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Exploring the Supply Chain Coordination Dimensions for Artemisinin-Based Combination Therapies in Uganda

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Abstract - The aim of the study was to explore how the logistics, micro, market and macro coordination dimensions affect the availability of artemisinin-based combination therapies (ACTs) in general hospitals in Uganda. Following a qualitative approach, a multiple case study strategy was used. Specifically, four focus group discussions, each consisting of 8 respondents were conducted from four purposively selected hospitals. The respondents were selected using simple random sampling from representatives of the Drug Therapeutic Management Committee (DTMC) for the purpose of exploring the supply chain coordination. Thereafter, cross-case analysis was done to identify the key coordination mechanisms that could be incorporated into the existing framework. A number of coordination dimensions were identified from the focus group discussions and regrouped using hierarchical coding scheme. Whilst the study's findings on micro dimensions and logistics dimensions are in accordance with previous scholars, the market and macro dimensions reveal valuable insight into the dimensions necessary for supply chain coordination of ACTs. Market dimensions such as joint training, monitoring and quarterly meetings with key stakeholders are highly regarded for enhancing better coordination of ACTs. The macro coordination dimensions such as verification of ACTs, policies, and regulation are enablers, yet political interference, poverty and donor funding, culture, and lack of appropriate technology affect the availability of ACTs. The novelty of this study is that it adopts a holistic approach to the supply chain coordination of multi-embedded distribution system and extends insight of coordination framework to include the market and macro dimensions that reflect practice.

Keywords: *Supply chain, coordination, dimensions artemisinin-based combination therapies, availability.*

1. Introduction

Malaria treatment pills, majorly described as ACTs – are becoming the most efficacious drugs for control and treatment of uncomplicated malaria in the developing world. Most countries with high incidences of malaria have instituted national malaria treatment policies, which specify which drugs suit which cases of malaria, but more importantly, ensure that drugs are readily available for treatment and use in hospitals [1]–[3]. Malaria still poses a great burden in many African countries. Unfortunately, in most hospitals in the developing world and Uganda in particular, most often than not, malaria drugs are rarely available for treatment and dispensing to patients [4]–[6]. The causes of stock-outs have been documented by various scholars [7]–[11] among others. Although the studies differ, a common recurrence from their findings appears to be lack of supply chain coordination (see Table 1).

Table 1: Coordination problems

References	Focus of investigation	Findings
[9]	The impact of inventory management on stock-outs in Zambia.	Lack of coordination for funding, between institutions, interventions, and public and private actors at global, national, and local levels.
[11]	Diagnosis of the Root Causes Health Product Supply Chains in several	Lack of coordination in terms of supply chain planning, lead time, incentives, skills and designs.

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	developing countries: and an agenda for reform.	
[12]	Factors impacting supply chain coordination leading to stock-outs in developing countries.	Lack of coordination causing a malfunctioning supply chain for essential medicines causes non-availability.
[13]	Supply chains and global health in low-income countries.	Coordination problems across multiple stakeholders with widely divergent objectives.
[10]	Expiry of medicines in supply outlets in Uganda.	Lack of coordination between public medicine wholesalers and their clients to harmonise procurement and consumption as well as with vertical programmes to prevent duplicate procurement.
[8]	Root causes of continuous stock-outs of medical supplies in Uganda.	Lack of coordination with national medical stores, prioritisation and forecasting, planning, data management and monitoring systems when tracking amounts of drugs ordered.
[14]	Examining the pharmaceutical supply chain for artemisinin-based combination therapies in Ghana.	Lack of coordination of information flow leading to delays and disruptions in the supply chain system.
[15]	Improving health in developing countries: reducing complexity of drug supply chains.	Lack of coordination between distribution points and stakeholders.
[16]	Expiry of medicines in supply outlets in Uganda.	Lack of coordination between public medicine wholesalers, vertical programs and clients to harmonize procurement and consumption.

The recurrence and observation of coordination issues raised by the scholars listed in Table 1 prompted the quest to explore and examine the coordination of ACTs in developing countries. In this context, the supply chain coordination frameworks developed by previous scholars [17]–[29], appears to opine for different dimensions, yet with focus to internal organisation (micro environment). Yet, evidence from a survey of empirical cases relating to the supply and distribution of ACTs in developing countries revealed a link and interplay of market and macro dimension in the distribution of ACTs [30]. Unfortunately, existing coordination frameworks are inconclusive in terms of measuring the coordination of ACTs, and possibly explain the issue of stock better, unless adjusted to reflect practice. Hence, the purpose of this study was to explore the key micro, market and macro supply chain coordination dimensions in order to possibly address some of the issues of stock outs. The results of the current study extended earlier findings by exploring the dimensions, links and nature of interplay of the market and macro environment in the supply and distribution of ACTs, but from a perspective of general hospitals in Uganda.

The next section draws empirical summaries related to supply and distribution of ACTs vis-à-vis the different existing frameworks and associated dimensions. This is followed by the conceptual framework that underpinned the exploration and examination of the dimensions. An exploratory design and its application in this case are discussed. Finally, the findings that articulate in detail the implications to coordination frameworks and health care supply chain are discussed together with the relationships and outcomes, on the one hand, and availability of ACTs, on the other hand.

1.1 Review of related literature

1.1.1 Supply chain coordination frameworks Vis-à-vis empirical case evidence of ACTs

The lamented gap between theory and practices has received great attention over the past three decades [31]–[34], with little emphasis in the service industry [35]. The major concerns raised by the latter scholars emphasize equally the widening gulf between theory and practice due to numerous issues such as:

- less useful academic research for practical problems;

- a lack of implementation of academic findings;

- inadequate action by academics towards practicing theory;

- changing business environment; and

- ignorance or practitioners' lack of willingness to adopt the findings of academic research.

The subsequent issue arising from the gap between theory and practice is knowledge production and knowledge transfer problems [34]. In this study, the issue observed was related to the latter findings, but slightly different in that it had nothing to do with transfer of knowledge per se, but the relevance of the instrument (coordination frameworks) for the purpose of knowledge production and knowledge transfer (addressing coordination of the ACTs problem). This study argues that an attempt to understand coordination of ACTs using the existing frameworks, including their logic and assumptions creates the risk of observation bias (known as the streetlight effect), which point out addressing the current and complex ACTs problem, with frameworks not grounded in current practice as envisaged in developing countries. Looked at differently, it is most appropriate to diffuse theory continuously for the discourse through which practices are constituted in order to change the different perspectives and competencies necessary to resolve complex phenomena, such as the supply chain coordination of ACTs. In this sense, this study was concerned with the existing coordination frameworks and their application as envisaged in empirical case evidence of ACTs. It is argued that in order to understand the issues of coordination of Acts better, coordination frameworks (theory) and empirical evidence of ACTs (practice) observed, have to proceed from a single ideological viewpoint as the development of one is intrinsically linked to the development of the other.

From the literature reviewed [17], [19], [23], [25], [36], the frameworks propounded by coordination advocates are questionable with specific relevance and suitability to the supply and distribution of ACTs in developing countries. In this context, the dimensions of the supply chain coordination frameworks, which mostly incorporated most of the dimensions covered by [25], appears to be incongruent with empirical case studies' evidence on the distribution of ACTs in developing countries [1], [37]–[44]. Ref. [25] coordination framework proposes information sharing, collaborative decision-making, and top management commitment, consideration of responsiveness and

organisational factors underpinning the micro environment. Hence empirical evidence of ACTs studies in nine developing countries (Malawi, Kenya, Uganda, Democratic Republic of Congo, Tanzania, Cameroon, Zambia, South Sudan, and Zimbabwe), indicate interaction of the three management environments, namely micro, market and macro, and how these could influence supply chain coordination to affect availability of ACTs in general hospitals in Uganda [30]. The market factors were collaboration with suppliers, joint research, and training. The macro factors considered in the framework were policies for funding, use of public-private partnerships, putting in place of surveillance systems and performance monitoring and working with health workers. What is not entirely clear from the empirical case surveyed is the nature of key critical variables in detail, hence, the exploration by this study.

In order to minimise confusions that may arise from different supply chain and coordination literature, a consolidate definition is offered. Supply-chain coordination is defined differently by different scholars. The activity mainly concerns managing a range of interdependencies that account for the flow of products, resources, and information to achieve better supply and distribution of goods and services to end users [22], [45]–[48]. In an effort to manage the interdependencies, several scholars have developed different measures and frameworks of supply-chain coordination mainly in the private for profit industry [25], [20].

However, in the case of supply and distribution of a malaria drug (ACTs), the existing frameworks appear to be inconclusive to be used as a management tool and measure for the interdependencies in the developing world. This argument is drawn from evidence of empirical case studies surveyed by Ref. [30], which reveals a rather interesting link, interplay, and dimensions of market and macro environment that led to the development of the conceptual framework depicted in Figure 1. However, the framework provides only a conceptual interplay of the three management environments necessary for recognizing the significance of supply chain coordination for ACTs. The framework could do more to illustrate the flow of relationships and the expected interdependencies of the different players in the supply chain. Therefore, it can be implied that for effective and efficient supply chain coordination of ACTs, there ought to be an interplay and demonstration between the three management links that describe and analyze the effect of the management environment to the supply and distribution of ACTs as illustrated in the conceptual framework in Figure 1.
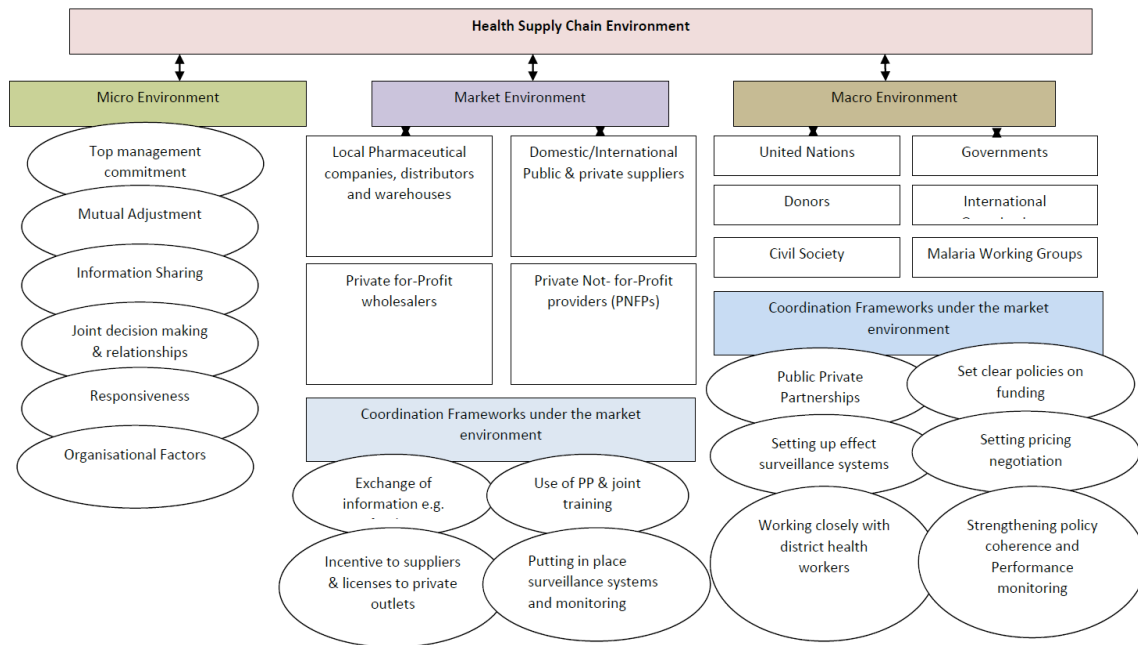
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Figure I: Interplay of the three management environments

1.3 Research questions

i)   What are the most critical micro supply chain coordination dimensions affecting availability of malaria treatment pills in general hospitals of Uganda?

ii)   How do the logistics activities affect supply chain coordination of malaria treatment pills in general hospitals of Uganda?

iii) How do the market environment dimensions affect supply chain coordination of malaria treatment pills in general hospitals of Uganda?

iv)   How do the macro environment dimensions affect supply chain coordination of malaria treatment pills in general hospitals of Uganda?

2.   METHODOLOGY

2.1. Research design and strategy

The study adopted an interpretivist research philosophical paradigm to explore how supply chain coordination is managed within the general hospitals in making ACTs available in developing economies, especially in most endemic parts of Uganda. Specifically, an exploratory multiple case study design was adopted for this study to answer the research questions [49], [50]. Ref. [51] contends that the design is appropriate when the problem is persistent and used for developing more focused questions. Therefore, the focus of this study was to understand the meanings and interpretations of DTMC members and to understand their world from their point of view, which is highly contextual and hence not widely generalizable [52]. Thus, because of the subjective nature of this paradigm, and the emphasis on language, qualitative approaches to data gathering were adopted in this study. Ref.[53] argue that qualitative research offers rich descriptive reports of 'individuals' perceptions, attitudes, beliefs, views and feelings, the meanings and interpretations given to events and things, as well as their behavior. Therefore, based upon these, the current study adopted qualitative data to understand in depth the critical dimensions underpinning supply and distribution of ACTs from the experts in the public general hospitals.

2.2 Case study strategy

Out of the 45 general hospitals, four hospitals were purposively selected from the Northern and Eastern regions of Uganda because it has the highest malaria burden [54]. The target population were members of the Drug Therapeutic Management Committee [DTMC]. Eight DTMC members were selected on the basis of experience and availability [53].

2.3 Data collection tool and analysis

Focus group discussions (FGDs) are widely used in explorative studies [51].Upon signing of the consent forms, FGDs were used to collect data in each of the four selected hospitals. Each FGD was conducted by the corresponding author assisted by two trained research assistants. The FGDs lasted between ninety (90) minutes and two (2) hours [53], [55]; [56]. Prior permission to tape-record the sessions was also

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sought. The FGDs were structured using a guide, which was tested and revised [57]. Ref. [58] proposed that practitioners and academicians should approach the development of knowledge through 'discovery' using exploratory studies.

FGDs proceeded up to the point of theoretical saturation, based on the principle of diminishing returns as suggested by Ref. [56]. In health and social science-related studies conducted by different scholars, it was concluded that thematic saturation occurs after realising during the data analysis stage that no new themes or findings are observed in the data {Formatting Citation}.

Qualitative data analysis took a three-phase approach comprising data reduction, data display, conclusions, and verification [59], [60]. The data analysis process involved engaging with and reflecting on the collected raw data through coding and grouping of concepts and themes, and interpreting the data. This was done to provide their underlying meanings through thematic data analysis process [62]; [49]. Organising data was part of the preliminary analysis before the next FGD [71]. For trustworthiness and credibility, an independent co-coder was consulted. Using the pattern matching

technique, data was displayed in the form of matrices to facilitate comparison of patterns [63].

The computer aided qualitative data analysis software program, known as Nvivo 9.2, was used to analyze the transcribed data, which assisted in identifying the critical key dimension [66]. The data analysis involved the process of coding and recording the text as well as categorising it into parent nodes and child nodes, according to the semantics of NVIVO. The analysis also included verbatim quotations to specify the source from which the information was extracted as well as making sure all participants' views were presented.

2.4 Target population and sample selection under case approach strategy

In Uganda there are 45 government-owned general hospitals [61]. Public general hospitals were studied because they offer a big number of outpatient and inpatient services. In addition, they provide supervisory support to lower-level health facilities and maintain linkages with communities through community health departments.

Table 2: Hospital description of selected general hospitals

Hospital	Location	Reason for selection
General hospital (GH) A	Northern Region	The district has the highest malaria prevalence in Uganda. It serves other neighbouring districts.
General hospital (GH) B	Eastern region	It is a referral facility for the district. It serves a catchment population of over 1.5 million covering several districts. The vision of the hospital is to improve health and reduce the disease burden by at least 85–90% in the district and surrounding areas.
General hospital (GH) C	Eastern region	This GH is located in the eastern region of the country. Like all government-owned hospitals, it is supervised by the Ministry of Health. It serves the general public despite several challenges of poor remunerations of doctors, insufficient medicines, inadequate staffing and funding, and a lack of medical equipment.
General hospital (GH) D	Northern region	The hospital offers a number of services including Out Patient Department (OPD), inpatient, ophthalmology, X-ray, ultra sound, orthopaedics, health promotion and education, occupational therapy, HIV/AIDS, immunisation, environmental health, and special clinics. It was constructed because there were no other hospitals in the region. Other general hospitals are very far.

The participating GHs above were selected using non-probability sampling procedure. Using replication logic, two hospitals were purposively selected from each of the two most malaria-endemic regions of the country (northern and eastern regions) [54]. Ref. [62] explained that critical case sampling involves selecting a small number of important cases to "yield the most information and have the greatest impact on the development of knowledge". Theoretical replication logic and cross-case

comparison within the four hospitals was applied [63].

The target population from each of the hospitals comprised the 11 members of the Drug Therapeutic Management Committee (DTMC). The committee was judiciously anticipated to have expert knowledge by virtue of the fact that they are responsible for selecting, quantifying, procurement storage and distribution of medicines within the hospital.

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For this study, eight DTMC members were selected for each of the four hospitals as supported by [53]. These participants interacted at the direction of a moderator to generate data on a particular issue or topic. They also provided an opportunity for creative, direct and explicit discussion of difference as they emerged in the group. Given that the DTMC is a group of experts in charge of supply and distribution of ACTs, the focus group was considered the most appropriate data collection technique since participants were from similar therapeutic backgrounds.

2.5 Methods of verifying qualitative data

Validity of the qualitative data was evaluated in terms of trustworthiness and credibility. Trustworthiness constituted dependability, transferability and conformability [68], [69]. Validity was ensured through observance of detail and accuracy in order to ensure the authenticity and trustworthiness of the research process. To ensure credibility, results were reviewed by inquiry participants by commenting about the fairness, completeness or perceived validity of data from the study. Applicability or transferability was ensured through preserving the thick descriptions of the analysis, and findings from the qualitative strand for the benefit of other researchers to judge whether these findings may be transferable to similar populations. While confirmability was achieved by reviewing transcripts from FGDs. This warranted that participants' voices were reflected and that the findings accurately represented their perspectives. For completeness, the researchers checked whether the themes identified in the data analysis were expressly mentioned in the transcripts. Those deemed unrelated to the study questions were removed from the report.

3. Findings and discussions

3.1 Participants characteristics

The participants from the four (4) selected hospitals comprised of hospital administrators, general operations staff, pharmacists and staff from the stores. The study registered 54% female participation and 46% male participation, with male participants dominating senior hospital positions. The majority of the participants (78%) were above 35 years, while 22% were below 35 years. Respondents who held senior management positions in the hospital were in the age category of 35 years and above. In terms of positions, the majority of the participants of the study were nursing officers (38% of participation), followed by medical staff (22%), inventory management officers (11%), hospital administrators and pharmacists were each represented by 5% participation and finally, the surgeons constituted 3%. The background

information provided opportunity for getting first-hand operational information in addition to management information. In terms of education, the majority of the participants were bachelors' degree holders (76%), followed by certificate holders (14%) while those who had completed post-graduate programmes were the least represented, at 11%. It was however noted that the respondents who held key hospital management positions had completed postgraduate programmes in hospital management. Participants' experience in the selected hospitals ranged from 1 year to 30 years. Notably also, was that 46% of the participants had served for more than 10 years in the hospital, 32% had served for between 5 and 10 years, and only 22% had served less than 5 years in the hospitals. The key hospital management positions were however held by those who had served at least 9 years.

3.2 Micro supply chain coordination dimensions and availability of ACTs

This section is designed to understand the current supply and distribution mechanisms of ACTs in general hospitals at micro-level environment.

3.2.1 Organisational factors and availability of ACTs

Across all the general hospitals in Uganda, there is a common structure of centralized stores to improve supply and distribution of malaria treatment therapies. General Hospital A (GH A) emphasised an early warning system whenever the supplier was not in a position to deliver, monitored whether the drugs had been given to the right patients, and carried out spot checks as key dimensions for improved supply and distribution of ACTs. General hospital B (GH B) ensured that a Drug Therapeutic Committee (DTC) was in place to meet on a quarterly basis and monitor consumption of drugs. For GH B, this was an important ingredient for improved supply and distribution of ACTs.

In GH C, the ACTs drug supply process was hampered by a lack of an active pharmaceutical committee and an in-charge of these essential medicines, which compromised the system. Overall, monitoring and external supervision were methods for improved supply and distribution of ACTs. Similarly, GH D drew on well-structured internal dimensions to coordinate demand and supply of ACTs. It made strong use of these robust systems to lobby for funds from donors to procure the drugs through National Medical Stores (NMS). Furthermore, in this hospital, issuance of local treatment guidelines, accountability for drugs requisition and supervision were all key dimensions for improved supply and distribution of ACTs.

A significant proportion of the participants indicated that the institutional structures were effective in

ensuring ACTs availability. While studying the financial sector of middle-class countries, it was concluded that institutional structures are significant drivers of change that can lead to effectiveness [70]. However, some participants expressed dissatisfaction in the institutional structures in ensuring ACTs availability, adding that the structure created a gap in the planning and budgeting for ACTs. However, it was reported that the bureaucratic structure sometimes makes it hard for urgent communication, causing a delay in the process of supply of ACTs. Previous research found that the rigid bureaucratic system can slow down the operations of any organisation[71].

3.2.2 Information flow and ACTs availability

The general dimensions across the study hospitals indicated that sharing information in hard copies enhanced information flow on the status of stocks, which improved supply and distribution of ACTs. GH A typically depended significantly on the information of internal ACTs usage patterns shared between it and the supplier of the drugs. This is the first cog in the supply wheel. The use of the Rx solution system (the electronic drug management system) was the only tool in this mechanism of interdependence between the supplier and the hospital. However, the main communication was verbal dissemination of information during continuous medical education (CME) and staff meetings promoting supply and distribution of ACTs. In GH B, information was stored on stock cards. Sharing of stock status, though tedious, improved supply and distribution of ACTs. GH C made an effort to balance the demand with supply by ensuring that the stock status of ACTs drugs was shared, that there was intradepartmental cooperation in terms of redistribution of drugs across other facilities, and the that the standard Rx solution system, in which the electronically calculates optimum stock levels. However, the lack of an active pharmaceutical committee and an in-charge of these essential medicines, compromised the system. Overall, GH D viewed the use of the Rx solution system and sharing of stock information as helping to improve supply and distribution of ACTs.

All the participants from the four hospitals reported poor quality and nature of the integration among all supply chain members. "*There are inadequate information technology (IT) tool and system that supports integration*". Most participants reported using their personal phones as the main tool for integration. Even those who had Rx tool (a form of technology tool) and an intercom system reported failure and breakdown of the system. All these challenges led to ineffectiveness in ensuring integration among supply chain members. The majority of participants reported using manual

stock cards and the Rx solution system only within stores as the main IT tool for stock record purposes. The discussants, however, reported verbal communication as the main technique used among supply chain members. This makes it difficult to forecast, share, and aggregate accurate and timely information in a secure style [72].

3.2.3 Responsiveness and availability of ACTs

A cross-case analysis of the common theme in all the general hospitals showed flexibility in the redistribution system. The theme in GH A was that of timeliness in schedules by stores from where they issue ACTs to other units. Internal redistribution between units is also a key dimension that improved supply and distribution of malaria treatment pills. In GH B, there were specific days for requisitioning and issuing medicines from the general store, easy transfer of drugs to other units using stock cards, and efficient delivery time from the pharmacy. These are important dimensions for improved supply and distribution of malaria treatment pills. GH C emphasised timely supply, redistribution and requisitioning of emergency orders, which had improved supply and distribution of ACTs. Finally, GH D used personal phones to call when stock ran out before the next cycle, set specific days for distribution, had a schedule for the supplier, and placed emergency orders, all of which had led to improved supply and distribution of malaria treatment pills.

Previous research in manufacturing firms indicated that responsiveness is a key ingredient in supply chain [79, 80]. The participants portrayed mixed views about the level of responsiveness within the internal supply chain of ACTs. Those who reported a good level of responsiveness attributed it to the flexibility of the system with all key stakeholders. As quoted from one of the participants, "*…stores generally have in place a flexible schedule for issuing ACTs to other units and the delivery time from the pharmacy is very efficient*". The internal redistribution process allows for an informal transaction in which the units are just notified and the redistribution effected with ease. "*During emergency, the stores often adjust to the demands of ACTs and respond immediately*". Respondents who reported a poor level of responsiveness within the internal supply chain of ACTs associated it to inflexibilities of the system during certain emergency hours, especially at night, which mostly leaves patients stranded and unattended on the one hand, and a lack of documentation on the redistribution of stock on the other. "*Once redistribution is done, the documentation will show in the stock cards under losses and adjustment*"

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3.2.4 Mutual understanding and ACTs availability

The general theme from the four general hospitals showed that trust among supply chain partners improves supply and distribution of ACTs. GH A emphasizes that staff coherence, following standard guidelines and understanding new policy changes towards treatment and using ACTs are the main dimensions that improve supply and distribution of ACTs. In GH B, clinicians have a high level of trust in the internal systems and well-defined guidelines on how to use and monitor ACTs. The dispensing staff are also well aware of how and when to administer the ACTs, which reduced waste and improved supply and distribution of the malaria treatment pills.

In GH C, however, the commitment by the hospital to the vision of apt service delivery in the district was questionable. Even the internal innovations such as participatory planning, recruitment of a qualified pharmacist, and refresher training proved less helpful if the administration of the drugs was not streamlined. The hospital management nevertheless tried to improve drugs monitoring through external supervision, and it assumed that each staff member was aware of what was expected from him or her based on job description and their departmental work plans. As a result, supply was timely, thereby enhancing supply and distribution of ACTs. In GH D, each player in the hospital seemed to have a very good understanding of issuance and usage of ACTs guidelines as a result of a shared understanding of standard procedures. It appeared to be the same with the suppliers. Therefore, staff awareness of the job demand, a shared vision and general understanding of the pull system, have all improved the supply and distribution of Acts. Insights into supply chain management showed that trust is a dynamic factor [75] in mutual understanding. The participants asserted that there is a significant level of trust among them. Many times patients had received ACTs as per prescription given by the clinicians showing trust amongst themselves. The method used by the pharmacy in ordering and dispensing medicine was trusted by the key stakeholders involved in the process. This was supported by an excerpt; If *the pharmacist fully trusts the laboratory result to the point that once the blood sample is negative, everyone in the chain will consider it negative; this has led to minimization of the treatment of those not clinically ill.* Some participants, however, asserted that there are still instances where some patients came up with prescriptions unaligned with the results which in one way or another affected the level of trust among members. Trust is, therefore, beneficial when is accompanied with incentives and control system [75], [76].

The general findings from the participants indicated the existence of a good level of mutual understanding among supply chain members. *Standard procedures are in place and always followed by all responsible parties.* The existence and availability of guidelines that specify drug usage, the likely changes and side effects of drugs, created a common understanding among the stakeholders. Mutual understanding, gaps regarding the dispensing of ACTs were highlighted. For instance, there existed situations where a patient was given ACTs without prior testing. This pointed to a lack of mutual understanding among the team members at pharmacy level. Prior research highlighted the importance of mutual understanding where partners sit together in order to enhance face-to-face communication and socialisation[77].

3.2.5 Relationship and joint decision making and availability of ACTs

The emerging theme in most general hospitals was good working relationship among supply chain partners, which led to improved supply and distribution of ACTs in public hospitals. GH A showed that good relationships between patients and hospital staff, prescription of ACTs to patients and joint decision-making during procurement planning, had improved supply and distribution of ACTs. GH B emphasised that good working relationships, communication and feedback from the supplier, and inter-departmental cooperation had improved supply and distribution of ACTs. In GH C, interdepartmental cooperation in terms of redistribution from other facilities and existence of feedback loops from other units had enhanced supply and distribution of ACTs. In GH D, a good relationship with suppliers ensured that orders were sent and that ACTs were delivered as per schedule. *"Owing to the clinicians' high level of trust in the internal systems and well-defined guidelines on how to use and monitor ACTs, the dispensing staff were well aware of how and when to administer the ACTs, which reduced waste".* The system is structured around independence and trust of each player across the internal clinical chain – from the clinical area to the prescriber, laboratory and the pharmacy. At the time of this research, the hospital had received support and guidance from the supplier leading to improved supply and distribution of ACTs. When there were emergency needs, flexibility prevailed.

3.2.6 Top management commitment

The general theme emphasised support of staff training through CME. GH A emphasised provision of transport in cases of emergency demand, investing time, finances, monitoring tools that enhanced feedback on the status of ACTs. It was noted that management supported planning, and adoption of new ideas, all of which led to improved

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supply and distribution of ACTs. GH B supported the issuance of guidelines on how to use and monitor ACTs, frequent communication whenever there is a stock-out and invested in time and resources in monitoring ACTs. This had led to improved supply and distribution of ACTs. In GH C, commitment to facilitate strategic planning, innovation in participatory planning, recruitment of new staff and refresher training had improved supply and distribution of ACTs. In order to improve this system continuously, GH D had invested resources in providing transport for redistribution, IT systems, and staff training through CME, which had all improved supply and distribution of ACTs.

Participants in all the hospitals agreed that top management provided local guidelines for hospitals on how to use ACTs. They also lobbied for funds for ACTs. With regard to supervision and its effect on quality and availability of ACTs, the participants pointed out that the main supervision system used was always top-bottom as explained in the following excerpt. *The supervision structure had enabled quicker distribution of ACTs" The hospital now mainly focuses on checking or monitoring of expiry dates. The system always ensures that drugs are given to blood sample (BS) positive patients only.* However, the use of traditional physical supervision to audit stock is time-consuming and costly [78].

Table 4: Summary of Critical micro supply chain coordination dimensions at the micro level

Theme	Emerging dimensions
Organisation factors (OF)	Early warning systems in place; regular monitoring; active drug therapeutic committees in place; regular meetings; issuance of local guidelines; accountability; supervision; lobbying of funds; spot checks; pharmacist's guidance; centralised distribution by pharmacist; delegation enhances the swift ordering of ACTs.
Information sharing	Verbal communication; Rx-solution system; information on stock cards sharing of stock status; use of notice boards; use of hardcopy reports; electronic drug management system
Responsiveness	Following of scheduled issuance by NMS; flexible ordering system; supplier schedule; ease of calling the supplier; placement of emergency orders; internal redistribution between units or internal transfers of ACTs from one unit to another; efficient delivery timelines from pharmacy.
Mutual Understanding	Communicating of policy change; staff awareness of their job requirements; instructions on use of ACTs; staff coherence and mutual trust among staff; staff knowledge of the procedures; shared vision and goals; general understanding of the pull systems; development of work plans enhances ACT availability; understanding of the new policy change.
Relationship and joint decision making	Interdepartmental cooperation; good working relationships among staff; joint decision-making during procurement planning; good relationship of the hospital with her suppliers; feedback loop with other units.
Top Management commitment	Frequent feedback on stock status; support for online ordering; provision of transport in times of emergencies; issuance of guidelines; frequent communication; support for hands-on training enhances ACT availability; strategic planning; investment in monitoring; tools; support for redistribution; continuous medical education (CMEs).

Proposition 1: *Micro Management environment dimensions positively affects the availability of ACTs in general hospitals in Uganda.*

3.3 Logistics activities and ACTs supply chain coordination

This subsection provides answers to the question: How do the logistics activities affect supply chain coordination of malaria treatment pills in General hospitals of Uganda. Ref. [79] argued that logistical activities are an important component of service

delivery in a swift, safe, flexible, and reliable manner.

3.3.1 Forecasting method affecting ACTs availability

We noticed in the cross-case analyses that similar methods were used at the time of this research to predict future demands for ACTs. The main method

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presented by the participants for predicting future demand for ACTs was the average monthly consumption rate as advocated by [80]. It was further noted that the consumption pattern was aggregated per month. The stock cards were used to identify previous consumption trends before 3 months' forecast was made. Some participants also mentioned use of disease patterns as an alternative method for forecasting ACTs.

3.3.2 Quantification dimensions affecting ACTs availability

The guiding principle for quantification was minimum-maximum stock. All the participants reported that hospitals manually quantifies ACTs demand using the average monthly consumption patterns taking into consideration the season and the peak. However, there was seasonal variation of ACT demand, and it was very difficult to predict the peak times depending on the past records [81].

3.3.3 Procurement and ordering affecting ACTs availability

In general hospitals A, B, C, and D, joint procurement planning was held with respect to the allocated budget. The common emphasis among the four general hospitals was preparation of annual work plans with the guidance of NMS, to inform ordering of ACTs.

The participants from the four GHs also pointed out that ordering followed a schedule issued by NMS. "…*although the funds are insufficient, the ordering mechanism has enabled strict adherence to planned schedules and orders".* Furthermore, the participants agreed that adherence to agreed lead time and requisitioning based on approved budget improved supply and distribution of ACTs. Identification of needs and online ordering using personal e-mails further improved supply and distribution of ACTs [74].

3.3.4 Storage management and ACTs availability

Even with best logistics and forecasting tools, with poor storage management—supply chain management will be in vain [13]. The participants mentioned different ways the hospitals store and manage ACT stocks. The most common ways were; use of shelves and palates for storage as explained in the excerpt below; *we enter the ACTs receipts in the stock cards and store them in the boxes, shelves and pallets in the main store".* Use of Labels: *"The mechanism involves labeling the boxes containing ACTs for easy identification and access before storage and mainly store them in their big boxes, and some few (in their small boxes) displayed on the shelves".*

To maintain life expectancy of the drugs, thermometers are used. The findings are consistent with [82] who theoretically suggested that inventory techniques are critical in enhancing product availability and quality. However, manual systems are tedious and time-consuming.

3.3.5 Dispensing and ACTs availability

In all the general hospitals, participants agreed that dispensing followed a particular procedure. For instance, the participants concurred that; *prior testing of blood samples using Rapid Diagnostic Tests (RDTs) is mandatory before issuance of prescription by the clinician and dispenser.* This greatly improved the availability of malaria treatment drugs. It was ascertained that GH A paid attention to First in First out (FIFO) or Last in Last out (LIFO) inventory management techniques depending on expiry dates.

The summary of the interpretive structural modelling is presented below

Table 5: Summary of Logistics activities dimensions

Theme	Emerging dimensions
Forecasting	Estimating the average monthly consumption; disease patterns; information from stock cards.
Quantification	Monthly consumption; maximum–minimum stock levels information from the dispensing logs; malaria season enhances & peak times enhances.
Procurement and ordering	Needs identification; preparation of annual procurement plans; team involvement during procurement planning; ordering based on approved budget; adherence to delivery schedules; requisitioning as per plan; observance of lead-time.
Storage management and distribution	Team verification before storage; labelling; verification of expiry dates; stock cards, storage equipment (shelves or pallets); monitoring of room temperatures; use of medicine registers; enforcing the drug management policy; observance of minimum–maximum levels; authorised distribution by specific personnel.
Dispensing	First in first out or last in last out policy; prior testing of blood; verification of prescriptions; clear instructions on medicine usage; authorised signatures; verification of dispensing logs.

Proposition 2: *Logistics activities dimensions positively affects the availability of ACTs in general hospitals in Uganda.*

3.4 Market environment dimensions and ACTs' availability

According to [42], within the market environment, many actors and organisations (suppliers, manufacturers, wholesalers, and retailers) interact with one another in order to play a central role, proactively coordinating through regular meetings, and developing joint research and educational plans

At the time of this research, GH A mainly used emails, telephones and routine regional monitoring and evaluation meetings, which had improved supply and distribution of ACTs. GH B used the M-track system and Rx tool (IT tools) connected to individual telephones. The effect was improved supply and distribution. GH C pointed out that following the NMS schedule had helped to improve supply and distribution. GH D emphasised regular correspondence and liaison with the NMS regional representatives as a way to improve supply and distribution "…*orders are signed by the Hospital Medical superintendent*". It was further ascertained that the decision-making process often started with stores and then proceeded to the Medical Superintendent then to NMS. A participant pointed out that;

> Once permission has been granted, the hospital arranges transport to pick the ACTs through redistribution arrangements.

3.4.1 Collaborative partnership for joint training

The participants had mixed responses about the existence of collaborative partnership for joint training with suppliers and the district local government. GH A reported that it had no joint training with NMS, which affected supply and distribution of ACTs. GH B emphasised that training offered by NMS and the Drug Monitoring Unit improved supply and distribution. GH C emphasised that refresher training held by the Ministry of Health (MoH) in collaboration with the Malaria Consortium improved supply and distribution of ACTs. GH D emphasised that training done by Non-Governmental Organisations (NGOs) on drug monitoring and supervision improved supply and distribution of ACTs. This conclusion was reviewed and subsequently upheld by [30] who nevertheless reiterated that relevant coordination frameworks based on studies in Africa should be developed to enhance strategic management of ACTs.

3.4.2 Strategic alliance between the hospital and private pharmacies

In terms of existence of a strategic alliance between the hospital and private pharmacies, all the participants reported that there were no such alliances. Most of them indicated that being government institutions, there were no direct alliances with private pharmacies other than recommending the patients to buy drugs from private business during stock-out periods.Ref. [14] proposed the formation of strategic alliances between the organisation and suppliers, manufacturers and distributors to produce and market ACTs.

In case of an emergency especially maternity ward, the Medical Superintendent may informally write to a private pharmacy so that they supply what is not available and later pay".

Nevertheless, strengthening service delivery in the health sector is a complicated endeavour because of the multifaceted stakeholders. It requires balancing the different conflicting goals and interests of politicians, health workers, and patients without disregard to other stakeholder [25].

3.4.3 Relationship between lower health units and ACT availability

The four general hospitals emphasised that relationship with lower health units had improved supply and distribution of malaria treatment pills. All the four GHs emphasised good relationships, support for each other and redistribution of ACTs to other health units whenever they run out of stock. The actions had improved supply and distribution of drugs as illustrated in the following excerpts;

> *"In case the hospital run out of stock of ACTs and the lower unit have, the hospital coordinate and they come to the rescue and vice versa. This process is often done through communication and coordination with the District Health Office. Health supply chains do not only deliver medicines and health products to the populace but they also transmit critical information about need, demand, and consumption to health system planners".*

Therefore, the supply chain plays an essential role in improving health system performance regarding general behavioural aspects of the health system [11]. Table 5 indicates the emerging dimensions under the market environment.

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Table 6: Summary of emerging market environment dimensions affecting ACTs availability

Theme	Dimensions
SC interdependence with suppliers	Regular communication with supplier (NMS); regular meetings with the supplier; use of e-mail correspondence with the supplier; use of personal phone calls to the NMS; routine regional monitoring with stakeholders; evaluation meetings with supplier; use of M-track with other external stakeholders; use of the Rx tool; sharing of schedules with the supplier; regular correspondence with the supplier's representative.
Collaborative partnerships for training	Joint training with NMS; collaborative training with drug monitoring unit; refresher training with MoH; collaborative training with NGOs.
Information sharing with suppliers, MoH, Donors	Online sharing of information; regular exchanges of information using hard copies of reports; use of IT tools (M-track); sharing of weekly or monthly reports; holding of quarterly meetings with external stakeholders.
Relationship between lower health units	Hospital's relationship with lower health units; support for redistribution enhances ACT availability.

Proposition 3: *Market management environment dimensions affect the availability of ACTs in general hospitals in Uganda.*

3.5 Macro environment

This section discusses the relationship between political, economic, social-cultural aspects, technological and legal effects towards ACT supply chain coordination.

3.5.1 Political environment dimensions affecting ACTs availability

Different opinions under political environment that affect malaria treatment were considered. It was argued that politicians spread negative propaganda. The politicians mostly talk negatively about the service delivery in the hospital to the community to their benefit, which made the community lose trust in the work of the nurses and doctors, hence affecting the utilisation of ACTs. Similar findings were observed in United Kingdom [84]. The miscommunication from local politicians to the public that medicines are available even when they are not, caused confusion and mistrust between the hospital and the patients [11]. Others participants revealed that some politicians interfered in the hospital operations, especially where some patients with connections to politicians tended to bypass normal procedures and dictate what should be administered as shown in the following excerpts. *"They always want special treatment because of support from politicians". "... sometimes politicians go to the hospital and demand for ACTs just for their use at home without following the right procedures".* However, some discussants were of the view that politicians too played a supportive role through advocacy for constant supply of ACTs to the hospital whenever ACTs issues were properly

channelled to them. *"They use platforms like health education and sanitation committee meetings and sectorial committee meetings to address critical issues related to ACTs".*

3.5.2 Economic Environment dimensions affecting ACTs availability

In general, poverty among the community seemed to be the most glaring effect of economic environment factors on malaria as pointed out by most participants in all the focus group discussions. This is supported by prior research carried out in Australia [85]. As reported by a discussant, *"Availability of ACTs majorly depends on support from donor funds".* This means that the quantity and frequency of donor funding to the government affected the availability of ACTs. If the development partner does not provide the funds, then ACTs' availability was affected. The high cost of the ACTs affected their availability. It was revealed that, at the time of this research, the health system in Uganda did not permit cost sharing to supplement what the government supplies, which greatly affected the availability of ACTs.

3.5.3 Legal environment dimensions affecting ACTs availability

In as far as the legal environment is concerned, there was consensus among the participants that nationally the NMS (national supplier) is a monopoly when it comes to the supply of ACTs and they often dictated what to supply and when to supply. One participant said that "*Even if the hospitals have an annual plan and budget, they*

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cannot procure ACTs from another supplier, which affects ACT availability. The ACT grant is managed by the NMS and they release the grant quarterly to the hospital as per the framework. This affects malaria treatment. The participants pointed out that the hospitals operated under set guidelines for dispensing and use of ACTs. Some participants mentioned that ACTs were considered as first-line treatment, and to avoid wastage, it was only given to malaria positive patients as per the hospital regulation. Other participants asserted that the legal environment for free distribution and dispensing of ACTs to patients had often created conflict between the patients and nurses during periods of stock-outs, which affected service delivery in the hospital.

3.5.4 Social-Culture dimensions affecting ACTs availability

The majority of the participants agreed that the community had developed a culture of flocking to the hospital on the day of the delivery of the ACTs to the hospital by the NMS, regardless of whether they were sick on not sick. When asked further to explain, it was ascertained that they believed that the truck had "*brought their medicines*". Failure to be given the ACTs leds to reporting the hospital management to the politicians. Often, when the health workers went to the village, the community gathered around asking for ACTs as they believed that the health workers had gone to distribute the medicine. And failure to do so led to conflict between relatives and the health workers. The participants also reported that the community still has a culture of stockpiling ACTs for home use just in case of an emergency. The participant asserted that; *to make matters worse, when they come to the hospital, they may have to forge prescriptions to get more, such as through getting a prescription of another person or using relatives who are hospital staff.* All this affected the availability of ACTs and treatment of malaria. Some participants highlighted that some communities still believed that mangoes caused malaria, and often mistook pneumonia or colds or any fever for malaria and, therefore, expected to receive ACTs. Similar to previous research, this was highlighted as a cause of malaria in Burkina Faso [86].

Some participants also mentioned that after experiencing the symptoms of malaria (fever, general body weakness, etc.) some communities still believed that they had been charmed or bewitched, found solace in traditional treatment instead of going to the hospital. One participant noted that there is a belief that; "*If children are injected, they will die*".

All these community myths led to multiple sicknesses which affect the use of ACTs and complicated the management of malaria treatment as observed in Kenya [87]. The participants pointed out that most communities had a culture of disregarding lower health centres and preferred to get treatment from the main hospital. Another participant revealed that the community has a belief that "*hospital staff are well trained and offer better services than those in the lower health centres, and medicines exist only in the hospitals*". This, therefore, posed a challenge to the hospital staff as they were overwhelmed by the number of patients, which often caused stock-outs of malaria drugs in the main hospital. Furthermore, some participants highlighted that most people still do not complete their dosages; they fell sick often and even developed resistance to the drugs thus complicating malaria treatment [10], [42].

3.5.5 Technological environment dimensions affecting ACTs availability

In trying to understand how technological factors affect ACTs, participants pointed out that the hospitals' current system was very tedious and ineffective. The presence of more robust system would make it easier for the hospital to know the quantity to order in real time instead of the manual entry. The implication was delayed diagnosis and prescription process by the doctors [88]. However, some participants asserted that hospitals use M-track system to ease information sharing and tracking of the disease prevalence. One participant revealed that; "*technology has helped to ensure ACTs are availed on time, since orders are made via emails*". Some participants urged that they had experienced doubts with the testing kits (technology issues). *For instance, a person may test for malaria and the results turns out negative, thus the person may not get ACTs, yet he or she actually had malaria.* This caused mistrust where the community thought that the staff were not competent enough or that they did so in bad faith as emphasised in the trust model [89]. Participants clarified that the rapid diagnostic test (RDT) tests only one species of malaria, leaving out the other four strains, and someone might be declared free of malaria, yet he or she actually has malaria. This may compromise the quality of health of the potential patient. This supports prior research [5], [90]. Emerging dimensions are summarised in table 7 below.

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Table 7: summary of macro environment dimensions affecting ACTs availability

Theme	Dimensions
Political dimensions	Politicisation of ACTs; political publicity; politicians' interference; political support whenever need arises; awareness by politicians; verification of ACTs; advocacy by politicians; surveillance or monitoring.
Economic dimensions	Poverty within the communities; cost sharing; availability of donor funds.
Social-cultural dimensions	Clicks within the community; culture of self-medication; belief of keeping ACTs by households; public attitude towards the lower health facilities; compliance to dosage.
Technological dimensions	Use of personal phones; use of toll-free lines; M-track system; use of RDT and use of the Internet.
Legal dimensions	Testing and dispensing policy; clinical guidelines; regulating consumption; pull policy change.

Proposition 4: *Macro management environment dimensions affect the availability of ACTs in general in Uganda.*

4. Conclusion

The main factors that influence the supply and distribution of ACTs in Uganda can be categorized into three main dimensions; micro supply chain coordination, logistic dimensions, market and macro environment dimensions. Under micro supply chain, mutual understanding and top management are the main pillars that influence the availability of ACTs. Decision made by the management have direct effect on the relationship and mutual understanding by the team in the GHs. Although different mechanisms (timely forecasting, distribution and dispensing) have been developed to improve logistics dimension, the storage management is still hindering factor if ACTs stocks are to be scaled up. Lack of steady electricity in these regions makes drug stores inappropriate for ACTs storage. The temperature upsurge in the stores affect the life span of malaria pills. Under macro environment, socio-cultural factor presents the biggest strain toward the availability of ACTs. A lot of awareness is required by the hospitals in conjunction with the district authorities regarding ACTs usage and treatment since a number of people still expend local herbs as an alternative towards malaria treatment. The government of Uganda and other agencies that are involved in eradicating malaria deaths ought to invest more funds towards IT tools to enable real time exchange of information. The study findings are limited to the four general hospitals from the two most malaria endemic regions in Uganda. Another limitation is the novelty of the subject in health sector and the lack of data in this area. Further studies can be done from other parts of the country to observe similarities and differences using quantitative approach. It is anticipated that the study will identify better ways of managing essential medicine availability and probably save lives.

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