Webology (ISSN: 1735-188X)
Volume 18, Number 6, 2021

Logistic Network Optimization To Maximize Route Utilization: A Case Study Of Nato Supply Routes

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Abstract

This paper examines the history of the North Atlantic Treaty Organization's (NATO) fuel logistics operation in Afghanistan and its implications for the logistics community as a whole. The research focuses on a small group of individuals and how they were able to supply over three million liters of fuel per day to Afghanistan with minimal commitment from ISAF nations. The paper explains how these individuals managed NATO fuel operations outside of typical institutions such as the NATO Support Agency (NSPA) and the U.S. Defense Logistics Agency (DLA) Energy. In addition, this analysis compares NATO's mission in Afghanistan to analogous historical examples of large-scale coalition fuel initiatives with extensive communication networks. These historical case studies provide background for the successes of NATO logisticians and the level of risk they assumed in supplying gasoline to the ISAF deployment headed by NATO. In times when governments are reluctant or unable to provide logistical assistance for their military, the NATO case study serves as a model for coalition support.

Key Words: North Atlantic Treaty Organization, International Security Assistance Force, Defense Logistics Agency.

Background of the study

As global sourcing and selling become more prevalent, every supplier, manufacturer, distributor, and retailer is involved in multiple supply chains. Corporations no longer have cost-effective distribution networks as a result of 20 years of fundamental changes. Logistics network optimization is critical for end-to-end decision support in a constantly changing context. In transportation and distribution, the best network architecture balances cost and service.

One of the most critical responsibilities in today's ICT environment is resource utilization and planning. Information technologies have been used in a variety of business processes to solve and optimize real-time critical problems such as "logical network optimization, calculation and identification of shortest routes, and transportation optimization," among many others that required complex calculations and analysis (Fleischmann, Krikke, Dekker, & Flapper, 2000). Communication tools have assisted in bringing together key actors from various company departments. As a result, relevant stakeholders can share useful information inside networks or cycles.

Network or lifecycle cost and time measurement are tough. Optimizing and assessing performance is difficult without exhaustive examination and consideration of every component (Klibi, Martel, & Guitouni, 2010). Research on network optimization is broad.

Supply chain management (SCM) addresses logistical and distributed network issues. Several companies ship their products via scattered networks. These businesses are constantly looking for new tools, strategies, frameworks, and application software to optimize the route their products take from origin to destination. To maximize route utilization, route network design, development, and deployment must incorporate Network Optimization methods (Fleischmann, Krikke, Dekker, & Flapper, 2000).

NATO logistics in the Afghan War refers to the organization's efforts to supply Afghanistan with petroleum, food, hardware, and other logistical supplies (2001-present). Since 2015, the Resolute Support Mission has handled logistics operations.

Afghanistan is landlocked; therefore, goods must be transported via other countries or flown in. Transporting nonlethal weapons via air is too expensive for NATO forces, thus they rely on land transit. This is accomplished by transporting goods to the port of Karachi in Sindh or via Russia and Central Asia.

All ammunition, artillery shells, and missiles are transported via flight (Bill, 2010). Airlifting is 10 times more expensive than transporting through Pakistan (Craig, 2011). These items are frequently transported by sea to Persian Gulf ports and then flown to Afghanistan to save money. The initial air supply effort was the third-largest in history, following the Berlin Airlift and the airlift during the 1990 Gulf War.

After the Salala incident in November 2011, two routes between Pakistan and Afghanistan were shut down and restored in July 2012. Both routes originate in Karachi, the principal port on the Arabian Sea for Pakistan. From there, one route traverses the Khyber Pass, enters Afghanistan by way of Torkham, and concludes in Kabul. Its length is 1,000 miles. The second route traverses Balochistan at Chaman and ends in Kandahar, Afghanistan.

Along these lines, NATO delivered fuel and supplies, but no weapons. Until their collapse, Pakistani pipelines provided the majority of Afghanistan's fuel for NATO. In 2007, the military consumed 575 000 gallons of petroleum per day from Pakistani refineries (Robert, 2007). Bagram and Kabul air bases possessed less than three million gallons of gasoline, therefore NATO mainly relied on Pakistani supply lines. In October 2007, NATO constructed 3 million gallons of additional storage at Bagram Air Base. As relations between the United

States and Pakistan deteriorated in 2010, the United States military increased its stockpiling and storage capabilities (The Guardian, 2012).

This research optimizes logistic networks to maximize route utilization. Simulation of the NATO Supply Route will serve as the model for research. The planned project will design, construct, and evaluate a NATO supply network to Afghanistan that is cost-effective. In this study project, multi-route calculations and evaluations based on delivery time, security and storage costs, speed, route condition, and road density will be conducted (route flow).

To remain relevant in the post-Cold War era, NATO has undergone a profound transition during the past two decades. It has changed to acting in areas outside of its usual field of operations, collaborating with other international organizations on crisis management, and creating global alliances with nations. Despite this, the most successful partnership in contemporary history is at a crossroads. In many ways, the Afghanistan operation represents a crossroads where the alliance must decide whether to evolve and go beyond its collective defense trappings or to adhere to a stable but inflexible security structure. The North Atlantic Treaty Organization (NATO) has already devised new ways to generate war fighting capabilities, and new institutions to deal with evolving threats, and is collaborating with nations in places distant from the waters of the North Atlantic. The purpose of the study was to determine the significance of logistic optimization in route usage.

Research Objectives

Following are the objectives of this research:

I. The research will be the evaluation of the route utilized for the NATO supply to deliver the goods to Afghanistan. There is a multi-route available to send the goods to the NATO supply. The evaluation will be performed on major routes and will help to identify the best route to send the goods to Afghanistan. The evaluation will be based on different parameters.

II. The analysis will be performed with help of the Multi-objective programming by assigning different weights to each factor.

III. The research study will present a design of a deterministic model for the available routes to bring the goods from Afghanistan

IV. The research study will achieve optimized balance by minimization of operating expenses and maximizing the route capacity for NATO forces containers,

V. The research study will be minimizing logistics costs (security/ storage) focusing on the mission-critical conditions.

LITERATURE REVIEW

Transportation is the supply chain

Transport operations determine product movement efficiency. Techniques and management principles boost movement load, delivery velocity, service quality, operating expenses, facility utilization, and energy savings. Stewart (1998) SCM includes purchasing, production, and transportation (Thomas et al., 1996). Cooper et al. (1997) assessed the business processes, managerial components, and network structure of supply chain management.

The supply chain is managed by a diverse group of companies, including producers, transportation service providers, distributors, retailers, and end-users. Items could not be produced or distributed without it (Simchi-Levi, Kaminsky, and Simchi-Levi, 2000; Nagurney, 2006).

Uncertainty is not only one of SCM's most intricate concerns but also one of the most crucial for evaluating SC performance (Sabri and Beamon, 2000). Due to shifting and rising client expectations (Gupta and Maranas, 2003), the increased number of network tiers, and new complicated limitations resulting from globalization and increased unpredictability, the business environment is very volatile (Klibi and Martel, 2010; Longinidis and Georgiadis, 2011). Designing an efficient and adaptable SCN is vital for any business in the current industry (Klibi and Martel, 2010).

Consider uncertainty when developing and planning supply chains so that existing capacity is efficiently utilized and a robust SC infrastructure is established to accommodate all inherent variability (Papageorgiou, 2009; Klibi and Martel, 2010). Uncertainties include swings in demand and prices, raw material shortages, interest and currency rates, product launches, and geopolitical shifts. A corporation cannot defend itself from risks or seize opportunities if SCN design and planning concerns are ignored (Gupta and Maranas, 2003).

In today's competitive market, where goods are rapidly produced and made and where efficient production and cost reduction are required, a nimble firm has evolved. An adaptable corporation may operate in a market where opportunities appear and alter frequently (Pan and Nagi, 2010).

Peidro et al. (2009) published a comprehensive literature assessment on quantitative models for uncertain supply chain planning. Few models include more than three sources of uncertainty. the majority of models include only one source of uncertainty. All uncertainties should be factored into the planning model for the supply chain since they can have an impact on SC operations.

Sabri and Beamon (2000) suggested an approach that blends strategic and operational SCN planning in response to the production, delivery, and demand uncertainty. A multi-product supply chain and a multi-echelon structure were considered. Increase distribution volume flexibility while lowering fixed and variable costs in the plant. It gauges the SC's performance.

A branch-and-bound model for supply chain design optimization was put forth by Tsiakis et al. in 2001. Scenario analysis was used in this model to evaluate a multi-echelon, multi-product supply chain and demand unpredictability. The main objective of this initiative is to lower infrastructure and operational costs. To reduce manufacturing and shipping costs, a multi-site SC was planned using a two-stage stochastic model established by Gupta and Maranas in 2003. Decisions about production and logistics were separated by the model. Manufacturing choices concentrate on the effective distribution of production capacity between sites before the realization of demand. Logistics choices are deferred until issues with supply and demand can be resolved. The model takes into account both manufacturing costs and consumer pleasure. The author developed a distribution-based strategy to model uncertainty.

Santoso et al. (2005) presented a two-stage stochastic programming methodology to build SCNs with unknown costs, demands, supply, and capabilities. Minimize total investment and operations costs. This model handles several uncertain circumstances using sample average approximation and accelerated Benders decomposition. Also, two real SCNs were presented. Guilleén et al. (2005) provided a two-stage stochastic model for designing and retrofitting an SC under uncertain demand that incorporated profit over time and demand satisfaction.

Azaron et al. (2008) proposed the use of Pareto-optimal approaches to enhance decision-making. The modeling of demand, supply, processing, transportation, shortages, and capacity expansion costs. First-stage variables consist of network configuration, whereas second-stage variables comprise product flow and quantity. Lastly, SCN design for a wine company employed the method. Wassick et al. (2009) proposed a stochastic linear programming model with two stages that incorporate demand and freight rate uncertainty. The model was utilized to plan a multi-period global chemical supply chain. This connected production, stock, shipping methods, and customer service. To balance cost and risk, a risk management strategy and multi-objective optimization were implemented. In this strategy, manufacturing, distribution, and inventory decisions are made in the "here and now," while other decisions are made in the "future."

A robust heuristic optimization method for SC design under uncertainty was devised by Pan and Nagi (2010). Cost fluctuation owing to demand uncertainty and penalties for unfulfilled demand is included in the goal function. Multi-echelon, single product SC, and a single transportation method are simulated.

In their book, Longinidis and Georgianidis (2011) claim that a slew of authors has used scenario and probability methods to evaluate demand uncertainty. This method fills a gap in supply chain management models by incorporating financial and demand uncertainty into SCN design. A scenario method with "wait-and-see" and "here-and-now" decisions is used to model uncertainty in a two-stage programming paradigm. Last but not least, the monetary contribution is diminished by this approach.

Bidhandi and Yusuff (2011) developed a two-stage stochastic model that takes into consideration operational costs, consumer demand, and capacity. Variables in the first stage deal with configuration choices, whereas variables in the second stage deal with product transport options. Multi-commodity fixed-SC structures were studied in this model during a single period. Both fixed and variable costs are kept to a minimum using this function.

The multistage stochastic MILP model developed by Nickel et al. (2012) integrates financial considerations for facility location, product flow, and alternative investments. The ultimate goal is to increase one's overall financial position. Also included were demand and interest rate scenarios. To deal with stochastic capacity planning and dynamic network design issues, Pimentel et al. (2013) introduced a multi-stage stochastic MILP technique and a Lagrangian heuristic procedure for identifying appropriate boundaries in an acceptable amount of time. Managers can use this strategy to determine which facilities should be opened or shut down based on demand fluctuations. In the face of unpredictable demand, this method combines facility placement, network architecture, and capacity planning.

A stochastic mathematical model for constructing SCNs with unknown demand and supply was developed by Baghalian et al. (2013). Recurrent linear regression and mixed-integer nonlinear programming are used in the model (MINLP). The model's goals were to maximize profit and minimize risk. A case study on the Middle Eastern rice industry also used the methodology. To account for the inherent uncertainty in SCN building, Singh et al. (2013) developed a two-stage stochastic model. Reduce the total cost of investment, tactical costs, deficiency costs, and storage expenses.

Optimization of routes

Transportation policymakers must find a means to guarantee long-term growth while minimizing negative effects (Jakimavicius, Burinskiene 2007; Maciulis et al. 2009). Over the past few years, there has been a surge in the use of contemporary technologies. A few technological advancements, such as multimodal cargo transit and contemporary information technology, have significantly impacted logistics (Batarliene, Baublys 2007).

Supply chain modeling is challenging. There are numerous formulations and solution techniques available. Other formulations are employed in supply chain modeling, including Cohen and Lee's stochastic submodels and the analytical techniques of Burns et al. (1985). (1988). In this review, the study design based on MIP models is being looked at. MIP models are frequently used in supply chain models, and there are numerous tools and software options available. Many different supply chain models exist. Models often only do one action (e.g., strategic, tactical, or operational). At each level of decision-making, there are different supply chain models based on the supply chain tiers. The sections that follow discuss several supply chain models.

The distribution network architecture's plant and warehouse count and locations have received the most research attention. Selim and Ozkarahan's (2006) investigation of the supply of goods to retailers focused on the locations and storage capabilities of manufacturing facilities. Wang et al. developed a design for a multi-echelon distribution network that took transportation and inventory into account (2005).

To establish a multi-product supply chain distribution network, Rabbani et al. (2008) looked at the optimum distribution strategy from manufacturing facilities to warehouses and then from warehouses back to customers. A distribution planning technique was investigated by Lee et al. (2008) to lower logistical expenses when transporting goods from warehouses to customers. Ambrosino et al. (2009) examined a business with a single depot, a diverse fleet, and neighborhood customers for their study. The goal was to cut distribution costs by building depots in each zone, distributing vehicles by region, and designing routes that began and terminated at the central depot.

To cut down on location and inventory costs, Sourirajan and his colleagues examined the placement of distribution facilities in terms of service levels and lead times in 2007. Marian et al. (2008) solved capacitated location-allocation problems using evolutionary algorithms. Using steady-state genetic algorithms, Altiparmak et al. (2009) created a multi-product, multi-stage supply chain network.

Several academics have included production and/or distribution in their supply chain models. Jung and Mathur (2007) investigated inventory and distribution choices in a two-tier distribution system with one warehouse and N retailers, where items are held at both locations. Park (2005) found that combining production and distribution planning increased net profit. Operational decisions were made using an intuitive approach for a variety of situations with a variety of considerations to take into account.

For the design and planning of production-distribution systems, Thanh et al. (2008) developed a MILP. This model was used to make strategic and operational choices, such as the opening or shutting of a facility, the selection of a supplier, and the movement of goods and services through the supply chain. Adding financial constraints (manufacturing expenses, transportation expenditures, and exchange-rate-sensitive duties) to operational limitations was Tsiakis and Papageorgiu (2008)'s focus (e.g., quality, production and supply restrictions, allocation of production, and the work-load balance). They devised a MILP model to describe the production and distribution optimization problem under operational and financial limitations. To better understand distribution network optimization difficulties, researchers used case studies.

Standard Register Company's production-distribution network was optimized using operations research by Ahire et al. (2007) to lower overall landed costs. They used regression analysis, optimization, and simulation modeling to overcome their challenges. Strategic network planning and master production scheduling difficulties were the focus of three case studies conducted by Jonsson et al. (2007).

Strategic and tactical production-distribution allocations and transfer pricing were demonstrated in two case studies by Goetschalckx et al. (2002). A case study on Pepsi Co.'s supply chain optimization decision support system was given by an unidentified author in 2000. For companies that produce and distribute via regional business units and franchises across the United States, the model provided a tool that could plan production and distribution without requiring external training and support, as well as time and money, and confusion to make the tool tactically useful.

An analysis by Le Blanc et al. (2006) used Producer Gate Pricing (FGP), which is when the merchant buys directly from a producer and pays all subsequent expenses. They emphasized the advantages of a Dutch retail distribution network in terms of better coordination and lower costs. Direct plant warehouse shipments are similar to those evaluated in the research. Several academicians believe that a supply chain network should have many goals. In the majority of models, other objectives, such as response time or lead time, should also be included. Research on models having more than one purpose, such as the supply chain, is uncommon.

Multiple criteria are used to model where and how resources should be allocated. Integer and linear programming approaches were created by Portillo (2008) to simplify the design of multi-level supply chains, including the location and allocation of new facilities, capacity assignments, production and distribution network factors, and other worldwide challenges. His multi-criteria approach integrates financial, customer service, risk, and strategic aspects into the decision-making process. Relocating production and distribution sites was done by Min and Melachrinoudis (1999) utilizing a plan that had varied goals in mind. There was an analysis of the Analytic Hierarchy Process (AHP) as well as standard ranking approaches used.

Non-preemptive goal programming was used by Melachrinoudis and Min (2000) to solve a multi-period MILP with two equal weighted objectives. Pokharel (2008) proposed a bi-criteria model for making strategic decisions in the supply chain network architecture of a single product, taking into account supplier, production, and third-party storage capacity limitations. Reduce overall costs while improving the quality of service provided to customers.

Supply chain network configuration and product movement have been studied by others. Order splitting, transportation allocation, and inventory control are all part of a model proposed by Ding and colleagues (2009) for building production-distribution networks. They were looking for a middle ground between price and quality.

Strategic and operational multi-criteria sub-models for supply chain design were developed by Sabri and Beamon (2000). Supply chain configuration and material flow are optimized by the strategic submodel and stock levels are optimized by the operational model. Talluri and Baker (2002) created a multi-phase mathematical programming strategy for successful supply chain design using multi-criteria efficiency models based on game theory and linear and integer programming methodologies.

An AHP model was created by Korpela et al. (2002) to optimize the strategic importance and preferences of customers while minimizing risks associated with customers. To reduce costs and travel time, Zhou and colleagues (2003) devised a bi-criteria system for distributing clients to DCs. A supply chain network's order distribution problem was tackled using a multi-criteria optimization modeling framework by Erol and Ferrell (2004), to reduce costs while also improving customer satisfaction.

For manufacturing and distribution challenges, Chan et al. (2005) developed a hybrid genetic algorithm/AHP method. Gaur and Ravindran (2006) used a bi-criteria non-linear stochastic integer method to study inventory aggregation in distribution networks. The alternatives were ranked using optimization and AHP. A method created by Fulya and co-workers in 2006 is a genetic algorithm for multi-objective supply chain network optimization.

Integrated manufacturing, distribution, and logistics at the strategic level to build a multi-echelon supply chain network with agility as its major goal, according to Bachlaus and colleagues (2008). To optimize fixed and variable costs and improve plant and volume flexibility, an optimization model was designed. Physical and intangible components were then included in the problem of assigning resources in a product-driven supply chain by Bachlaus et al. (2009) There was a multi-objective optimization model used to determine the difficulty of the problem. This model aimed to maximize profit, early delivery, quality, and volume flexibility.

Using stochastic programming, Solo (2009) devised a two-phase technique that incorporates both production and distribution. His concept reduces supply chain response time and demand uncertainty while increasing profits. Stochastic programming was used by Azaron et al. (2008) to create supply chains that could not be predicted in advance. Adding two objective functions strengthened the typical supply chain design. Investment costs, transportation, shortage, capacity growth costs, total cost variance, and the risk of not meeting a specific budget are all reduced by their multi-objective model.

Factors affecting route optimization

Risk assessment and management are major challenges in the planning of oversize and heavyweight freight transit and infrastructure projects (Palsaitis, 2011; Parentela, Cheema 2002). A failure to meet demand promptly can lead to a loss of potential market share (see, for example, Christopher (2005) and Gustafson, von Schmiesing-Korff, and Ng (2004)) or even worse, extra injuries or death as in crises (e.g., Van Wassenhove (2006)). Griswold investigates the relationship between the characteristics of LCVs and traffic safety (2010). The infrastructure and vehicles might be damaged by narrow roads and abrupt turns (Grislis 2010). This study was conducted by Maciulis, A.; Jakubauskauskas, G. (2009).

RESEARCH METHODOLOGY:

Focus on the research approach is the most important part of any study. The research approach aids in the application of theoretical and methodical analysis to the data collected. To accomplish the desired goal or mission, the research process is broken down into several distinct steps. All of these stages are intertwined.

While the methodology does not directly address the research question, it can aid in the achievement of that aim if it is properly used. For example, "Water Fall Model (McConnell, 2006), Six Sigma (Tennant, 2001), and many others have all been the subject of extensive research in the domain of research methodology design and development. It's possible to implement most of these methods based on the principle of bespoke design and get the desired results.

Logistics and supply chain management are in high demand, and that demand is growing at a rapid pace. To maximize route utilization and network optimization, logistics companies are spending a lot of money. Using the most efficient route possible directly reduces transportation costs and improves efficiency by delivering the goods to the desired place in a predetermined amount of time and money. With the help of optimum route utilization, the vehicle routing issue has been resolved. The vehicle routing has also been simulated using the intelligent information system.

The study methodology for optimizing the logistic network is presented in this chapter to maximize the use of routes. To enhance the efficiency of the NATO supply chain's path to Afghanistan, researchers have calculated and analyzed the most efficient routes. The commodities can be delivered to the NATO supply chain via some different routes. It's the goal of the study to determine which key routes can be used to bring products to Afghanistan, as well as the optimum path to take. "Mathematically formulation, Cost analysis, and optimization methods" are some of the tools and approaches used in the evaluation.

Sequentially, we have designed and developed the approach for conducting research. The individual steps in this process are interconnected. Each phase has its own set of chores and activities that must be completed before moving on to the next one. A total of eight steps make up the proposed research approach. All of these phases are intertwined. As a result, the research can go back to the previous stage and re-examine certain tasks and activities if any issues arise.

There are a total of eight steps in the research plan. The research problem is defined in the first phase. Core issues are around building a logistics network that maximizes "North Atlantic Treaty Organization" supply route use. As the NATO supply line has a variety of constraints. Logistical firms involved in the supply chain process work to minimize waste, cut costs, and make the most efficient use of available transportation options. Defining the study objectives is the second step in the process. An evaluation of the route used by NATO supplies to deliver commodities to Afghanistan, a reduction in operational costs, and an increase in the capacity of NATO troop's containers are the key objectives of this research.

According to Logistic Network Optimization to Maximize Route Utilization, optimization methodologies, and supply chain management, the literature study is formulated in the third step. There is now an understanding of the findings of past researchers. It is the purpose of this phase to learn about and analyze the tools and strategies used by other researchers to deal with vehicle routing issues. The model is constructed and developed based on the existing methodologies in the fourth stage of the process. Techniques and tool sequences are selected in this step. Route Probability, Linear Programming, and Cost Evaluation are explored in this research study.

The data gathering takes place in the fifth phase of the project. The most important part of the research process is gathering the information. Analysis and study outcomes depend solely on the data gathering and analysis that was performed. The data was gathered from primary and secondary sources. The data was gathered from the four primary routes used by the NATO supply convoy to reach Afghanistan's countryside. Analysis of data has been carried out using a software application at this point. Google maps have been used to view the area of the countries via which NATO supplies can be transported.

The route utilization strategies have been applied to the data acquired from various sources in the seventh phase of this project. Various characteristics such as "Cost, Time delay, Probability, Environment condition, and other parameters" have been analyzed for NATO delivery to determine the most efficient method. Results were interpreted and conclusions were drawn from these interpretations at this phase.

Theoretical framework

Research is basically to find the optimal route for NATO withdrawal in 2014. A managerial decision-making approach, mathematical models, and statically techniques will be combined to formulate an optimized result, which will further be analyzed using the static technique. In this research x,y,z and we are different routes and hence are decision variables. While 8, 11, 40, and 60 are delivery times associated with routes. This route will be analyzed on the basics of delivery time (DLT). The using elimination technique some routes will be eliminated. Then remaining routes will be analyzed on the basics of security cost and traffic flux. The desired results will be analyzed by using multi-objective programming by assigning different weights.

Route x,y,z, and w are associated with delivery time. x,y,z and we are decision variables while DLT is the independent variable. A deterministic model based on opportunity cost will be formulated.

Deterministic model

Any system that lacks randomization and can anticipate its future states is said to be deterministic. On the other hand, a deterministic model will always produce the same outcome given the same initial condition.

Analysis of results

The opportunity cost of all available routes will be evaluated and the decision will be based on minimum opportunity loss.

Linear programming

Optimization of a linear function, such as production or cost, using a mathematical technique. Using linear programming, available paths can be maximized.

Security/storage cost minimization while using Lagrange multipliers

Security/ storage cost is a nonlinear function hence Lagrange multipliers will be used to determine the minimum cost.

MOP

Multi-objective programming will be used to determine the optimum route utilization of both techniques.

SOUTHERN DISTRIBUTION NETWORK & NORTHERN DISTRIBUTION NETWORK

The web of all the supply routes, the US can utilize for NATO supplies Southern Distribution Network

On December 7, 2001, US Special Forces and CIA agents expelled the Taliban from Kandahar. President Obama termed the situation "perilous" in March 2009 due to strategic neglect, ineffectual government, corruption, and a cross-border haven in Pakistan in light of the Taliban's comeback.

Approximately 2,500 to 4,000 NATO supply vehicles are currently en route to Afghanistan via Torkham or Chaman, Pakistan. Through Pakistan, NATO personnel are supplied with food, clothing, and blankets, but no arms or ammunition. Small artillery and missiles are transported via aircraft to military airfields. The vast majority of international trade is conducted by sea, with cargo ships docking in Karachi, Pakistan, and unloading onto trucks. Before approaching Afghanistan, you will traverse the dry Himalayas for more than a thousand kilometers.

Challenges on SDN

Karachi is the primary point of delivery for most U.S. aid to Afghanistan (see map II). There is no critical information in these packages. The Torkham Gate near Peshawar is the point of entry for around 66% of this total. The Chaman Gate in Baluchistan is used by 34% of the population. There is no involvement from the U.S. military in the transportation of these supplies.

These trucks are driven by civilians without military protection because of worries about Pakistani sovereignty. Hazardous work pays well. Motorists are the primary targets of kidnappings, roadside bombs, rockets, and bazooka attacks. Many vehicles were damaged in

2009, according to US reports, and one transport company alleges that 50 of their trucks were assaulted, killing many people. Five American logisticians are in danger of being kidnapped while traveling through Pakistan. Pakistan's thieving rate has risen to 1%. Despite its size, this was government property worth $16 million. A commercial freight facility in Bayonne, New Jersey, had a theft rate of 0.5 percent.

As a result of 112 tanker attacks since 2008, 254 trucks have been destroyed and 50 people have been killed, making the Baluchistan-Afghanistan-via-Chaman border route one of the most dangerous.

Aside from the financial toll, the NATO airstrikes claimed the lives of innocent Pakistani motorists. Supply convoys from Karachi to Chaman via the Qalat division and Bolan, say official sources.

Using the two lines, NATO began supplying Afghanistan in 2009. 90 NATO tankers were set burned during more than 60 terrorist attacks in the Qalat region, costing the alliance millions of dollars. In the provincial capital of Baluchistan, Quetta, 42 NATO tankers were destroyed.

Pakistani Taliban attacks on southern supply routes, along with growing U.S.-Pakistani ties, prompted the United States and its allies to search for alternate transit routes, including the Central Asian Republics (CARs). U.S. military strategists have given their blessing to the NDN, a commercially based logistics corridor linking Baltic and the Black Sea ports with Afghanistan. The NDN is a more expensive option than southern truck routes because of the high costs of jet fuel, base rental, and airport renovations. This is the ultimate geopolitical cost-benefit analysis: is it better to ship goods via Afghanistan's northern neighbors or to pay bribes along southern routes?

Northern Distribution Network

As a result of persistent insurgent attacks, pilferage, trucker strikes, and other threats, defense planners were forced to look for new ways to resupply their forces in Pakistan. Increasing air shipments could be an option, as well. When asked if a Berlin airlift would be possible, General McNabb replied, "I think so." I wouldn't have been able to afford it. The cost of airlifting supplies to Afghanistan, according to NATO estimates, is $14,000 per tonne, or $7 a pound. 9 Volga-contracting Dnepr's of U.S. airlift to Russian and Ukrainian firms shows that the United States lacks adequate airlift capacity to make this option viable. The United States intended to establish new supply lines into Afghanistan in order to avoid the high expenditures of a "Berlin Airlift" and the rising insecurity of Pakistan's supply routes. As a result, the U.S. chose a route that connected Baltic and Black Sea ports with Afghanistan, known as the Northern Distribution Network.

Nonlethal cargo destined for Afghanistan can now be transported by train through the former Soviet Union's borders via an agreement reached between NATO and Russia, Kazakhstan, Uzbekistan, and Turkmenistan as part of the NATO Lines of Communication Project.

In the summer of 2008, U.S. planners began seriously considering this idea. The Northern Ground Line of Communication campaign plan was approved by CENTCOM in September. The campaign plan was called the NDN in October.

United States authorities were tasked with persuading transiting nations that non-military supplies could be transported through their borders. At the NATO-Russia conference in April 2008, the United States had already obtained approval to ship nonlethal supplies through Russia. A NATO-Tbilisi pact inked in March 2005 gave Georgia similar permission. 11 In February 2009, Kazakhstan became the first new country to allow nonlethal travel within its territory.

Rear Admiral Mark Harnitchek of the U.S. Transportation Command said on Tajik state media later that month that Tajikistan has agreed to allow non-military items intended for Afghanistan to traverse its road and rail network.

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By agreeing to the use of Baku for transit and export of commodities to the International Security Assistance Force (ISAF) mission in Afghanistan, Azerbaijan made it apparent during a three-day meeting that ended on March 11, 2009.

13 Uzbekistan followed suit in April 2009 by agreeing to nonlethal travel as well. In the summer of 2009, Kyrgyzstan became the final country to sign a nonlethal ground transportation agreement.

NDN North

Riga, the Latvian port city where NDN North gets its start. There, it uses Soviet-era train lines to travel across Kazakhstan and Uzbekistan. Cargo is permitted to enter Uzbekistan once it has crossed the border. There is an additional 2 to 3 percent cost to this route compared to the costs on SDN because it is 8000 kilometers in length. There is also the fact that it's a very pricey alternative.

NDN South

NDN South avoids Russia entirely by passing across the Caucasus. From the Georgian port of Poti on the Black Sea, this route travels across Azerbaijan and finally ends up at Baku. To cross the Caspian Sea, cargo is loaded aboard ships in Baku. Aktau, Kazakhstan's west coast port, serves as a gateway to Uzbekistan, where the supplies continue to Afghanistan (see map IV). Port of Turkmen Bashi could be an extra destination for commodities departing the Bakuby ferry if and when the United States wins a transit agreement from Turkmenistan.

NDN North and KKT are more practical routes, but this one costs twice as much because cargo must first be unloaded in Baku before it can be placed onto ferries to traverse the Caspian Sea. Unloaded at Kazakhstan's seaport of Aktau, the cargo is then transported by trucks and trains to its next destinations. As a result, the cost of transporting freight was doubled. However, it's a viable possibility.

The KKT Route

The KKT route covers Tajikistan, Kyrgyzstan, and Kazakhstan. It acts as a second line of defense at the Uzbek-Uzbek border crossing at Termez (see map V). According to TRANSCOM, Tajikistan has several subpar road segments that slow down throughput on the route. This path also includes a lengthy, costly, and time-consuming trek to Afghanistan. The NDN is a multi-route logistics network that makes use of commercial suppliers and existing infrastructure to convey non-military goods. The Savoie air freight hub in Uzbekistan and the Caspian Sea ferries are the only exceptions to the NDN's reliance on road and rail.

In terms of its inception as well as its continued sustainability and effectiveness, the NDN is a tremendous logistical success story. Even though the NDN wasn't ideal, US Central Command (CENTCOM), the Defense Logistics Agency (DLA), the Secretary of Defense's Office, the State Department, and other parties collaborated to make it an operational success. As a result, 300 20-foot equivalent units (TEUs) are now transported through the NDN each week, but at a cost that is 250 percent higher per TEU than the rate for products moving through Pakistan. The TEUs' weekly carrying capacity might be extended to 500 if necessary. The NDN had transported 4500 TEUs to Afghanistan by November 2009. According to this proportion, 12.5 percent of TEUs that were shipped through Pakistan in 2008 were supplementary supplies for Afghanistan.

Conclusion

By extending military supply lines via countries with a history of internal struggle, external friction, and tense ties, the United States renders itself susceptible to geopolitical influence. In addition to becoming friendlier with the United States as a result of the NDN, these nations have also grown more involved in Afghanistan. If these linkages can be handled efficiently in a highly dynamic environment, establishing the NDN will be beneficial to the United States' near-term goals in Eurasia, and in particular to efforts to stabilize Afghanistan. If so, then the foundation of the NDN has cleared the way for a more long-term plan of economic integration and development in Eurasia.

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