Proceedings of the Annual General Donald R. Keith Memorial Conference
West Point, New York, USA
April 29, 2021
A Regional Conference of the Society for Industrial and Systems Engineering

AFRICOM Illicit Drug Trade in South and East Africa

Jeremy Spencer[1], Jessica Rawls[2], Tommy Upton[1], Ike Nawa[1], and Dereck Kennedy[1]

[1]United States Military Academy
Department of Systems Engineering
West Point, NY

[2]United States Military Academy
Department of Mathematical Sciences
West Point, NY

Corresponding author's Email: thomas.upton@westpoint.edu

Author Note: This study is the result of a year-long capstone design project in support of the United States Africa Command (AFRICOM) J59, Counter-Narcotics and Transnational Threats Program Division. The team is grateful to J59 team for its assistance in the development and refinement of the products created during the project.

Abstract: South and East Africa has become an increasingly popular transshipment route for transporting heroin to major demand locations in Europe, Asia, and North America. As the drugs move through South and East Africa, they leak into the domestic population affecting social and economic dynamics. The presence and activities associated with the illicit heroin trade and its actors are capable of destabilizing regions and impeding the accomplishment of U.S. foreign objectives. This capstone employed the Systems Decision Process to capture a new perspective on the issue. Using this methodology, the capstone first identified the major actors and influencers within the heroin trade before generating value functions that would degrade the impact of the trade. Models were then built using the measurable variables comprising the value functions to ultimately inform AFRICOM on the impact of the illicit heroin trade in their area of operations.

Keywords: Illicit Heroin Trade, The Southern Route, AFRICOM

1. Introduction

Africa's history of poor living conditions and social and economic factors have left the continent and many of its nations vulnerable to illicit activities by malicious regional actors. Moreover, in the last 15 years, South and East Africa has increasingly become a primary transshipment route for transporting drugs to major demand locations in Europe, Asia, and North America. These drugs are being trafficked through South and East African along the "Southern Route" where the supply leaks into domestic populations creating drug users and traffickers (Haysom, 2018). According to the United Nations Office on Drugs and Crime (UNODC), drug seizures from 1988 to date have increased in the trafficking of heroin to eastern Africa from the middle east. Furthermore, UNODC's seizure and arrest statistics show that a larger percentage of the domestic population is becoming involved in the trafficking of drugs (UNODC, 2021) indicating the solidification and growing support for illicit trade networks. Current work on this issue frequently alludes to direct and indirect destabilizing effects caused by the presence and activities of the illicit drug trade and its actors in the region. These destabilizing effects increasingly impede the accomplishment of US and partner nation objectives. However, the relationship between unstable domestic states and the illicit heroin trade is still vague and has much to be explored. Current research also indicates south and eastern Africa is home to various Violent Extremist Organizations (VEOs), and suggests the possibility that these organizations, in the AFRICOM area of operations (AOR), may profit from the illicit drug trade, further adding to the importance of understanding the complexity of the AOR. The Department of Defense (DoD), including AFRICOM, is not primarily responsible for counternarcotic operations; however, DoD objectives and resources necessitated their support as a primary integrator and enabler of intelligence and law enforcement agencies outside the DOD. The responsible AFRICOM division for these efforts is the J59. AFRICOM continues to refine its understanding of this complex operating environment. It felt the impact of illicit drug activity on US objectives was ill-defined given the inherent complexity of the operating environment, and it could benefit from further exploration and decomposition of the illicit drug trade.

This project seeks to enable AFRICOM's understanding of the illicit drug trade by leveraging the Systems Decision Process (SDP) and several associated models. The SDP is an iterative systems engineering methodology that consists of four phases: problem definition, solution design, decision making, and solution implementation. The predominance of the capstone team's work has focused on the problem definition and solution design phases. The problem definition phase consisted of distinguishing not only what the problem was but also what kind of solution AFRICOM was seeking. The group first generated and refined a problem statement by conducting literature reviews that eventually drove the development of a Findings, Conclusions, and Recommendations Matrix as well as a Systemigram that visually represents the system. The culmination of this phase produced a Qualitative Value Model to aid in the identification of variables to be modeled and assessed in the solution design phase. As the group transitioned to the Solution Design phase, these products were used to build preliminary models that can inform AFRICOM on various perspectives of the illicit heroin trade.

2. Problem Definition

2.1 Problem Statement

The United States Africa Command headquartered in Stuttgart, Germany, is a US Department of Defense (DOD) entity responsible for securing U.S. strategic objectives in Africa. Operationally, AFRICOM's 2020 posture statement defines their strategic approach across three themes: "We partner for success, compete to win, and maintain pressure on malign networks" (2020 Posture Statement to Congress). This project intersects AFRICOM's objectives in the environment where the illicit drug trade, transnational crime organizations, and VEOs exist. The presence and activities associated with the illicit drug trade and its actors directly and indirectly destabilize regions within AFRICOM's AOR allowing VEOs and TCOs to thrive. It is from this intersection that the following problem statement was developed:

How can this Capstone inform AFRICOM policy development and resource prioritization for countering the illicit heroin trade in South and East Africa by identifying, modeling, and analyzing critical actors, dynamics, and environmental factors that yield institutional and social compromise in such a way that expands VEO's and TCO's operational capability to challenge U.S. objectives in the region?

2.2 Qualitative Value Model

The figure below shows a portion of the qualitative value model (QVM) developed as a part of the Problem Definition phase of the Systems Decision Process. The purpose of the QVM is to provide the functions a system should perform, objectives required to accomplish the functions, and value measures to measure the performance of viable solutions. The fundamental objective, derived from the project's problem statement, is the guiding end state this project seeks to accomplish. The fundamental objective of degrading the impact of the illicit drug trade in South and East Africa on US objectives in the AFRICOM AOR is accomplished by functions such as understanding critical actors, dynamics, and environmental factors. The functions and sub-functions in the QVM describe the necessary actions that must be taken to achieve the fundamental objective. Only one branch of the QVM is depicted in Figure 1 to draw attention to sub-functions 3.3 and 3.5. These two sub-functions were identified by the client as the main focuses for AFRICOM when addressing the illicit drug trade in South and East Africa. The objectives in this model represent the values to be modeled used when developing alternatives, and the value measures are the standards used to determine the success of a models' ability to achieve the objectives.

ISBN: 97819384962-0-2

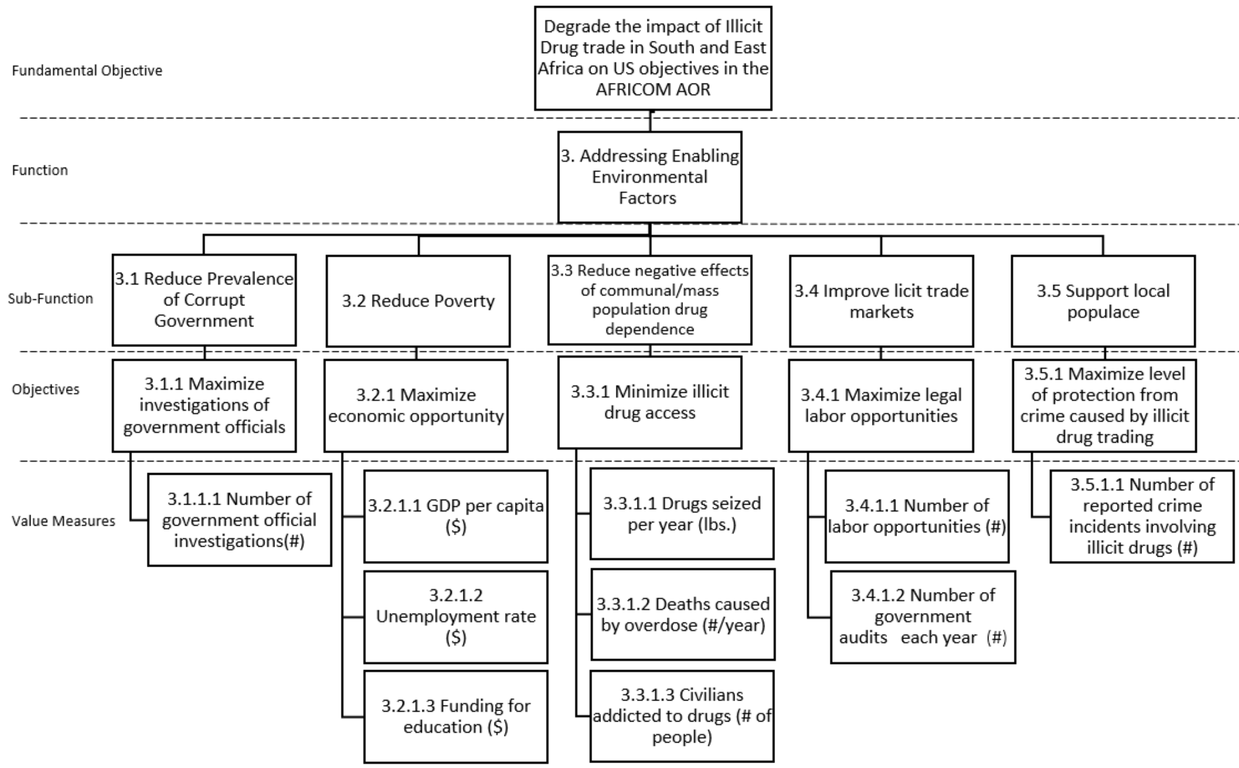

Figure 1. A visual representation of the 3rd branch of the Qualitative Value Model

3. Solution Design

Within the systems process, the solution design phase is a process for solving a problem using the client's needs (Parnell, et. al., 2011). This process generates and develops alternative solutions for stakeholders, providing near-solutions that carry uncertainties and risk (Parnell, et al., 2011). Solution design constructs alternatives that provide the J59 team and AFRICOM with potential avenues for future work, while refining alternatives for future evaluation in the following phases: decision making and solution implementation. The team will use the following models to analyze methods and courses of action to address the drug trafficking in South and East Africa in relation to US objectives. The network analysis model will be used to track and analyze the most densely prevalent routes throughout the area of operation. The system dynamics model helps with idea generation on how to best influence the environmental factors found in the quantitative value model through simulations on drug use. Together, these models provide context and information to decision makers as future alternatives are presented.

3.1 Network Analysis Model

Drug traffickers ship heroin throughout Africa, where it flows through different locations and routes with the goal to minimize total cost and risk of seizure. Almost all heroin transported through Africa originates from Afghanistan and enters along the Eastern coast via dhows, a vessel used primarily for fishing and trading, from Pakistan (*The Smack Track*, 2015). Upon entry, much of the heroin is moved to South Africa and then shipped to Europe or North America (Africa is heroin's new highway to the West, 2019). The entire system is called the Southern Route (*The Smack Track*, 2015). Transportation modalities for heroin include land, air, and sea, often using postal and courier services through international airports (Haysom, 2018).

The team chose to leverage the inherent network structure of the drug trade by developing a linear programming model to represent the flow of drugs through East and South Africa and how it is affected by various factors. Specifically, a variation of the well-known transshipment problem was used. The purpose of the model for the client is to represent the real-world illicit heroin networks that drug traffickers use to move throughout South and East Africa then Europe. Generally, the transshipment problem seeks to optimize some coefficient related to the flow through a network. In this case, our model seeks to represent the routes the drug traffickers could use based on their desire to minimize cost and risk of seizure. These considerations are the

ISBN: 97819384962-0-2

basis for our objective function, (1) in our model formulation. Within the transshipment model, three types of nodes where used: supply, demand, and transshipment. Supply nodes represent potential sources for heroin entering the network, primarily Pakistan in this case. Transshipment nodes are the intermediate points between supply nodes and to the final destinations, or demand node, from which supplies leave the continent for Europe or are locally consumed (Brias, 2010). Transshipment nodes for this model were primarily based on the ENACT group's map of the illicit drug trade in our area of interest which include seaports, international airports, and cities in Somalia, Mozambique, Kenya, Tanzania, and South Africa (Haysom, 2018). Arcs between the nodes represent the feasible routes a commodity can take when moving from one place to another with a per unit cost associated with the movement. A key assumption held to ensure the feasibility of the transshipment problem is that the total supply coming into the system equals the total demand required from the system. Several assumptions were required during the initial model development. First, all international airports within the region of interest were deemed possible locations for illicit heroin traffickers use to transport their drugs through Africa and into Europe. Also, there was no cost associated with transitioning supply between co-located nodes that represented a transition between modalities (i.e. air to land). Additionally, drug traffickers want to minimize their cost and risk while smuggling drugs through different countries based on previous studies about drug trafficker's decision making when choosing their routes (Caulkins, 1993). Lastly, it was assumed that most of the transshipment nodes could be categorized as demand nodes due to domestic consumption (Haysom, 2018).

As is the case for all linear programs, two of the main components are the objective model and constraints (Taylor, 2006). As previously stated, the objective function captures a desire by traffickers to minimize the cost and risk of transporting drugs and is subject to constraints that dictate how flow can traverse the network. The model's structure is primarily composed of a distance matrix, cost matrix, and decision variable matrix. The distance matrix includes the mileage between locations based on the transportation used, air, ground, or sea. Straight-line distances were used between air-to-air and sea-to-sea while road distances for ground-based transport. Costs were then estimated for each transport modality and multiplied by the corresponding distances to create the cost matrix. The cost was estimated based on how much each means of transportation charged the weight of their packages. In addition to cost for the objective function, a by-arc risk coefficient is incorporated into the model. As seen in a study by Magliocca, a risk coefficient integrates additional factors drug traffickers likely consider when assessing the risk of using different routes in the drug system (2019). Risk is currently calculated as a weighted additive score for each arc determined using values for the expected law enforcement presence along an arc (l_{ij}), regional intelligence sharing and surveillance based on the modality type m that was used (s_m), and law enforcement and government corruption (pc_m). The formulation of the risk coefficient is how the team seeks to enable AFRICOM decision making by incorporating factors that can be influenced by the command. As such, it will continue to be a point of emphasis for refinement as the project continues. Constraints used for this model include material balance constraints for each node (2), equality of total supply and total demand (3), upper bounds for flow across arcs (4), and non-negativity for all decision variables (5). Below are the decision variables, coefficients, objective function, and constraints for the model.

x_{ij} = number of units of flow sent from node i to node j through arc (ij)
b_{ij}= net supply (outflow – inflow) at node i
c_{ij} = cost of transporting 1 unit of flow from node i to node j via arc (ij)
U_{ij} = upper bound of flow through arc (ij)
r_{ij} = amount of risk scored between node i to node j calculated as $r_{ij} = w_1 pc_m l_{ij} + w_2 s_m$

It can be written as

$$min \ \sum_{(i,j)\in A} c_{ij}x_{ij} + \sum_{(i,j)\in A} r_{ij}x_{ij} \ = \ Z \quad (1)$$
$$\text{s.t.} \quad \sum_{j:(i,j)\in A} x_{ij} - \sum_{j:(j,i)\in A} x_{ji} = b_i \quad \forall i \in A \quad (2)$$
$$\sum_i b_i = 0 \quad (3)$$
$$x_{ij} \le U_{ij} \quad \forall (i,j) \in A \quad (4)$$
$$x_{ij} \ge 0 \quad \forall (i,j) \in A \quad (5)$$

A primary means for validating the model will be feedback from the client based on expected flow patterns under specific parameter values. Additionally, the team will also use sources such as the ENACT group's "The Heroin Coast" to compare the results of the transshipment model to reported trafficking activity.

ISBN: 97819384962-0-2

3.2 Systems Dynamics Model

System dynamics applies causal loop diagrams, stock and flow diagrams, networking, and many other tools to help model and analyze many variables of a given system. Vensim, a system dynamics tool, helps to aid stakeholders and decision makers with visualizing drug impact on South and East Africa through simulation of drug flow, addiction rates, and overdoses. Kenya, a hotspot for heroin with the most accessible data in the region, was chosen because of its similarity in population and demographics with the surrounding countries. The stock and flow diagram models simulate the drug impacts on the Kenyan population, while factoring in recovery rates, births, deaths, and other variables, establishing data outputs that show the number of people addicted to heroin, recovered from heroin, and fatalities from a heroin overdose. A Systems Dynamics methodology was adopted into the solution design phase, because of the qualitative nature of the heroin trade and how the capstone sought to understand it. Our capstone's mission was to inform AFRICOM so that they could make policy decisions about how best to attack the illicit heroin trade, and the ability to simulate varying scenarios in Vensim provides a more holistic model.

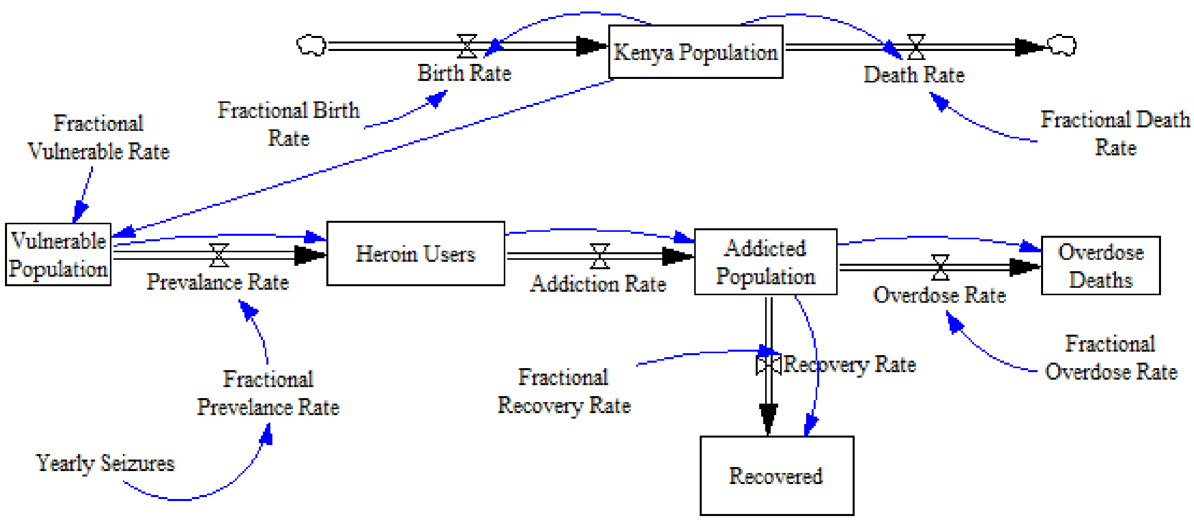

Figure 2. Stock and Flow Diagram of the Illicit Heroin Trade Impact in Kenya

The figure above illustrates the foundation of the illicit heroin trade in Kenya as it relates to the domestic population. Using the QVM in Figure 1, this tock and flow diagram was developed to model and assess the impact of key value measures identified by the client, specifically, value measures 3.3.1.1-3.3.1.3. Taking the entire population, the model first identifies the population aged 15-64 as the vulnerable population because it was assumed children and the elderly were not doing heroin. The vulnerable population was the further segregated into Heroin users via the prevalence rate. The prevalence rate refers to the fraction of people who try heroin one time in a given year. From there they became illustrated as heroin users before being further decomposed into an addicted population that is not just using heroin but addicted to it. In our model a heroin addict could either just stay a using addict, recover, or die from an overdose. The rate at which people fell into these population categories was dependent on the addiction, recovery, and overdose rates respectively.

The focus for AFRICOM historically has been the yearly seizures. In Figure 2, the variable "Yearly Seizures" represents the percentage of total heroin seized globally that was seized on the Southern Route, of which Kenya is located. While AFRICOM has traditionally measured their success in degrading the heroin trade in terms of the number of seizures according to the client, the model this capstone developed measured the success of the heroin trade by the size of the addicted population. If the addicted population was growing, the capstone group saw this as an indicator of a growing heroin trade. Figure 3 below illustrates four different simulations that were run with different seizure percentages. According to the United Nations 2020 world drug report, in 2018, 5% of global heroin seized was on the Southern Route, so this was the identified base case for the model. From there, a variation of 3% both increasing and decreasing was conducted to show the sensitivity of the addicted population to the quantity of heroin seized. The decrease in the addicted population associated with an increase in 3% of global heroin seizures is substantially smaller in magnitude than a decrease in 3%. From this data, the capstone group can propose AFRICOM that continuing to divert resources to seizures will have diminishing returns, present alternative solutions in the future to combat the illicit heroin trade.

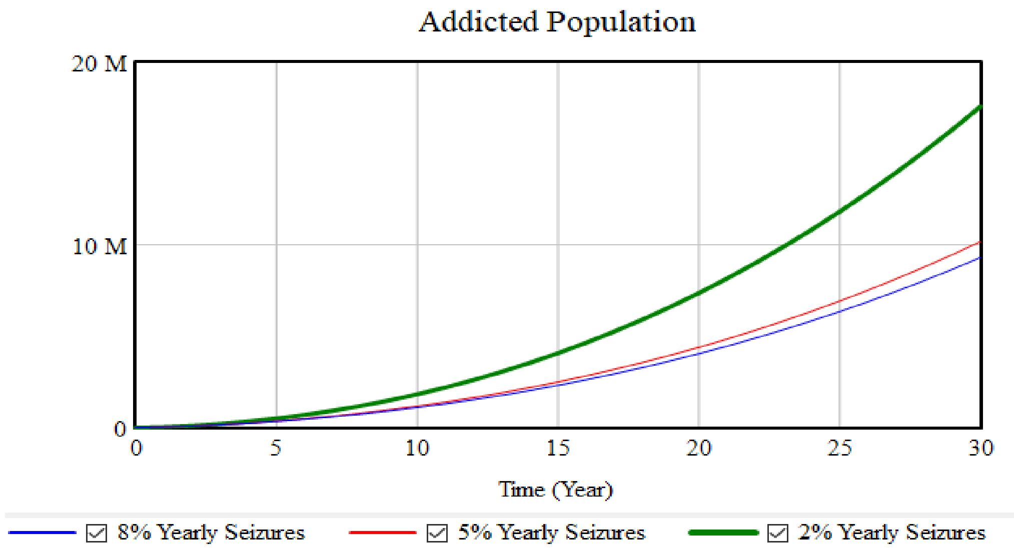

Figure 3. Graph Estimating the Cumulative Kenyan Heroin Addicted Population Over the Next 30 Years

4. Future Work

Moving forward, the team will use the models developed in the Solution Design phase to generate solutions for AFRICOM. After presenting candidate solutions, the team will continue to work alongside the client to evaluate the proposed solutions as well as measure their sensitivity to change until a solution is found that satisfies the clients demands. As the heroin trade has only begun to be addressed in the last couple of decades, data for things like seizures and prevalence is limited. While this capstone has been able to define and model a variety of aspects in the illicit heroin trade in South and East Africa, iteration of the SDP will be critical as more data about various aspects of the heroin trade become available to include. Thus, in time this capstone anticipates better abilities for data collection that can be used to increase the efficacy of potential solutions. Additionally, this capstone was unable to find a way to link VEO activity to the heroin trade itself, but AFRICOM has shown a heavy interest in being able to prevent any mutual gain between the two. Future research groups should look to add further complexity to this capstones Systems Dynamics model to measure the sensitivity of the heroin trade to a broader scope of environmental factors and illicit actors.

5. Citations and References

Brias, M. (2010). Transshipment model in the function of cost minimization in a logistics system. *Interdisciplinary Management Research*, 50. http://www.efos.unios.hr/repec/osi/journl/PDF/InterdisciplinaryManagementResearchVI/IMR6a04.pdf.

Caulkins, J., Crawford, G., & Reuter, P. (1993). Simulation of adaptive response: A model of drug interdiction. *The RAND Corporation*, (17), 38.

Haysom, S., Gastrow, P., & Shaw, M. (2018). The heroin coast: A political economy along the eastern African seaboard. *ENACT*, (04), 2-34. Retrieved 16 September 2020.

Parnell, G., et al. (2011). *Decision Making in Systems Engineering and Management*. Wiley Series. 2011.

Parry, C. (2021). Drug Use in Southern Africa Findings. *Drug Abuse*. Accessed 13 March 2021. https://www.drugabuse.gov/international/abstracts/epidemiology-drug-use-in-southern-africa-findings-sendu

The Smack Track. (2015, January 15). Retrieved September 16, 2020, from https://www.economist.com/middle-east-and-africa/2015/01/15/the-smack-track.

UNODC. (2021). 2020 World Drug Report. *United Nations Office on Drugs and Crime*. Accessed 23 March 2021.

2020 Posture Statement to Congress. (2020). In *United States Africa Command.* Accessed 22 November 2020.