Macro environment determinants affecting the availability of artemisinin-based combination therapies in Uganda

Pross Oluka Nagitta

*Department of Economics and Managerial Sciences,
Uganda Management Institute, Kampala, Uganda, and*

Marcia Mkansi

*Department of Operations Management, University of South Africa,
Pretoria, South Africa*

Abstract

Purpose – Artemisinin-based combination therapies (ACTs) have been developed to treat uncomplicated malaria. However, scanty studies exist to inform the role of macro factors in explaining the nonavailability of ACT in developing countries. Therefore, this paper aims to evaluate the different macro-environment factors affecting the availability of ACTs in the public hospital setting.

Design/methodology/approach – This study applied a quantitative methodological approach and structural equation modeling (SEM) to test hypotheses statistically. SEM examines linear causal relationships among variables while accounting for measurement error. Confirmatory factor analysis (CFA) was used to assess model reliability. CFA and SEM were used to determine the shared variance-covariance of variables, define the latent construct and provide a more precise way to account for the error variances associated with the variables, which, if untested, could lead to biased parameter estimates. This was guided by the data collected from 40 general public hospitals with 283 respondents.

Findings – This study's results support a model for promoting social-cultural, technological and legal factors. The availability of ACTs is significantly affected by legal factors. Improving legal aspects by a unit can enhance ACT availability by 0.59. Political factors scored the least, and they do not influence the availability of malaria drugs.

Research limitations/implications – The design was quantitative and cross-sectional. Future research could be longitudinal with a mixed-method approach and consider other external stakeholders.

Practical implications – Reducing the impact of the nonavailability of antimalarial drugs in general public hospitals requires a holistic concerted and coordinated supply chain approach that tackles the political, economic, social-cultural norms, technological and legal factors.

Originality/value – The authors develop and test a model using macro factors: political, economic, social, cultural, technological and legal factors. This model is relevant for many developing countries to supply chain coordination perpetually experiencing medicine shortages.

Keywords Pharmaceutical supply chain, Political factors, Economic, Social-cultural, Legal, Technology, Developing countries

Paper type Research paper

1. Introduction

In 2019, 229 million clinical malaria cases were reported worldwide, with an estimated death of almost half a million people – of these, 67% were children aged below five years. Sub-Saharan Africa accounts for the largest number of malaria cases – 94% in 2019. Malaria control and elimination were estimated to be \$3bn by 2019 (WHO, 2020). The situation is not any different in Uganda, which has the third highest global burden of malaria cases (5%) and the eight highest level of deaths (3%). It also has the highest proportion of malaria cases in East and Southern Africa, 23.7% (WHO, 2020; Yeka et al., 2012). Premised on this critical incident, Uganda has made great strides to make artemisinin-based combination therapies (ACTs, antimalarial) available in all public hospitals and health facilities. However, the country still faces inconceivable shortfalls in health-care delivery to its population. One of the critical components of universal health coverage is making medicines available, accessible and affordable. Without free medication, the patients are left with no option but to either purchase the medicines from private pharmacies, which in most cases is expensive (Prinja et al., 2015), or use traditional medicine to bridge the gap (Grundmann, 2011). Previously, the problem was partly attributed to the conventional placement of the medicine supply structure under the Ministry of Health (MoH). To address the issue, Uganda institutionalized drug procurement models (Push and pull) under the National Medical Stores in 1993 to provide constant supply and distribution of medicines in all public health facilities at no cost.

In recent years, ACTs have been widely adopted as the first-line therapy for uncomplicated *Plasmodium falciparum* in most malaria-endemic countries (Yeka et al., 2012). When adopted as the first-line treatment for malaria, ACTs are either free of charge or at a highly subsidized price. In Uganda, public hospitals are vital in treating malaria-affected patients (Nagitta et al., 2021). Nonetheless, some public health facilities in Sub-Saharan Africa run out of stock of malaria medicines, while in others, the medicines expire, leaving the majority of the impoverished populace desperate for treatment (Rassi et al., 2016; Sugiharto, 2010; Ushie et al., 2016). Achieving a malaria-free environment may be farfetched, especially in Sub-Sahara Africa, because of the multiplicity of stakeholders from the macro-management environment (Khuluza and Heide, 2017; Mwathi and Ben, 2014), unless both the internal and external chain partners are coordinated (Nagitta and Mkansi, 2019). Hospitals ought to manage the supply and distribution interdependency of medicines with local, regional and international partners on harmonization and standards development to harness the mutual benefits and learning from the partnership. Despite several studies that have explored the unavailability of medicines in Sub-Saharan Africa (Jahre et al., 2012; Leung et al., 2016; Yeka et al., 2012), the studies did not holistically focus on the macro-environment factors that inhibit the availability of antimalarials in public health facilities. Some authors have tended to study each factor independently of the other (Paton, 2010; Rural Health Information Hub, 2017). The one-dimensional discourse restricts the coordination of the medicines supply chain. Therefore, this paper examines how the macro-management factors, political, economic, social-cultural, technology and legal factors, enhance the availability of ACTs in hospitals.

2. Theoretical framework, literature review and hypotheses development

The external or macro environment is essential in guiding the hospitals' activities to the needs of society. This paper adopts the PESTLE framework to study the macro-environment dimensions of the external environment affecting the different sectors. The PESTLE variables are political, economic, social, technological and legal environmental (Mir and Mir, 2019). However, this paper does not study each element in isolation because some are more heavily

dependent than others. For example, the economic environment cannot be separated from the social or political environment. As macro elements do not evolve simultaneously in the same direction and with the same intensity, the effects may be outstanding. This section discusses a review of the literature on political, economic, social-cultural, technological and legal factors and the availability of medicines. Hypotheses are developed and later tested.

2.1 Social-cultural factors and availability of medicine

In every organization, social-cultural factors must be evaluated from time to time so that management can learn from its past, adjust its needs to the present and predict the future (Buller and McEvoy, 2012). Socially, medical personnel are critical resources for offering patients diagnostic and treatment services. According to Szulanski, (1996), hospitals operate on some known routines embedded partly in individual skills and partly in collective social-cultural engagements. However, for hospitals to be trusted and used, the citizens must have confidence in the health facilities' ability to provide medicines to the patients. Otherwise, the absence of antimalarials may repulse the sick from pursuing treatment from qualified health providers. Culturally, poor people are more likely to resort to either herbal or self-medication (Awuah et al., 2018). This may affect the throughput of health workers, despite the government's efforts to boost the availability of malaria medicines. Cohen et al. (2015) assert that culturally, some potential patients presume that any fever is malaria. The implication is that they end up treating symptoms without prior confirmation through a blood test. Other patients have a culture of self-medication without any prescription (Suswardany et al., 2017) or use traditional herbs. For others, it is normal to demand the pills from health personnel even when they are not sick (Cohen et al., 2015). The problem of irrational use of medicines leads to either resource wastage or becomes harmful to patients. The resultant effect is the increasing incidence of malaria and drug resistance (Ukpe et al., 2013).

When people often speak of their community's legal and political system, they do not mean that static bundle of traits traditionally used to classify legal systems. Instead, they are speaking of concrete activities going on about them. They think of lawyers and politicians at work, legislators passing laws, administrative agencies making rules and settling disputes. One way to look at the political and legal system is as a process – what legal institutions do and how they do it. The output of the legal and political system are rules, doctrines, statutes and decrees influenced by the community's culture. The social-culture values and attitudes bind the system together, which determines the place of the political and legal system in the culture of the society as a whole. What kind of training and habits do the lawyers and politicians have? What do people think of the law? For what purposes do people turn to lawyers; for what purposes do they use other officials and intermediaries? Is there respect for the law, government or tradition? What informal social controls exist in addition to or in place of formal ones? Who prefers which kind of controls, and why? With the change in social-cultural attitude toward rapid testing and diagnosis, following treatment policies and guidelines, antimalarial availability will be sustained. We thus hypothesize as follows:

H1a. Social-cultural factors influence political and legal factors in relation to antimalarials availability.

2.2 Technological factors and availability of medicine

Technology is key in transforming and integrating health-care chains and creating the necessary visibility of antimalarial stock levels, not only at the hospital but communicating

with external stakeholders (Barrington *et al.*, 2010). This requires instituting a change in structure, strategy and control. However, the lack of appropriate technology makes it difficult to plan, measure and evaluate the inventory demand levels, and delivery schedules for antimalarials (Hossain *et al.*, 2019). The increasing complexity of diagnosing and treating patients makes clinical decision-making more difficult without technology (Bhavnani *et al.*, 2016; Joshi *et al.*, 2019). For this reason, hospitals need to promote the advancement of cheaper health care. According to (Lenin, 2014), short messaging service (SMS) technology should be enforced when sending patients reminders on their treatment schedules via their smartphones. The SMS can also be helpful when sharing information between the different supply chain stakeholders such as; delivery truck drivers, national medical sores (NMS), outsourced firms and other government officials (the district medical officer [DMO] and the district pharmacist). This may assist the hospitals in knowing the specific hospitals are at risk of stock-out of antimalarials. Albabtain *et al.* (2014) contend that one application that could be used is the m-Health application, which provides real-time information for diagnostic treatment and enables the collection of data and monitors medical services and other health-care services. Henceforth facilitating the allocation of the right resources for the right individuals.

> *H2.* Technology enhancement improves the availability of antimalarials through economic factors.

2.3 Political factors and availability of medicine

Very few scholars have studied the relationship between politics and medicine. Yet, the availability of drugs is shaped by politics (Lister, 1970). Politicians are critical stakeholders in ensuring that hospitals are stocked with drugs for optimal patient benefit by appropriating the budgets and enacting legal laws (Watkins, 2008). The dominance of politicians in all sectors of the economy is experienced in distributing scarce resources, including the health sector. Therefore, the amount of money appropriated to the health sector will either enhance or inhibit the availability of medicines in hospitals (Do Amaral and Blatt, 2011). In the same vein, the enactment of rules and standards put in place by politicians should be interpretable by the judicial arm of government. Politicians have a vested interest in determining health budgets. They balance the conflicting objectives and selfish motives of different stakeholders in the supply chain. Otherwise, it may cause bullwhip effects in supply and demand (Masters *et al.*, 2014). Previously, Baez-Camargo (2012) asserted that formal institutional mandates, informal political power and the usage of patronage networks across countries should not be overlooked because they curtail wastage in the drug supply chain; thus:

> *H3a.* Political factors improve the availability of antimalarials.

> *H3b.* Political and legal factors improve the availability of antimalarials.

2.4 Legal factors, social-cultural factors and availability of medicines

Iqbal *et al.* (2016) argues that policies must be efficient to help dispensers rationally use medicines at all levels of the hospitals. These must document the procedures regarding medicine administration without constraining the inflow of medicines and scarce resources. For any country, hospitals' robust medicines management policies should specify how to select, forecast, quantify, procure, store, distribute and dispense. This

improves the availability of medicines of the right quality standards, and right quantities, at reasonable prices, without any stock-out periods in between. However, with the National medicine policies in place, one of the main pillars of the global health agenda, the implementation of the procedure may be achieved (Atif *et al.*, 2019). Operationally, medicines management requires a concerted effort involving all stakeholders with a strategy for an uninterrupted therapeutic supply chain. Unfortunately, in many developing countries, medicines supply chains face challenges of undocumented policy frameworks (Portela *et al.*, 2010). The absence of clear standard procedures and policies regarding medicines usage stifles the flow of medicines to patients (World Health Organization, 2015). The more the rules are adhered to, the better the availability of antimalarials (Mohanta and Manna, 2015). However, a cultural change among the medical staff and knowledge of dispensing should be considered to reduce medicine wastage (Hamid *et al.*, 2019). Legal institutions are responsive to social change. Social factors have a definite role, rather poorly understood, as instruments that set off, monitor or otherwise promote the fact or pace of legal change. Thus, legal factors are influenced by social factors. From the discussion, we derive the following hypothesis:

H4. Legal policies improve the availability of antimalarials.

H1b. Social-cultural factors affect legal factors that enhance the availability of antimalarials.

2.5 Economic factors and availability of medicine

Among national medicine policies and therapeutic management aims is making medicines affordable in private and public hospitals. However, this goal may only be achievable by building beneficial partnerships, the right incentives and mutual understanding (Health, 2012). In most developing countries, most of the population is poor; therefore, medicines can be costly and henceforth pose a considerable burden for underprivileged persons (Konde-Lule *et al.*, 2010). In most African countries, the health budget has stagnated below 15%, contrary to the 2001 Abuja Declaration, making it impossible to bridge the funding gap in the health sectors (Ongwae, 2019; Wambugu *et al.*, 2015). Since 2001, the health sector budget performance in Sub-Saharan Africa has remained wanting (Taylor *et al.*, 2017). Without donor funding to complement the government's efforts to address antimalarials, the medical burden would be huge on the poor populace. We thus derive the fifth hypothesis:

H5. Economic factors improve the availability of antimalarials.

3. Study design and methodology

The study adopted a cross-sectional design and quantitative approach to examine the association between macro-environment variables and the availability of antimalarials in developing economies. This was derived by using data from 40 general public hospitals. The participants were selected using a simple random sampling technique, which was done using the lottery method of sampling. After getting a list of staff per public hospital, the lead researcher wrote the numbers for all the staff on a single paper to create a sample. The numbers were put in a small box and mixed. Then, the researchers randomly picked the numbers corresponding to the list. To examine the relationship among the

study variables, the pragmatism approach was used. This is because of its practical and real strategy for resolving challenges. Pragmatism allowed quantitative approaches to scale the strength of variables/parameters that might impact the ACT availability in the medical sector. The fundamental question for this problem is how macro-environment variables can enhance the availability of antimalarials in developing economies, the case for Uganda.

Ethics approval and consent to participate 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.

3.1 Pilot study and data collection
The empirical base of the study consisted of questionnaires for eliciting information from public hospital staff. This is because government staffs were involved in the supply chain activities such as; forecasting and quantification, ordering, storage and rational use. These were able to provide information that is fundamental to the aspects of macro factors and the availability of ACTs. Upon establishing the research variables, a research questionnaire was designed to test the hypotheses of the study as formulated in Section 2. 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 legal experts and three medical managers from the medical sector. After piloting, the research tool was corrected for mistakes, clarity, language and coherent flow of the proposed model. Data on the constructs were collected via a Web-based and in-person questionnaire.

3.2 Data and reliability analysis
Data were cleaned to check whether responses were entered correctly, check for missing values and outliers and decide how to deal with them. This was followed by parametric assumptions or diagnostic tests of normality, linearity and homogeneity of variance to explore the data and determine its distribution. Overall, 304 questionnaires were completed and returned out of 320 (95% response rate). 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. Seven responses were eliminated due to disengaged responses, as each variable registered the same answer. Outliers can significantly impact the correlation and regression among variables; based on the Mahalanobis analysis of outliers, three research responses 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 used to estimate the internal consistency (IC) and how closely the measuring variables contributed 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 (Ajayi and Oyedele, 2018; Nagitta *et al.*, 2021). To improve CA, items with a CA greater than the overall CA were deleted to improve the IC. Using this approach, some items were deleted; for example, one item under the availability category was deleted – the CA for the group increased from 0.904 to 0.911. The overall CA for the tested variables in this study was 0.858, with no individual group eliciting $CA < 0.800$, as elicited in Table 1. Thus, the proposed hypothetical model elicits good IC and reliability.

4. Results

4.1 Demographics
The respondents comprised 52.3% females and 47.7% males. The qualifications of the respondents were as follows: 3.2% hold secondary school certificates; 24.0% are diploma holders; 50.2% have bachelor's degrees; 18.4% have master's degrees; and 4.2% have PhD as the highest qualification. A total of 7.1% of the respondents had more than 10 years' of experience, while only nine respondents had less than one year in the medical industry. These are summarized in Table 2.

4.2 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. For a proposed model to

Group	CA[a]	No. of items
Political factors	0.850	8
Economic factors	0.898	3
Social culture	0.914	3[b]
Technology factors	0.815	4[c]
Legal factors	0.919	3[c]
Availability	0.911	6[c]

Notes: [a]Overall CA = 0.858; [b]two items were deleted; [c]one element was deleted

Table 1.
Reliability test based
on 283 respondents
and listwise deletion

Variable	Category	*N*	(%)
Gender	Male	135	47.7
	Female	148	52.3
Age	20-29	67	23.7
	30-39	102	36.0
	40–49	76	26.9
	50+	38	13.4
Education	Certificate	9	3.2
	Diploma	68	24.0
	Degree	142	50.2
	Master	52	18.4
	PhD	12	4.2
Supply chain training	Yes	83	29.3
	No	196	69.3
Position	Senior manager	32	11.3
	Middle manager	60	21.2
	Supervisor	51	18.0
	Officer	140	49.5
Experience	<1	9	3.2
	1–3	105	37.1
	4–6	116	41.0
	7–9	33	11.7
	10+	20	7.1

Table 2.
Demographical
nature of the
respondents

pass CFA and validity analysis, the average variance explained (AVE) and composite reliability (CR) should be ≥ 0.50 and 0.70, respectively (Nagitta *et al.*, 2021). The maximum shared variance (MSV) < average shared variance (ASV) and the square root of AVE should be higher than inter-construct correlations (Hair *et al.*, 2010). The initial values of the hypothetical model are summarized in Table 3. The results in the table elicit abysmal levels of the initial proposed model. To improve the model outputs, suggestions based on AMOS yield were followed. Besides, items with residual co-variance > |2.0| were eliminated (Owoseni and Twinomurinzi, 2018). Based on these recommendations, items like SC02, SC03 and TF05 were eliminated from the model. The removal of such items suggests the heterogeneous nature of ACT availability. Removing such items plummets measurement error, which revved reliability among the retained items, thus ameliorating model validity. Table 3 elicits the validity and factor correlation matrix before (as shown in Figure 1) and after modification. Figure 2 shows the CFA measurement after adjustment.
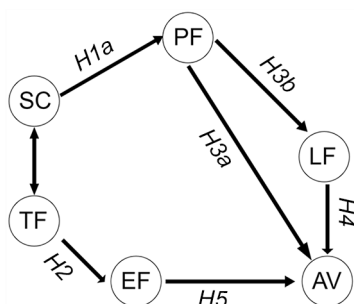
4.3 Structural equation model

Structural equation model (SEM) is a set of statistical techniques used to measure and analyze the relationships between observed and latent variables. SEM was used because it examines linear causal relationships among variables while simultaneously accounting for measurement error. SEM analysis was conducted using AMOS software version 24. Maximum likelihood (ML) was used in the model evaluation because there was no univariate normality, and the data were normally distributed (Ajayi and Oyedele, 2018; Hair *et al.*, 2010; Lee and Kim, 2018; Nagitta *et al.*, 2021). The goodness of fit indices (GOFIs) were tested using the different parameters, as outlined in Table 4 (Sischka, 2017). Some GOFIs failed to pass the minimum requirement. To improve the model fit, co-variances and causal relationships were established among the model variables and error terms. AMOS modification indices were used as a baseline to build the interrelationships among the measured parameters (Masiko *et al.*, 2022; Shi *et al.*, 2016). Further modifications to the model established co-variance relations, as illustrated in Figure 2. For example, the covariance between "timely delivery (A01)" and "donor funds (EF02)" makes sense in the way that the availability of funds ensures the purchase of

Proposed	CR	AVE	MSV	LF	SC	TF	EF	AV	PF
LF	0.923	0.802	0.358	*0.895*					
SC	0.916	0.785	0.212	0.407	*0.886*				
TF	0.816	0.526	0.162	0.256	0.314	*0.725*			
EF	0.870	0.695	0.212	0.300	0.460	0.402	*0.833*		
AV	0.912	0.600	0.358	0.598	0.403	0.196	0.293	*0.775*	
PF	0.861	*0.444*	0.009	−0.020	0.097	−0.063	0.024	0.044	*0.666*
Adjusted	*CR*	*AVE*	*MSV*	*LF*	*SC*	*TF*	*EF*	*AV*	*PF*
LF	0.923	0.802	0.358	*0.896*					
SC	0.916	0.785	0.212	0.407	*0.886*				
TF	0.816	0.526	0.162	0.256	0.314	*0.725*			
EF	0.870	0.695	0.212	0.300	0.460	0.402	*0.833*		
AV	0.912	0.600	0.358	0.598	0.403	0.197	0.293	*0.775*	
PF	0.857	0.505	0.009	−0.026	0.095	−0.065	0.023	0.045	*0.710*

Notes: AVE: average variance explained, CR: composite reliability, MSV: maximum shared variance, ASV: average shared variance, LF: legal factors; SC: social-culture factors, TF: technology factors; EF: economic factors; PF: political factors; AV: availability factors. Common method bias based on the percentage of variance = 64.7%. It was conducted by running ML with Promax rotation

Table 3.
Validity and factor correlation matrix with the square root of AVE on the diagonal

Notes: LF: legal factors; SC: social–
culture factors; TF: technology
factors; EF: economic factors; PF:
political factors; AV: availability
factors

Figure 1.
Theoretical
framework that
governs antimalaria
availability

Antimalarials on time–thus, timely delivery. Table 4 summarizes the GOFIs of the final model
after several refinements; all the minimum requirements were satisfied. For instance, GFI =
0.909; thus, the model outcomes are well explained by the collected data; RMSEA = 0.037,
eliciting high confidence levels among variables.

Table 5 elicits the standard regression coefficient of each retained item in the model. All
the path coefficients are positive and significant at $\rho < 0.05$. Three hypotheses, *H1b*, *H2* and
H4, are supported based on the data collected from the survey; however, *H1a*, *H3a*, *H3b* and
H5 are not supported. The multiplication of the effects determined the indirect effects. For
example, the mediation effect of social culture through legal impact was determined by
multiplying both SC (LF) effects (0.423*0.592 = 0.250). The *p* of this effect was determined
by running bootstrapping at 2,000 and a bias-corrected confidence interval of 90. The results
elicited an indirect effect of social culture through legal factors. These results suggest that
strengthening social behavior through legal mechanisms enhances antimalarial availability.

5. Discussion and conclusions
Results from the macro-environment show that socio-cultural dimensions and economic,
technological and legal dimensions influence the availability of ACTs, as illustrated in Table 5.
Although it scored least and the hypothesis was not supported, political factors should be noted
that the availability of medicines is shaped by politics (Lister, 1970). Politicians cannot be
bypassed because they determine the resource envelop and are crucial in legislating the laws of
the country on medicine usage and ensuring that hospitals are stocked with medicines for
optimal patient benefit (Watkins, 2008). Therefore, the amount of money appropriated to the
health sector will either enhance or inhibit the availability of medicines in hospitals (Do Amaral
and Blatt, 2011). From the results, the hypothesis between economic factors and the availability
of antimalarials was not supported. The reason could be that the health sector is underfunded.
Therefore, without supplementing the health sector budget from development partners,
supplying ACTs in developing countries will be farfetched and a problem for the poor populace
(Vledder *et al.*, 2015). Making medicines available requires political participation and actions
despite the fact that it scored low.

The socio-cultural factors were found to affect ACTs availability significantly. The same
was found with the link between social-cultural and legal policies. On a positive note, this is
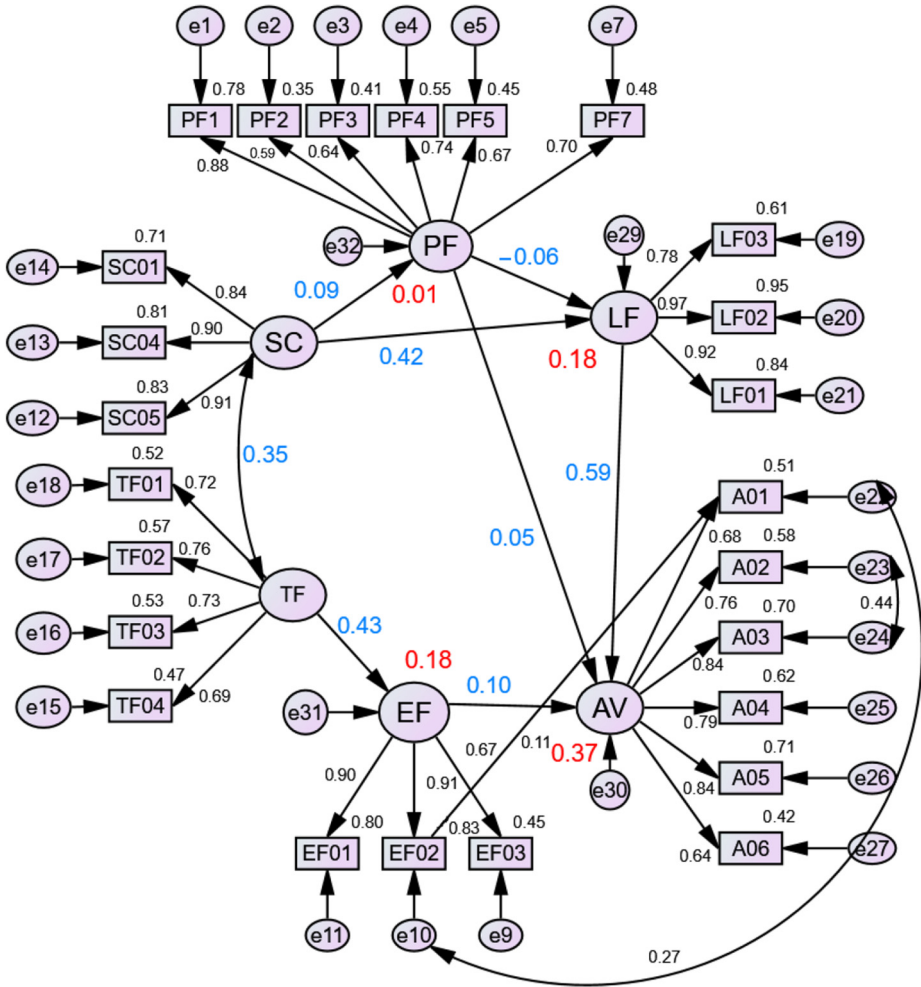
Figure 2.
CFA covariances

Notes: LF: legal factors; SC: social-culture factors; TF: technology factors; EF: economic factors; PF: political factors; AV: availability factors. All observed variables are defined in Appendix A

linked to attitude change among the hospital staff toward prior testing and diagnosis, following treatment policies and guidelines. This implies that only sick people are issued with medicines, thus leading to a sustainable supply of medicines and reduced wastage (Mohamadloo *et al.*, 2017). The impact of cliques on the availability of ACTs scored highly (SC01 = 0.84). In Uganda, there is a culture of seeking medical attention after having severe bouts of malaria – this is rooted in the culture of using herbal medicines. At least 60% of Ugandans depend on herbal medicines – for every 400 people, there is a herbalist (Kamatenesi-Mugisha and Oryem-Origa, 2005); comparing this to Western countries

Goodness-of-fit measure	Acceptable threshold	Hypothetical model	Revised model
RMSEA	<0.08	0.044	0.037
GFI	>0.90	0.895	0.909
AGFI	>0.90	0.871	0.889
CFI	>0.90	0.964	0.975
NFI	>0.90	0.905	0.917
TLI	>0.90	0.959	0.971
PCFI	>0.50	0.851	0.858
PNFI	>0.50	0.799	0.807

Notes: 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

Table 4.
Results of GOFI
measures

(1:20,000), the odds favor traditional medicine usage. The flooding of Asian drugs on the market further escalates this situation. In addition, regardless of their availability, herbs are too cheap compared to ACTs. Therefore, as people continue to associate themselves with such norms and clicks that do not encourage malaria treatments from recognized hospitals, the situation will worsen – even if the stores are full of ACTs.

The hypothesized relationship between social-cultural factors and economic dimensions was also supported. The finding may be supported culturally, where poor people cannot afford medicines. The resultant negative effect is resorting to either herbal medicine or self-medication. Although these dimensions are beyond the jurisdiction of the hospital administration, they may validate why non-health-care guidelines and procedures are vital to be factored into perspective in the health supply chain. Therefore, the social and cultural grouping to which one belongs impacts the decision of whether to use ACTs or not.

Under technology, the hypothesis was also not supported. This may be explained by the fact that the hospitals use manual systems, making it difficult to visibility stock levels and real-time consumption rates. Moreover, with manual systems, synchronization and coordination in diagnosing and treating patients make the clinical decision-making process more difficult without technology. However, the relationship between technology and legal factors was accepted. This implies that the technology adopted must adhere to the hospitals' and national frameworks, specifying how to share the information between the different supply chain stakeholders such as; delivery truck drivers, NMS, outsourced firms and other government officials (DMO and the district pharmacist). In turn, it may assist the hospitals in knowing the specific hospitals are at risk of stock-out of antimalarials. The information technology tools could also be affordable and sustainable.

Under technology, the use of M-tracking systems (TF03), mobile phones (TF01) and toll-free lines (TF02) were ranked 0.73, 0.72 and 0.76, respectively. With the help of mobile phones, free lines and M-tracking, the central distribution office can quickly know the areas with fewer stocks, in addition to the stock rate consumption – hence, planning for the stock-out in advance. Moreover, M-tracking does help not only the planners but also the consumers. Before traveling there, users can quickly know which malaria therapies are available at the health center. The rapid development of M-tracking in Uganda supports this theory of adopting mobile ICT or multimedia technologies integrated with wireless health-care delivery systems, referred to as m-Health. The tool enables the dissemination of information to consumers and providers of these health services using mobile ICT applications, such as SMS when sending health reminders on their cell phones. Technological transformation within the health sector should integrate health-care chains

Path			Estimate	ρ	Path			Estimate	ρ
PF1	PF	<---	0.882	***	TF02	TF	<---	0.755	***
PF2	PF	<---	0.59	***	TF01	TF	<---	0.721	***
PF3	PF	<---	0.644	***	LF03	LF	<---	0.783	***
PF4	PF	<---	0.741	***	LF02	LF	<---	0.974	***
PF5	PF	<---	0.674	***	LF01	LF	<---	0.918	***
PF7	PF	<---	0.695	***	A01	AV	<---	0.684	***
EF03	EF	<---	0.673	***	A02	AV	<---	0.759	***
EF01	EF	<---	0.895	***	A03	AV	<---	0.838	***
SC05	SC	<---	0.913	***	A04	AV	<---	0.787	***
SC04	SC	<---	0.901	***	A05	AV	<---	0.844	***
SC01	SC	<---	0.843	***	A06	AV	<---	0.644	***
TF04	TF	<---	0.689	***	A01	EF02	<---	0.107	0.047
TF03	TF	<---	0.725	***	EF02	EF	<---	0.908	***

Hypotheses	Path	Effect	ρ	Results
H1a	SC → Political	0.092	0.162	Not supported
H1b	SC → Legal	0.423	***	Supported
H2	TF → Economic	0.428	***	Supported
H3a	PF → Legal	−0.065	0.277	Not supported
H3b	PF → Availability	0.054	0.332	Not supported
H4	LF → Availability	0.592	***	Supported
H5	EF → Availability	0.095	0.086	Not supported
Indirect effect	SC → LF → Availability	0.250	0.041	Supported
	SC → PF → Availability	0.005	0.251	Not supported
	TF → EF → Availability	0.040	0.035	Supported
	SC → PF → LF → Availability	0.004	0.202	Not supported

Note: ***Significant at $\rho < 0.00$

Table 5.
Standardized
regression weights
and hypothesis test

due to the complex social change process. This may necessitate a shift in strategy, structure and control dimensions.

Finally, the legal dimension's impact on ACTs' availability was significant; legal had the highest regression weight toward the availability of ACTs at 0.52. Therefore, the more rules are adhered to, the better the availability of antimalarials. Henceforth, hospitals must follow proper clinical guidelines detailing ordering, storage and dispensing. When properly regulated, the sector can contribute to the improved availability of essential medicines, including ACTs. However, with the national medicine policies in place, one of the main pillars of the global health agenda, the implementation of the procedure may be achieved (Atif *et al.*, 2019). This implies that policy frameworks must be adhered to for the uninterrupted flow of the medicine supply chain.

6. Conclusions, managerial implications, limitations and future research

This paper contributes to the medicine supply chain by examining the major macro determinants influencing antimalarial availability in public hospitals in developing countries. Reducing the impact of the nonavailability of antimalarial drugs in general public hospitals requires a holistic concerted, coordinated supply chain approach that tackles the political, economic, social-cultural norms, technological and legal factors. This implies that government and all stakeholders should complement each other, work hand in hand and prioritize funding of medicines over other business decisions. Drug therapeutic management committees (DTMCs) should work hand in hand with the politicians despite being scored least. There is an urgent need to change community attitudes toward the rational use of medicines so that medicine is prescribed only to those who are sick to reduce out-of-stocks. The use of affordable and easy-to-use technology is a must to allow visibility and a seamless flow of information for early action at the upstream and downstream supply chains. Because medicine shortage is a menace shared by health-care providers in most countries around the world, the findings may help direct future policy-making around the world.

The limitations of this study are mainly twofold; the design was purely quantitative in nature, and future research could use a mixed method approach and consider other external stakeholders like donors, district health officers, political leaders and MoH officials, among others. The sample was composed of only DTMCs from the general public hospitals leaving out other public hospitals. Our findings cannot, therefore, be generalized to other national or regional referral hospitals across the entire country. Practices are gained over time, so to examine the true nature of macro factors and factors affecting the availability of medicines, a longitudinal study is necessary. We recommend that a longitudinal study be undertaken in the future.

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Appendix

Political factors	
PF1	Politicization
PF2	Political publicity
PF3	Politicians' interference
PF4	Political support
PF5	Political talk shows
PF7	Political advocacy
Economic factors	
EF01	Poverty
EF02	Donor funds
EF03	Cost-sharing
Technological factors	
TF01	Mobile phones
TF02	Toll-free lines
TF03	M-track system
TF04	Rapid diagnostic tools
Legal factors	
LF 01	Policies
LF02	Clinical guidelines
LF03	Consumption regulation
Social-cultural factors	
SC01	Community cliques
SCO4	Patients' attitudes
SCO5	Population demographic
Availability factors	
A01	Timely delivery
A02	Flexible ordering
A03	Right quantities
A04	Right quality standards
A05	Orders met by the supplier
A06	Improved stock levels

Table A1.
Research tool

About the authors
Pross Oluka Nagitta is a Lecturer at Uganda Management Institute at the Department of Economics
and Managerial Sciences, School of Management Science. She holds a PhD in Management Studies
from the University of South Africa (Supply chain). She holds a Master of Business Administration
from Maastricht School of Management, the Netherlands, and a professional qualification in
Purchasing (NEVI A-CIPS Accreditation). She is also a Member of the Educational Programmes
Committee, the African Institute for Supply Chain Research (University of South Africa) and the
Institute of Public Procurement Professionals of Uganda. Oluka is an award winner of two grants
from Human Sciences Research Council (HSRC) and Facebook, and South Africa's African
Observatory on Responsible Artificial Intelligence. She is an Innovator of an app entitled "A mobile
application supply chain coordination software for artemisinin-based combination therapies drugs
(ACTs)." She won the first prize sponsored by the Gauteng Accelerator Program (GAP) and Emory
University and hosted by the Innovation Hub, a Gauteng Growth and Development Agency. Pross
Oluka Nagitta is the corresponding author and can be contacted at: nagittaoluka@gmail.com

Marcia Mkansi is a Professor of Operations Management at the College of Economic and Management Sciences, University of South Africa. She holds a PhD in Supply-Chain Management and e-Business from the University of Bolton. Marcia has produced five intellectual property artefacts that have won numerous awards for her research activities on supply chain innovation. Marica has published in peer-reviewed journals such as the *International Journal of Physical Distribution & Logistics Management*, *Research in Transportation Economics* and *Electronic Commerce Research*.