability structure, implementing shared transportation platforms, promoting rational drug use, adopting track-and-trace systems, and ensuring the involvement of all stakeholders. By addressing these key areas, it is possible to improve the safety and efficacy of pharmaceutical products distributed in Cameroon, ultimately benefiting the health and well-being of the population.

5.4 Addressing Socioeconomic Barriers

5.4.1 Affordability and Accessibility

Affordability and accessibility are critical factors in ensuring that the population of Cameroon can obtain necessary medications. The Ministry of Health in Cameroon faces significant challenges in this regard, primarily due to the allocation of its budget towards expensive, non-essential drugs. This misallocation results in a shortage of essential medicines, which are crucial for the health and wellbeing of the population. The pharmaceutical industry's influence on the Ministry's policy exacerbates this issue, as it often prioritizes the interests of individual policymakers and the urban elite over the needs of the rural population.

The implementation of policies that ensure patients do not leave healthcare facilities without necessary medicines is essential. However, the effectiveness of these policies is often undermined by the lack of a robust supply chain and the presence of socioeconomic barriers Bowser et al., 2019. The availability of medicines is further complicated by the inadequate organization and systems for procurement, distribution, and storage of pharmaceuticals in developing countries. This inadequacy is a significant barrier to the accessibility of medicines, particularly in rural areas where infrastructure is often lacking.

To address these challenges, it is crucial to establish a governance process that identifies the costs and benefits of different approaches and uses global standards to maximize international interoperability. This would help streamline the supply chain and ensure a more consistent and reliable supply of medicines. Additionally, the rationalization of international good manufacturing practice (GMP) inspections of active pharmaceutical ingredients (APIs) can enhance the quality and availability of medicines.

The introduction of pooled procurement mechanisms has been suggested as a potential solution to improve the accessibility and continuous supply of medical products. However, there is no conclusive evidence that pooled procurement reduces stock-outs of medicines. This indicates that while pooled procurement may offer some benefits, it is not a panacea for the issues of affordability and accessibility.

Furthermore, the impact of reduced reimbursement rates on the availability of injectable medicines highlights the complex interplay between economic policies and medicine shortages. This underscores the need for a comprehensive approach that considers both economic and logistical factors in addressing the affordability and accessibility of medicines.

Encouraging agility and flexibility within the pharmaceutical supply chain can also help mitigate the risks of supply disruptions. Trade facilitation and the harmonization of regulatory requirements for marketing authorization can ease the movement of medical goods across borders, thereby improving accessibility. For instance, the use of e-leaflets for hospital-administered products can facilitate the reallocation of products across countries with different languages and labeling requirements, ensuring that medicines reach those in need more efficiently.

In conclusion, addressing the socioeconomic barriers to affordability and accessibility of medicines in Cameroon requires a multifaceted approach. This includes rationalizing drug purchasing policies, improving supply chain infrastructure, implementing effective governance processes, and leveraging international cooperation and standards. By tackling these issues, pharmaceutical distribution companies can play a pivotal role in ensuring that essential medicines are available and affordable to all segments of the population.

5.4.2 Community Outreach Programs

Community outreach programs play a crucial role in addressing socioeconomic barriers that hinder effective pharmaceutical distribution in Cameroon. These programs are designed to bridge the gap between pharmaceutical companies and the communities they serve, ensuring that essential medicines reach even the most underserved populations.

One of the primary challenges in pharmaceutical distribution is the complexity of supply chains, which can be disrupted by various factors such as manufacturing issues, distribution problems, and local socioeconomic conditions. Community outreach programs can mitigate these disruptions by fostering direct communication and collaboration between pharmaceutical companies and local communities. This approach helps in understanding the

specific needs and challenges faced by these communities, allowing for more tailored and effective distribution strategies.

For instance, the Pan American Health Organization (PAHO) has demonstrated the effectiveness of technical assistance in demand forecasting, which is a key aspect of their Revolving Fund's success. By applying similar strategies in community outreach programs, pharmaceutical companies in Cameroon can better anticipate and meet the demand for medicines, reducing the risk of shortages and ensuring a steady supply of essential drugs.

Moreover, community outreach programs can address the issue of informal drug markets, which often arise due to shortages in formal health centers. These informal markets can lead to the misuse of drugs, making them potentially harmful. By engaging with communities directly, pharmaceutical companies can provide education on the proper use of medicines and the importance of obtaining them from authorized sources. This not only improves public health outcomes but also helps in maintaining the integrity of the pharmaceutical supply chain.

The authors of Bowser *et al*., 2019 indicate that while studies on antiretroviral (ARV) supply chain management have highlighted gaps in facility-level practices, these findings can be applied more broadly to other medicines. Community outreach programs can play a pivotal role in addressing these gaps by promoting best practices in medicine dispensing and inventory management at the community level. This ensures that health facilities are better equipped to handle stock-outs and other supply chain disruptions.

Furthermore, the concentration of active pharmaceutical ingredient (API) production in specific geographical areas poses a significant risk to the supply chain, especially in the event of natural disasters or other localized emergencies. Community outreach programs can help diversify the supply chain by identifying and supporting local manufacturers and suppliers. This not only reduces dependency on a few concentrated sources but also promotes local economic development.

Public policies that support the expansion and diversification of medical product supply are essential for the success of community outreach programs. By advocating for regulatory harmonization and trade facilitation, these programs can ensure smoother movement of goods across borders, making it easier to maintain a consistent supply of medicines in Cameroon.

In conclusion, community outreach programs are vital for overcoming socioeconomic barriers in pharmaceutical distribution. By fostering direct engagement with communities, promoting best practices, and supporting local supply chains, these programs can significantly enhance the availability and accessibility of essential medicines in Cameroon.

6 Conclusion

The comprehensive analysis of Cameroon's pharmaceutical supply chain highlights numerous challenges and opportunities that are critical for the development and enhancement of this vital sector. This detailed examination brings to light the complex interconnections between socio-economic, political, and quality-related factors that influence the distribution network, including health facilities, district stores, central medical stores, procurement entities, and manufacturers.

A significant observation is the notable disparity in drug supply maintenance between public and private sectors. Private institutions often maintain consistent stock levels due to direct payment models that ensure continuous drug availability. In contrast, public health institutions frequently experience shortages because drugs are provided free of charge without sufficient incentives for personnel to maintain constant supplies. This gap underscores the need for targeted strategies to improve efficiency and reliability across both sectors.

Political dynamics add another layer of complexity to Cameroon's pharmaceutical supply chain. Policymakers must balance elite interests with the needs of rural populations when allocating resources within the health sector. The reliance on coercive power rather than welfare provision also impacts the effectiveness of public health initiatives.

Addressing substandard and falsified medicines remains a critical issue given their higher prevalence compared to global averages. Regional solutions tailored to specific needs have emerged as a response to inadequate national guidelines.

Empirical data indicating order satisfaction rates by CENAME below 60% reveals substantial room for improvement in overall supply chain performance. Key facility-level supply chain management indicators have identified crucial areas such as product selection, forecasting, procurement practices, warehousing capabilities (including issues like inadequate lighting and wiring), inventory management systems, transportation logistics, dispensing procedures, waste management protocols, laboratory issuing processes as well as information infrastructure and human resources involved in SCM activities.

Global supply chain disruptions also significantly impact local markets—highlighting vulnerabilities exacerbated by external shocks such as pandemics or other international crises affecting inflationary pressures domestically.

Policy interventions play a pivotal role in shaping pharmaceutical market dynamics while training programs aimed at improving distribution practices underscore the importance placed on human factors within SCM processes; fostering better management practices leading towards improved patient care outcomes across Cameroonian healthcare landscape.

Addressing these multifaceted challenges requires comprehensive approaches that consider unique context-specific elements inherent within Cameroonian socio-political framework alongside leveraging both national-level policies coupled with localized strategies geared towards optimizing pharmaceutical supply chains ultimately ensuring equitable access to effective medications population-wide thus contributing positively towards enhancing overall public health standards countrywide.

Furthermore, examining examples from countries like Spain and Sweden could provide valuable insights into how transparency in sharing information on volumes can improve capacity to address supply chain issues more effectively. Implementing similar transparent systems may bolster Cameroon's ability to manage its pharmaceutical supplies more proficiently by enabling better anticipation of potential shortages and facilitating timely interventions.

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