Original Article

Global Advances in Health and Medicine
Volume 10: 1–2
© The Author(s) 2021
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/21649561211002126
journals.sagepub.com/home/gam
SAGE

The Relationship Between Market Environment Dimensions and Availability of Malaria Pills in Uganda

Pross Nagitta Oluka, PhD[1], Marcia Mkansi, PhD[2], and George William Kajjumba, PhD Candidate[3]

Abstract

Introduction: This study sought to examine the contribution of relationship building (in terms of collaboration, information sharing and supply chain interdependence) on the availability of malaria treatment pills in public hospitals in Sub-Saharan Africa using data from Uganda.

Methods: By means of a cross-sectional survey research design, the study used a questionnaire strategy to collect quantitative data. Out of the 320 questionnaires that were distributed in 40 public hospitals, 283 were answered and returned, which yielded an 88% response rate. Structural equation modelling (SEM) was used to establish the relationship between measured variables and latent constructs.

Results: Drawing on the survey results, the confirmatory factor analysist and the Structural Equation Modelling clearly demonstrate that relationship building (in terms of collaboration, information sharing and supply chain interdependence) significantly influences the availability of Artemisinin-based combination therapies in public general hospitals in Uganda.

Conclusion: Policy-makers should focus on developing cheaper information technology tools to exchange information regarding stock levels, forecasting, quantification, orders, and dispensing. This study developed a measurement model for an inter-hospital relationship, using relational view theory, and it employs dimensions in terms of information sharing and supply chain interdependence to predict and explain the availability of malaria pills in government hospitals.

Keywords

supply chain, collaboration partnerships, information sharing, public health, structural equation modeling, AMOS, malaria drug

Received June 21, 2020; Revised January 5, 2021. Accepted for publication February 23, 2021

Introduction

Medicines are strategic products, and their availability is a necessity, despite the complexity involved in managing the various stakeholders such as regulatory authorities, ministries, medicine manufacturers, distributors, wholesalers, retailers, customers, and information service providers.[1] Regrettably, there is a scarcity of research in the area of medicine supply chains.[2] Therefore, coordinating the medicine supply chain is vital whether in developed, emerging, or underdeveloped economies, despite the lack of research on the topic.[3] The availability of medicine is considered to be one of the activities with the most significant potential impact on human life; therefore, the need to coordinate it.[4]

Medicine supply chain coordination is defined as managing the interdependencies among the various actors internally and externally to the hospital to make health care delivery efficient and effective.[5] In particular, the planning or forecasting, quantification, procurement, storage, and dispensing should be synchronized to reduce stock-outs or variabilities.[6] Attempts to

[1]Department of Economics and Managerial Sciences, Uganda Management Institute, Kampala, Uganda
[2]Department of Operations Management, University of South Africa, Pretoria, South Africa
[3]Department of Civil and Environmental Engineering and Construction, University of Nevada, Las Vegas, Nevada

Corresponding Author:
Pross Nagitta Oluka, P.O. Box 20131, Jinja Road, Plot 44–52, Jinja Road, Kampala, Uganda.
Email: nagittaoluka@gmail.com

ensure the availability of medicines can strengthen the overall health system's responsiveness to the treatment of the patients.[7] Unfortunately, the stock-out of Artemisinin-based combination therapies (ACTS), which that have been approved by the World Health Organization (WHO) to treat uncomplicated malaria in health facilities in developing countries, has put many lives at risk and has sometimes led to death.[8]

In Kenya, several case studies.[9,10] have established that a mix of strategies was required to stabilize the artemisinin (ACTs) market to avert death among children under five and pregnant women. Similarly, another study[11] concluded that "the public health and private retail sector are important complementary sources of treatment in rural Tanzania for ACTs successful uptake". The same recommendation was made in Ghana to control deaths as a result of complicated malaria.[12] A case study[13] on Uganda advised that the private sector should be included in healthcare provision and should be encouraged to subsidize ACTs. This may lead to a dramatic improvement in the availability and improved uptake, and reduced deaths. Also in Uganda, a study[14] examined case studies of four rural districts in Uganda, and concluded that the failure of coordination was increasing the death burden on already pressured hospitals.

From the foregoing, it is clear that the frequent unabated unavailability of malarial drugs is of urgent global concern, as over 3.7 billion people are at risk of contracting malaria. In Africa alone, malaria is responsible for almost four deaths every five minutes. In 2019, 229 million cases led to 409,000 deaths; of these 67% (274,000) were children under 5 years.[15] In Uganda, malaria is the leading human killer, especially among children under five years and expectant mothers.[16] Several studies that have advanced a number of predictors of the availability of malaria treatment pills have found key enablers to include the use of cheaper information technologies.[12,17,18] Research[19] has emphasized that record keeping, employee training, supervisory and regulatory support needs to be strengthened. Similarly, a study[20] surveyed the internal chain orientations, particularly patient care units, hospital warehouse, patients, and the external chain consisting of distributors, vendors, and manufacturers. Previous studies have theoretically embraced transaction cost economic perspectives, while others have adopted the resource-based view and coordination theory to predict the availability of services and products in organisations.[21]

This study developed a measurement model for an inter-hospital relationship using the relational view theory. It employs the dimensions in collaboration, information sharing, and supply chain interdependence to predict and explain malaria pills' availability in Sub-Saharan Africa.[22] This re-conceptualized model is validated by a large-scale empirical study involving 283 Drug Therapeutic Management Committee (DTMC) members from 40 general public hospitals. Confirmatory factor analysis was used to assess the construct validity of the new measurement model.

With the increasing need for the availability of medical products and services, the public and companies are always looking for reliable suppliers. Hence, the need to build a buyer-supplier relationship to achieve long-term mutual benefits in terms of quality, efficiency, performance, opportunities, and competence.[23] However, there is a lack of relationship building in the public sector in Uganda, and where it exists, opportunism and corruption are the order of the day.[24] An earlier survey[25] found that relationship building is hampered by unethical conduct among procurement professionals in Uganda. Similarly, it was found that incentive alignment and information sharing were critical conjecturers of decision synchronization.[23] These factors may cause citizenry dissatisfaction; late deliveries, and stock-outs of products in the supply chain. The following section describes the hypothesis and model development.

Hypotheses Development

This study first adopted the conceptualization of collaborative relationships from Simatupang and Sridharan.[26] The study further adopted the conceptual framework developed by Nagitta and Mkansi[5] from a qualitative study. However, this paper aimed at measuring and validating the model.This study, therefore, aimed to test and validate the initial qualitative findings from the above scholars using a survey. The conceptualization of the collaborative partnership was conceived to involve joint training with external partners such as the Uganda National Medical Stores (NMS), Drug Monitoring Unit, Ministry of Health, and Non-Governmental Organizations. Information sharing involved variables such as the timely sharing of information with other stakeholders, credibility of shared information, sharing of delivery schedules, and exchange of evaluation reviews with external stakeholders. Finally, the constructs of supply chain interdependence involved variables such as the pooling of resources, standardization of processes, joint planning and mutual adjustment. In developing the hypotheses, this section reviews the literature on collaborative partnerships, information sharing, and the management of supply chain interdependence, and thereafter, they are tested.

Collaborative Partnerships and Availability of ACTs

The term 'collaborative partnership' refers to organizations working with each other towards a common goal instead of individually.[27] The management of medicine supply chains necessitates partners' capability to disclose, account, and scrutinize information flow. Therefore, in performing such actions, the collaboration with committed suppliers and other stakeholders of products and services should reduce stock-outs or deliver the needed medical supplies. Without focused collaboration and information sharing, it may be difficult for individual hospitals to make medical supplies available.[12,28] However, chain partners often opportunistically misuse their powers rather than creating better overall value, therefore, this calls for proposals to explain the interplay of power and trust mechanisms in collaborative interactions.[29] Nevertheless, supply chain entities and actors must integrate and act on similar terms to improve the flow of services and products, including financial information and overall economic impacts.[30]

Collaboration is characterized by a higher-level interest, representing an affective, volitional, shared interest process.[31] Other scholars[32] stress the importance of the shared interest by including the term "unity of effort." There must be some form of investment in the relationship that provides for mutual understanding, a shared vision, shared resources, and the achievement of collective goals.[33] Collaboration between firms is a powerful competitive advantage source, calling for the effective management of relationships in the supply chain. This includes the development and maintenance of capabilities to ensure the effective delivery of medical products and services.[34] proposed strategic alliances between the organization and suppliers, manufacturers, and distributors to produce and market ACTs. These scholars demonstrated the relevance of the development of coordination frameworks to enhance the strategic management of ACTs, and argued that the interaction of the micro-market and macro environments is vital for the supply and distribution of ACTs. They recommended that joint internal coordination frameworks are necessary for the successful availability of malarial drugs. Relatedly, collaboration is emphasized while seeking malaria treatment based on the need for malarial drugs in both the public and private sectors. Therefore, the following hypothesis is set forth:

> $H_{1:}$ There is a relationship between collaborations and availability of ACTs

Information Sharing and Availability of ACTs

Information sharing synchronizes the supply chain members' knowledge and expertise to increase the ability to serve downstream customers efficiently. The coordinated information includes, among others, changes in market demand and customer preferences, and helps to coordinate transaction-related activities.[35] Coordinated information is characterized by multiple dimensions, including timeliness, accuracy, adequacy, completeness, and information credibility.[36] The supply chain intervention's primary goals are to improve stocking levels of essential medicines, to and reduce the incidence and duration of pharmaceutical stock-outs.[37] Therefore, an effective supply chain plays a critical role in improving the health system performance regarding the general behavioral aspects of the health system.[7]

However, sometimes firms are reluctant to share information because of a lack of trust, leading to uncoordinated activities within the functional units.[38] The information helps to link the point of production seamlessly with the point of delivery or purchase. It allows planning, tracking, and estimating the lead times based on real-time data. Sharing of the information between the supply chain members is very important for effective coordination in the supply chain.[39] According to Kabra et al.,[40] the sharing of information between supply chain members helps to substitute information with inventory and lead time, reduces the supply chain costs, reduces the demand variability, enhances responsiveness, and improves the service level. Available empiricism, as investigated by Prajogo et al.[41] found out that information technology capabilities, particularly, have significant positive effects on integrated supply and distribution systems. The same study demonstrates that long-term supplier relationships have direct effects on logistics integration. However, sharing supply information among the general hospitals and donors remain a challenge in Sub-Saharan Africa.[42] The effective exchange of information with external suppliers is crucial for the supply chain delivery of health products.[41] Following the reviewed literature, it is hypothesized that:

> $H_{2:}$ There is a relationship between information sharing and the availability of ACTs

Management of Supply-Chain Interdependence and Availability of ACTs

The past decade has been characterized by pulling data together using different strategies towards an integrated supply chain from both suppliers and customers.[43,44] notes that managing supply-chain interdependence is a critical factor for organisations in various industries. It has potential benefits for firms' performance, resulting from the interdependencies of supplier business relationships.[45] Research on Kenya's Public Health Sector[46] found that the effective management of the health sector requires the efficient integration of the hospital processes using information technology tools so that products are provided adequately at the right time and delivered at the right places. This minimizes system-wide cost implications, while satisfying service requirements. Studies have shown that partners can easily adjust or vary fixed contractual terms, such as cost or budget pressures and volume adjustments, among others, when supply chain processes are integrated.[47] By this very fact, a high level of total interdependence, like the one in Uganda between NMS and health facilities, might indicate a strong, cooperative, long-term relationship. Both parties have invested time, effort, and money.[48] These scholars demonstrate that supply-chain interdependence ensures that medicines do not expire in any health facility, while there are either public or private outlets that do not have stocks. Therefore, we hypothesized that:

> $H_{3:}$ There is a relationship between supply-chain interdependence and the availability of ACTs

Methods

Research Philosophy and Approach

This study aimed to establish the cardinal parameters that influence the availability of ACT supply in Uganda to enhance malaria drug availability. The study employed the pragmatism approach to verify the relationship between the tested variables, because of its practical and real strategy of resolving challenges. Pragmatism allowed quantitative approaches to scale the strength of variables/parameters that might impact the availability of ACTs in the medical sector. The fundamental question in relation to this problem is how supply chain variables can enhance ACTs' availability in developing economies, a case for Uganda.

Data Collection Method and Pilot Study

The study adopted a cross-sectional survey design, and collected data through the use of a standardised questionnaire, which enabled us to draw inferences through the measurement of casual relations between the variables at a particular point in time.[49] Upon establishing the research variables, a research questionnaire was designed to test the hypotheses of the study. The research tool was based on the five-point Likert scale; the scale was created such that "5" elicits an outstanding variable, while "1" elicits an insignificant variable.

Before rolling out the research tool, a preliminary study was conducted with five market experts and three medical practitioners. After piloting, the research tool was corrected for mistakes, clarity, language, and the proposed model's coherent flow. Data related to the constructs were collected via a web-based and in-person questionnaire.

Survey Population, Sample Size, and Technique

The unit of analysis was hospitals and Drug Therapeutic Management Committee (DTMC) members in each hospital who handle the medicine supply chain. Out of the 45 general hospitals (GHS), 40 were selected based on Krejcie and Morgan.[50] This assumed 95% statistical significance testing level (confidence level). The population proportion of 0.5% or margin of error/degree of accuracy (5%) was expressed as a proportion (.05). From the 40 GHS, a population of 440 DTMC members were identified, out of which, 320 were selected using simple random technique (eight from each hospital). The members were able to offer insights from which we built supply chain coordination understanding from a public hospital perspective. Hence giving equal chance to estimate statistically the characteristics of the population from the sample. In addition, the respondents are responsible for planning and forecasting quantifying, procuring, storing and dispensing medicines. In total, 283 questionnaires were returned, giving a response rate of 88.4%. The sample was considered adequate because for factor analysis to be run, a sample size of at least 100 respondents is recommended,[51] even though the number of variables is less than 20,[52] or at least 10 cases for each item in the instrument.[53]

Operationalization of Variables

Availability refers to the physical presence of the medicine at the service delivery point, in good quality and in the right quantities, to treat ailments and diseases; timely delivery of drugs, stock-out frequency and improved stock levels.[54]

Collaborative partnerships. This variable entails hospitals working together in aspects of joint training with either the supplier, donors or Ministry of Health.[27]

Information sharing. This refers to the extent to which critical and proprietary information is communicated to a supply chain partner. It involves the aspects of accuracy, timeliness, adequacy and credibility of exchanged information. The information shared could be inventory and order levels, delivery schedules, customer demand and sales trends.[55]

Supply-chain interdependence. Interdependency relates to how the different functions or units within an organization connect with each other, given the interdependence among their internal and external operations through mutual adjustment, standardization of processes and joint planning.[56] The rest of the variables, as used in the study, are listed in Table 1.

Table 1. Extracted Dimensions and Their Coded Underpinnings.

Code	Item
Collaborative Training (CP)	
CP01	Joint training with NMS
CP02	Collaborative training with Drug Monitoring Unit
CP03	Refresher training with the Ministry of Health
CP04	Collaborative training with NGOs
Information sharing with suppliers (ISS)	
ISS 01	Accuracy of shared information.
ISS 02	Regular exchange of information.
ISS 03	Timeliness of information shared
ISS 04	Adequacy of shared information
ISS 05	Sharing of quarterly information with external stakeholders
ISS06	Sharing of delivery schedules
Supply chain interdependence	
SCI 01	Decision synchronization
SCI 02	Pooled interdependence
SCI 03	Reciprocal interdependence
SCI 04	Pooling of resources
SCI 05	Routine regional monitoring with stakeholders
SCI 06	Evaluation meeting for the mutual adjustment of plans
Availability of ACTs	
A01	Timely delivery of ACTs to user units
A02	Rate of improved stock levels
A03	Right quantities ordered and received
A04	Right quality in terms of national quality standards
A05	Stock-out frequency
A06	The rate at which ACTs run out of stock
A07	Observance of minimum–maximum levels
A08	Amount of ACTs available at the time of the study

Data Evaluation and Reliability Analysis

Structural Equation Modelling (SEM) was used to test the model. SEM is a multivariate statistical analysis technique that is used to analyze structural relationships. This technique is the combination of factor analysis and multiple regression analysis, and it can be used to analyze the fundamental relationship between measured variables and latent constructs. Missing and outliers were tested before subjecting the data to SEM.[57] Overall, 304 questionnaires were completed and returned. A total of 11 out of 304 were rejected on the grounds of being incomplete (more than 10% missing data). In questionnaires with less than 10% missing data, the median of the nearby point was used to replace missing data. Ten (10) responses were eliminated due to disengaged responses, as each variable registered the same response.

Table 2. Reliability Test Based on 283 Respondents and Listwise Deletion, Based on All Variables in the Procedure.

Group	CA[a]	No. of Items
CP	0.815	4
ISS	0.827	5
SCI [b]	0.760	7
Availability	0.904	8

[a]Overall CA = 0.838; [b]Seven items remained after deleting one item; ISS: Information sharing with suppliers; CP: Collaborative partnerships for training; SCI: Supply chain interdependence with suppliers.

Outliers can significantly impact the correlation and regression among variables, based on the Mahalanobis analysis of outliers, and three research tools were debarred. The symmetry (skewness, S) and tailing (kurtosis, K) of the data were also tested; all variables were in the allowable range of $-2 \leq S, T \leq +2$, which elicits good normality of the data. Cronbach Alpha (CA) was employed to estimate the internal consistency (IC), and to determine how closely the measuring variables were contributing to their respective latent variables. CA values range from 0.0 to 1.0; $CA < 0.70$ elicits unacceptable consistency, $0.7 \leq CA \leq 0.8$ elicits acceptable levels, while $CA > 0.8$ shows good IC.[58] To improve CA, items with a CA greater than the overall CA were deleted. Using this approach, one item under the supply chain interdependence with suppliers (SCI) category was deleted; and the CA for the group soared from 0.699 to 0.760. The overall CA for the tested variables in this study was 0.838, with no individual group eliciting $CA < 0.700$, as shown in Table 2. Thus, the proposed hypothetical model elicits a good IC and reliability.

Results and Discussions

Demographics

The respondents comprised of 52.3% females and 47.7% males. The respondents' qualifications were as follows: 3.2% held secondary school certificates, 24.0% were diploma holders, 50.2% had bachelor's degrees, and 18.4% had master's degrees, while 4.2% had PhDs as the highest qualification. A total of 7.1% of the respondents had experience of more than ten years, while only nine respondents had less than one year of experience in the medical industry. Overall, the demographics elicited a diverse dataset.

Confirmatory Factor Analysis and Validity Analysis

Confirmatory factor analysis (CFA) was used to assess the convergent validity of the hypothetical model. All the retained variables after CA were subjected to CFA, and IBM® SPSS® Amos (V.21) graphic software was applied in this analysis. A proposed model to pass CFA and validity analysis, the average variance explained (AVE), and composite reliability (CR) should be ≥ 0.50 and 0.70, respectively. The maximum shared variance (MSV) < average shared variance (ASV), and the square root of AVE should be higher than inter-construct correlations.[59]

The initial values of the hypothetical model are summarized in Table 3. The results shown in the table elicit abysmal levels of the initial proposed model. To improve the model outputs, suggestions based on the AMOS yield were followed. In addition, items with a residual covariance $> |2.0|$ were eliminated.[60] Based on these recommendations, items SCI01, SCI02, and ISS03 were eliminated from the model. Their elimination secured acceptable levels of reliability and validity for the model. The removal of such items suggests the heterogeneous nature of ACT availability, and plummets measurement error, which revved reliability among the retained items, thus ameliorating model validity. Table 3 elicits the validity and factor correlation matrix before and after modification. Figure 1 shows the CFA measurement after adjustment.

Structural Equation Model

Structural equation model (SEM) was applied to analyze the multivariate relationship between the measuring variables. AMOS software was used to study the relationship. Maximum likelihood (ML) was employed in the model evaluation, since there was no problem with univariate normality and the data was normally distributed.[58,59,61] The goodness of fit indices (GOFIs) was tested using the different parameters, as outlined in Table 4.[62] The majority of the GOFIs failed to pass the minimum requirement. To improve the model fit, covariances and causal relationships were established among the model variables and error terms. AMOS modification indices were used as a baseline to build the interrelationships amongst the measured parameters.[63] As a way of modifying the model in this regard, covariance relations were established, as illustrated in Figure 2. For example, the relationship in the error parameters of "evaluation meetings (SCI06)" with "routine monitoring (SCI05)" and

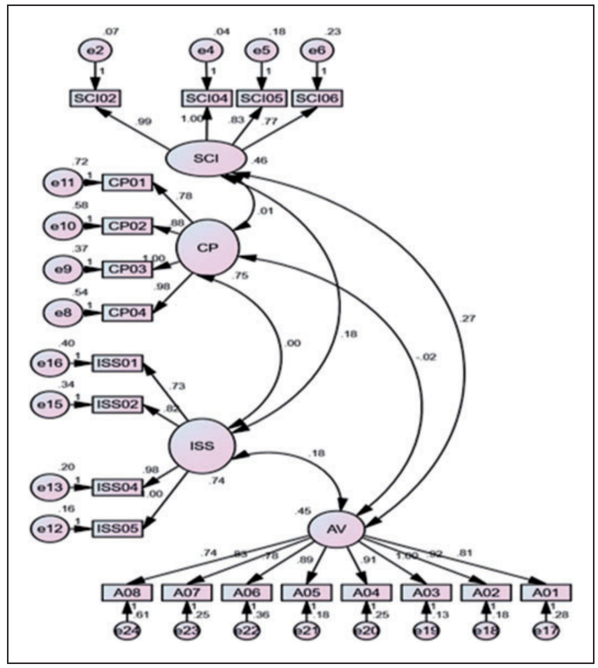

Figure 1. Hypothetical Model Measurement Using CFA. ISS: Information sharing with suppliers; CP: Collaborative partnerships for training; SCI: Supply chain interdependence with suppliers; AVG: Availability; e_n: error in n^{th} univariate variable; other variables are defined in Table 1.

Table 3. Validity and Factor Correlation Matrix With the Square Root of AVE on the Diagonal.

Proposed Model	CR	AVE	MSV	SCI	CP	ISS	AV
SCI	0.757	0.424	0.360	**0.651**			
CP	0.818	0.531	0.001	0.017	**0.729**		
ISS	0.812	0.538	0.100	0.316	0.006	**0.733**	
AV	0.910	0.562	0.360	0.600	0.027	0.307	**0.749**
Adjusted model	CR	AVE	MSV	SCI	CP	ISS	AV
SCI	0.919	0.740	0.361	**0.860**			
CP	0.818	0.531	0.001	0.015	**0.729**		
ISS	0.889	0.670	0.100	0.317	0.001	**0.819**	
AV	0.910	0.562	0.361	0.601	0.027	0.306	**0.749**

AVE: average variance explained, CR: composite reliability, MSV: maximum shared variance, ASV: average shared variance, ISS: Information sharing with suppliers, CP: Collaborative partnerships for training, SCI: Supply chain interdependence with suppliers, AV: Availability.

Table 4. Results of GOFI Measures.

Goodness-of-Fit Measure	Acceptable Threshold	Hypothetical Model	Revised Model
RMSEA	<0.08	0.720	0.042
GFI	>0.90	0.879	0.926
AGFI	>0.90	0.845	0.900
CFI	>0.90	0.932	0.978
NFI	>0.90	0.891	0.937
TLI	>0.90	0.921	0.973
PCFI	>0.50	0.804	0.803
PNFI	>0.50	0.681	0.768

RMSEA: Root Mean Square Error of Approximation, GFI: Goodness of Fit Index, AGFI: Adjusted Goodness of Fit Index, CFI: Comparative Fit Index, NFI: Normed Fit Index, TLI: Tucker-Lewis Index.

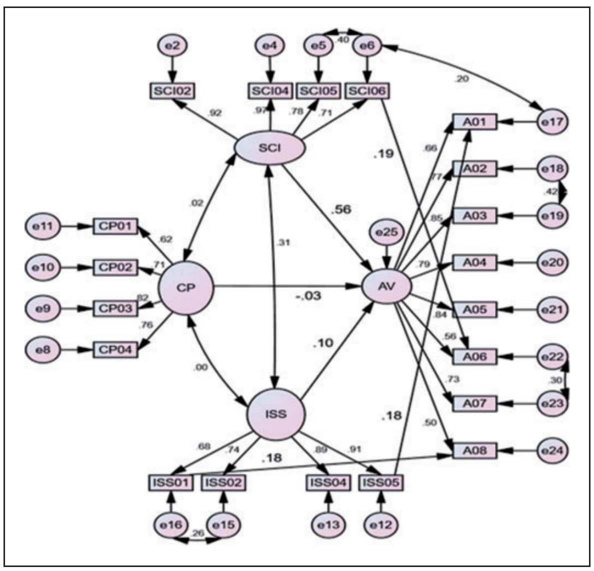

Figure 2. Path Coefficients of the Predictor Model. ISS: Information sharing with suppliers; CP: Collaborative partnerships for training; SCI: Supply chain interdependence with suppliers; AVG: Availability; e_n: error in n^{th} univariate variable; other variables are defined in Table 1.

"timely delivery (A01)" makes theoretical sense. This creates conceptual sense, as increased evaluation meetings mean revved routine monitoring, which fosters timely delivery.

Table 4 summarizes the GOFIs of the final model after several refinements, and all the minimum requirements were satisfied. For instance, $\text{GFI} = 0.926$, thus the model outcomes are well explained by the collected data; $\text{RMSEA} = 0.042$, which elicits high confidence levels amongst variables.

Table 5 elicits the standard regression coefficient of each retained item in the model. All the path coefficients are positive and significant at $\rho < 0.05$. The two hypotheses, H_2 and H_3 are supported, based on the data collected from the survey. However, H_1 is not supported by

Table 5. Standardized Regression Weights and Hypothesis Test.

Path			Estimate	p
AV	<-	SCI	0.564	***
AV	<-	ISS	0.096	0.027
AV	<-	CP	-0.034	0.552
SCI02	<-	SCI	0.923	***
SCI04	<-	SCI	0.969	***
SCI05	<-	SCI	0.785	***
SCI06	<-	SCI	0.714	***
ISS01	<-	ISS	0.678	***
ISS02	<-	ISS	0.744	***
ISS04	<-	ISS	0.891	***
ISS05	<-	ISS	0.911	***
CP01	<-	CP	0.621	***
CP02	<-	CP	0.706	***
CP03	<-	CP	0.817	***
CP04	<-	CP	0.756	***
A01	<-	AV	0.662	***
A02	<-	AV	0.770	***
A03	<-	AV	0.850	***
A04	<-	AV	0.789	***
A05	<-	AV	0.843	***
A06	<-	AV	0.559	***
A07	<-	AV	0.731	***
A08	<-	AV	0.500	***
A06	<-	SCI06	0.187	***
A01	<-	ISS05	0.175	***
A08	<-	ISS01	0.175	***

***Significant at $\rho < 0.001$.

the data. These results suggest that ACTs' vital supply chain coordination determinants can be enthused through information sharing with suppliers and supply chain interdependence with suppliers. From the foregoing results, collaborative partnerships were surprisingly not supported. Yet partners need to leverage on each other's strength to reduce stock-outs.[2] This is because public hospitals by policy only receive medicine supplies supplied by National Medical Stores (NMS) or Joint Medical Stores. Enhancing collaborative partnerships may require a fundamental shift in policy, which will necessitate ethical considerations to deter partners from opportunistically misusing their powers.[29] These findings contradict the findings of previous studies[30] that revealed that collaborative partnerships were a significant predictor of medicine availability. Nonetheless, without close working relationships with committed suppliers (donors, Non-Governmental Organizations, and other stakeholders), collaborative training and joint supervision of medicine usage may be difficult.[28]

Information sharing emerged as a critical theme in fostering the availability of ACTs to the populace. The finding is supported by Mbugua and Namada,[46] who assert that information sharing is effective through information technology tools that lessen system-wide cost implications, while satisfying service requirements. This then implies that all the stakeholders, particularly the beneficiaries of malaria drugs, should get the necessary information from government hospitals on where to obtain the drugs with ease and almost no effort.[36,37] Therefore, the hospital must have in place mechanisms for sharing information in real-time with suppliers and other external stakeholders.[38] The implication is an investment of resources in procuring appropriate information technology that will enable the integration of functions and systems within the hospitals and with external partners.[40]

Supply chain interdependency is the most significant predictor of medicine availability. The result denotes that decisions between the general hospitals and NMS should be synchronized to boost the availability of ACTs. With integrated systems, decision synchronization involving joint decisions in planning could be possible (SCI02 = 0.92 and SCI06 = 0.71). Pooled and reciprocal interdependence were among the univariate variables that were retained under supply chain (SCI04 = 0.97, and SCI05 = 0.78). Pooled interdependence is vital to the efficiency of any kind of operation, since this form of interdependence has to do with the joint utilization of resources. By utilizing common resources, economies of scale can be achieved in the performance of individual activities that belong to different supply chains.

Where activities are subject to counterpart-specific interdependence, and hence, are closely complementary, it is necessary to include reciprocal interdependence in the supply chains. This interaction may include adjustments of resources used in, or refined by, the activities subject to coordination to improve resource utilization or the means by which the activities are coordinated.[64] National Medical stores could work closely with the general hospitals when deciding to decouple or coordinate the inbound and outbound flows of inventories to reduce the ordering and channel inventory costs. The local government or Ministry of Health may have to invest in developing logistic infrastructure to significantly reduce the supply chain hurdles.

Conclusions and Implications

Based on the modified SEM model, the findings generally stick to the assertion that information sharing and interdependency improvements are significant predictors of the availability of ACTs. Therefore, it is essential for DTMC members in hospitals to enhance affordable information sharing, and manage the interdependency so as to make medicine available to the end-user. The implication for hospital management is to develop affordable information technologies which will be able to facilitate the information flow between different stakeholders. By so doing, the hospitals may minimize manual processes that sometimes are inaccurate and do not provide the much needed visibility. Taking note of the interdependence among supply chains partners implies that that hospitals need to share resources to the extent that is possible. This may require hospitals to rethink how to mutually adjust work plans the pooling of resources, and standardization of processes. This may in turn lead to the improved availability of medicines, to the neediest population, quality of service delivery, timeliness and reduced costs, which are key facets of good supply chain performance.

Acknowledgment

We thank the Drug Therapeutic Management Committee (DTMC) members in the 40 General Hospitals for taking part in this project.

Author Contributions

Oluka Pross Nagitta and George William Kajjumba designed the initial draft, wrote the manuscript, and did the literature review, while Marcia Mkansi edited the final revisions.

Availability of Data and Materials

The datasets supporting the conclusions of this article are available on reasonable request from the authors.

Consent for publication

All co-authors agree to a joint publication.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: We declare no competing interests. The manuscript is extracted from the Ph.D. study of the corresponding author while studying at the University of South Africa.

Ethics approval and consent to participate

This was provided by the Research Ethics Review Committee of the University of South Africa and the Gulu University. DTMC members provided written consent to participate in the study.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Publisher's Note

The authors remain neutral to any institutional affiliations claims.

ORCID iD

Pross Nagitta Oluka https://orcid.org/0000-0002-1664-3145

Supplemental Material

Supplemental material for this article is available online.

References

1. Sharma S, Chaudhury RR. Improving availability and accessibility of medicines: a tool for increasing healthcare coverage. *Arch Med*. 2015;7(5):1–9. http://www.archivesofmedicine.com/medicine/improving-availability-and-accessibility-of-medicines-atool-for-increasing-healthcare-coverage.php?aid = 7046.
2. Gupta S, Gupta NV. Pharmaceutical supply chain management. *Int J Pharm Sci Rev Res*. 2016;37(2):73–77.
3. Gao Y, Li Z, Taghipour A, Canel B, Kang DS. Supply chain coordination: a review. *J Adv Manag Sci*. 2018;6(4):213–217.
4. Jahre M, Dumoulin L, Greenhalgh LB, Hudspeth C, Limlim P, Spindler A. Improving health in developing countries: reducing complexity of drug supply chains. *J Humanit Logist Supply Chain Manag*. 2012;2(1):54–84.
5. Nagitta OP, Mkansi M. Exploring the supply chain coordination dimensions for artemisinin-based combination therapies in Uganda. *Int J Supply Chain Manag*. 2019;8(4):134–151.
6. Rassi C, Graham K, King R, Ssekitooleko J, Mufubenga P, Gudoi SS. Assessing demand-side barriers to uptake of intermittent preventive treatment for malaria in pregnancy: a qualitative study in two regions of Uganda. *Malar J*. 2016;15(1):1–14.
7. Yadav P. Health product supply chains in developing countries: diagnosis of the root causes of underperformance and an agenda for reform. *Heal Syst Reform*. 2015;1(2):142–154.
8. Khera A, Mukherjee R. Artemisinin resistance: cause for worry? *J Mar Med Soc*. 2019;21(1):4.
9. Shretta R, Yadav P. Stabilizing supply of artemisinin and artemisinin-based combination therapy in an era of widespread scale-up. *Malar J*. 2012;11(1):1–10.
10. Chuma J, Okungu V, Molyneux C. Barriers to prompt and effective malaria treatment among the poorest population in Kenya. *Malar J*. 2010;9(1):1–14.
11. Alba S, Dillip A, Hetzel MW, et al. Improvements in access to malaria treatment in Tanzania following community, retail sector and health facility interventions—a user perspective. *Malar J*. 2010;9(1):1–16.
12. Asamoah D, Abor P, Opare M. An examination of pharmaceutical supply chain for artemisinin-based combination therapies in Ghana. *Manag Res Rev*. 2011;34(7):790–809.
13. Yeka A, Nankabirwa J, Mpimbaza A, et al. Factors associated with malaria parasitemia, anemia and serological responses in a spectrum of epidemiological settings in Uganda. *PLoS One*. 2015;10(3):e0118901.
14. Talisuna AO, Noor AM, Okui AP, Snow RW. The past, present and future use of epidemiological intelligence to plan malaria vector control and parasite prevention in Uganda. *Malar J*. 2015;14(1):1–11.
15. World Health Organization. *WHO Publishes World Malaria Report 2018*. Geneva, Switzerland: WHO; 2018. www.who.int/malaria%0A; https://www.who.int/malaria/publications/world-malaria-report-2018/report/en/%0A; https://apps.who.int/iris/bitstream/handle/10665/275867/9789241565653-eng.pdf?ua = 1
16. Bahk YY, Cho PY, Ahn SK, et al. An evaluation of active case detection in malaria control program in Kiyuni Parish of Kyankwanzi district, Uganda. *Korean J Parasitol*. 2018;56(6):625–632.
17. Behuniak JA, Ahmad IA, Courtright AM. Project cost overruns. In: *Production Software That Works*; Elsevier B.V: Amsterdam, Netherlands, 1992;169–177. DOI: 10.1016/B978-1-55558-083-4.50024-6. https://linkinghub.elsevier.com/retrieve/pii/B9781555580834500246.
18. Pule S, Kalinzi C. Relationship management in downstream supply chain: a predictor of performance among selected pharmaceutical companies in Kampala, Uganda. *Int J Manag Value Supply Chain*. 2014;5(3):61–73.
19. Ashurst A. Reflecting on the nurse's role in record keeping. *Nurs Resid Care*. 2017;19(12):714–715.
20. Landry S, Beaulieu M. The challenges of hospital supply chain management, from central stores to nursing units. *Int Ser Oper Res Manag Sci*. 2013;184:465–482.
21. Malone TW, Crowston K. The interdisciplinary theory of coordination. *ACM Comput Surv*. 1994;26(1):87–119. http://crowston.syr.edu/papers/CCSWP157.html.
22. Radhakrishnan A, David DJ, Sridharan SV, Davis JS. Re-examining supply chain integration: a resource dependency theory perspective. *Int J Logist Syst Manag*. 2018;30(1):1–30.
23. Eyaa S, Ntayi JM, Namagembe S. Collaborative relationships and SME supply chain performance. *World J Entrep Manag Sustain Dev*. 2010;6(3):233–245.
24. Eyaa S. Opportunism in exchange relationships in supply chains: theory development and empirical evidence. 2017. A thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy (Management) Newcastle Business School, Faculty of Business and Law (Unpublished). Available at https://nova.newcastle.edu.au/vital/access/manager/Repository/uon:30675.
25. Ntayi JM, Rooks G, Eyaa S, Qian C. Perceived project value, opportunistic behavior, interorganizational cooperation, and contractor performance. *J African Bus*. 2010;11(1):124–141.
26. Simatupang TM, Sridharan R. The collaboration index: a measure for supply chain collaboration. *Int J Phys Distrib Logist Manag*. 2005;35(1):44–62.
27. Ramesh A, Banwet DK, Shankar R. Modeling the barriers of supply chain collaboration "Understanding the meaning of collaboration in the supply chain", supply chain management: an modeling the barriers of supply chain collaboration. *J Model Manag*. 2010;5(1):176–193.
28. Koçoğlu I, Imamoğlu SZ, Ince H, Keskin H. The effect of supply chain integration on information sharing: Enhancing the supply chain performance. *Procedia—Soc Behav Sci*. 2011;24:1630–1649.
29. Sridharan R, Simatupang TM. Power and trust in supply chain collaboration. *Int J Value Chain Manag*. 2013;7(1):76.

30. Simatupang TM, Sridharan R. Complementarities in supply chain collaboration. *Ind Eng Manag Syst*. 2018;17(1):30–42.
31. Tjosvold D, Weicker D. Cooperative and competitive networking by entrepreneurs: a critical incident study. *J Small Bus Manag*. 1993;31(1):11.
32. Lawrence P, Lorsch J. Managing differentiation and integration. *Organ Environ*. 1967;185–245.
33. Bhattacharya S, Mukhopadhyay D, Giri S. Framework for study of supplier relationships in Indian automotive supply chains. *J Supply Chain Manag Syst*. 2015;4(3):47–63.
34. Ogulin R, Selen W. Determinants of informal coordination in networked supply chains. *J Enterprise Inform Manag*. 2012;25(4):328–348.
35. Datta PP, Christopher MG. Information sharing and coordination mechanisms for managing uncertainty in supply chains: a simulation study. *Int J Prod Res*. 2011;49(3):765–803.
36. Pujara AA, Kant R. Supply chain information sharing. *Int J Inf Syst Supply Chain Manag*. 2015;8(1):22–38.
37. Vledder M, Friedman J, Brown T, Friedman J. *Optimal Supply Chain Structure for Distributing Essential Drugs in Low Income Countries: Results From a Randomized Experiment*. Ross School of Business Paper 1269; 2015.
38. Sharma A, Kumar R. *Sharing of Information in Supply Chain Management*; Vol 6; 2017. https://pdfs.semanticscholar.org/aca8/5d8eaa6a988e093ac5da0b6b4d9d14b5e559.pdf
39. Singh RK. Developing the framework for coordination in supply chain of SMEs. *Bus Process Manag J*. 2011;17(4):619–638.
40. Kabra G, Ramesh A, Arshinder K. Identification and prioritization of coordination barriers in humanitarian supply chain management. *Int J Disaster Risk Reduct*. 2015;13:128–138.
41. Prajogo D, Oke A, Olhager J. Supply chain processes linking SL integration, S performance, Lean. *Int J Oper Prod Manag*. 2016;36(2):220–238.
42. Williams BD, Roh J, Tokar T, Swink M. Leveraging supply chain visibility for responsiveness: the moderating role of internal integration. *J Oper Manag*. 2013;31(7–8):543–554.
43. Wang B, Childerhouse P, Kang Y, Huo B, Mathrani S. Enablers of supply chain integration. *Ind Manag Data Syst*. 2016;116(4):838–855.
44. Hugos M. Creating supply chains for competitive advantage. *Essent Supply Chain Manag*. 4th edn, eBook John Wiley & Sons Inc., 2018.
45. Roseira C, Brito C, Henneberg SC. Managing interdependencies in supplier networks. *Ind Mark Manag*. 2010; 39(6):925–935.
46. Mbugua AW, Namada J. Information technology integration effect on operational performance of Kenya's public health sector. *Integr J Bus Econ*. 2019;3(3):226.
47. Mofokeng TM, Chinomona R. Supply chain partnership, supply chain collaboration and supply chain integration as the antecedents of supply chain performance. *South African J Bus Manag*. 2019;50(1):10.
48. Duffy R, Fearne A. The impact of supply chain partnerships on supplier performance. *Int J Logist Manag*. 2004;15(1):57–72.
49. Saunders M, Lewis P, Thornhill A. *Research Methods for Business Students*. 7th edn, Harlow: Pearson, UK, 2016.
50. Krejcie, R V, Morgan DW. Determining sample size for research activities. *Educ Psychol Meas*. 1970;30:607–610.
51. Kline P. *The New Psychometrics: Science, Psychology and Measurement*. Routledge: New Delhi, India, 2014.
52. Arrindell WA, van der Ende J. Cross-sample invariance of the structure of self-reported distress and difficulty in assertiveness. Experiences with the scale for interpersonal behaviour. *Adv Behav Res Ther*. 1985;7(4):205–243.
53. Costello AB, Osborne JW. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. *Pract Assess Res Eval*. 2005; 10: 7.
54. Zinn W, Mentzer JT, Croxton KL. Customer-based measures of inventory availability. *J Bus Logist*. 2002; 23(2):19–43.
55. Huo B, Flynn BB, Zhao X. Supply chain power configurations and their relationship with performance. *J Supply Chain Manag*. 2017;53(2):88–111.
56. Kalsaas BT, Sacks R. Conceptualization of interdependency and coordination. In: *19th Annual Conference of the International Group for Lean Construction*; 2011:1–11; Lima, Peru.
57. Kattan WM, Abduljawad AA. Predicting different factors that affect hospital utilization and outcomes among diabetic patients admitted with hypoglycemia using structural equation modeling. *Diabetes Res Clin Pract*. 2019;153:55–65.
58. Ajayi SO, Oyedele LO. Waste-efficient materials procurement for construction projects: a structural equation modelling of critical success factors. *Waste Manag*. 2018;75:60–69.
59. Hair JF, Black WC, Babin BJ, Anderson RE. Multivariate data analysis. *Vectors*. 7th edn, Pearson Prentice Hall: New Jersey, 2010.
60. Owoseni A, Twinomurinzi H. Mobile apps usage and dynamic capabilities: a structural equation model of SMEs in Lagos, Nigeria. *Telemat Informat*. 2018;35(7): 2067–2081.
61. Lee HN, Kim JH. A structural equation model on Korean adolescents' excessive use of smartphones. *Asian Nurs Res (Korean Soc Nurs Sci)*. 2018;12(2):91–98.
62. Sischka P. Testing measurement Invariance in a CFA framework—state of the art evaluating sensitivity of parameters of interest to measurement invariance in latent variable models. *J Personal Soc Psychol Struct Equ Model J Appl Psychol Polit Anal Organ Res Methods Br J Math Stat Psychol*. 2017;95(66):1005–1018. https://orbilu.uni.lu/bitstream/10993/31370/1/Sischka-MI-Poster%282017-04-03%29.pdf
63. Shi S, Chong H-Y, Liu L, Ye X. Examining the interrelationship among critical success factors of public private partnership infrastructure projects. *Sustainability*. 2016;8(12):1313.
64. Dubois A, Hulthén K, Pedersen AC. Supply chains and interdependence: a theoretical analysis. *J Purch Supply Manag*. 2004;10(1 SPEC ISS):3–9.