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Synchronic Analysis of Adversarial Attacks in Syria Committed by the Islamic State

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2020

Abstract

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Abstract

Militarized technologies, large support infrastructures, and the unintended consequences of increased violence demonstrate that the current strategies are unsustainable to end modern conflict. However, the potential exists to precisely identify patterns from empirically reduced adversarial behaviors. Therefore, the purpose of this quantitative, non-experimental synchronic retrospective analysis was to determine the relationship between the distance, fatalities, and time (independent variables) to the hazard force (dependent variable) executed by ISIS in Syria between the years 2007 to 2015. A data set containing 12,326 records for attacks committed by U.S. adversaries in 20 countries between the years of 2007-2015 was analyzed using multiple linear regression. The theoretical foundation for this study was based on symmetrical and asymmetrical applied gaming theory, which differentiates between adversarial sizes and strategies. According to this theory, the potential direction between two attacks occurs because (a) adversaries operate with rationality, and (b) between any two targets (A and B); the rational preference is determined when the ratio of value of B over A is greater than A over B. This rational preference was calculated as intensity and was called hazard force. The analysis demonstrated a statistically significant association between fatalities and distance. The potential for positive social change as a result of this study may be through modeling adversarial events more accurately, reducing human costs, and redirecting finite resources to greater human endeavors, or creating policies with greater efficacy.

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Dedication

Thales stood alone. The pursuit of knowledge is one's true raison d'etre.

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Chapter 1: Introduction to the Analysis

Introduction

A goal of this analysis was to quantify ISIS attack behaviors approaching high value targets in Syria. The results of a multiple linear regression demonstrated that modern adversarial attacks can be understood empirically. Policy makers can use this information to act with timely precision or negate policy over-reactions. Reducing adversarial behaviors numerically to distance, fatalities, and time to derive hazard force (HF) provides greater insight into adversarial intent (Cioffi-Revilla & Romero, 2017).

Militarized technologies, large support infrastructures, and the unintended consequences of increased violence demonstrate that current strategies are unsustainable to end modern conflict. Military responses from 1968 to 2006 have only ended terrorists' conflicts 7% of the time (Chenoweth et al., 2019).

This analysis needed to be conducted to demonstrate that a quantitative computational methodology, multiple linear regression, can extract the behavioral nuances essential for more robust policy options other than war. Since the 9/11 attacks, the wars in Iraq, Afghanistan, Pakistan and Syria, the cost for homeland security and veterans came to the approximate sum of $4.3 trillion USD. The estimations for the fiscal year 2018 brought the total costs of the war on terrorism to more than $5.6 trillion USD (Crawford, 2017).

The potential for positive social change from this study is the objective assessment of cost versus efficacy. In responding to modern terrorists, lone military courses of action are not sustainable. The Government Accountability Office (GAO)

quantitatively demonstrated that when the United States increases military action, the adversarial response is increased violence (GAO-17-68, 2017).

Chapter 1 is structured to give the background on ISIS and why they are successful. This chapter's main sections are the Introduction, Background, Problem Statement, Purpose of the Analysis, Research Questions and Hypothesis, Theoretical Framework, Nature of the Analysis, Definitions, Assumptions, Scope and Delimitations, Limitations, Significance, and Summary.

It should be noted that this terrorist group, between the years 2007 to 2015, manifested many derivatives in name and structural organization. In this analysis and to align with the peer-review literature, the organization is referred to as "ISIS." The theoretical foundation and definitions will be introduced in this chapter.

Chapter 2 is structured to summarize the peer-reviewed literature about studies related to ISIS. There is a concentration on how terrorism has been studied and how it has emerged as a discipline, particularly after the 9/11 attacks. It has been argued that there is a bias in analytical methodologies on terrorism. This is a contributing attribute that leads to ineffective policies.

Chapter 3 includes a structured discussion on the methodology used to find significance with the independent variables to the dependent variable: distance, fatalities, and time to HF, respectively. This analysis demonstrated significance where $p < .001$ for the variables. However, the variable of time was analyzed as a split file. Significance was uncovered in the latter years of ISIS' existence. This statistical discovery within the data has been interpreted as adversarial learning. This is discussed in detail in Chapter 5.

Chapter 4 contains a structured presentation of the statistical results. The methodology used was a multivariate linear regression conducted on a secondary data set. The data acquired for this analysis is from the United States Government agency called Joint Improvised-Threat Defeat Organization (JIDO). Permission to use this data set was acquired from the Walden University Institutional Review Board (IRB) application (approval number: 01-31-19-039-0559). It should be noted that there is no personal identifiable information associated with this analysis or in the data.

Chapter 5 is structured as the interpretation of the data. In this study, I used United States government data that proved to be pertinent in answering the research question. The methodology extracted patterns of behavior by computationally calculating divided increments of time into years; this highlighted an increasing structural organization of behavior, or adaptive learning, by the adversary.

Background

In 2002, a jihadist, Abu Mus'ab al-Zarqawi, led a group called Jama'at al-Tawhid wal-Jihad. He aligned with al-Qa'ida and reinvented the group with a new name, "The Base of Jihad in the Land of the Two Rivers," aka al-Qa'ida in Iraq (AQI). Al-Zarqawi was killed in a coalition operation in June 2006. In October 2006 the group declared itself the Islamic State of Iraq (ISI). Abu Umar al-Baghdadi and Abu Ayyub al-Masri served as emir and minister of war, respectively. In 2010, this senior leadership was killed during a U.S. operation. The same year, Abu Bakr al-Baghdadi was also a prisoner of the United States in Iraq (Shatz & Johnston, 2015).

In 2011, Al-Baghdadi was released and emerged as ISI's leader. In 2013, al-Baghdadi established his group's presence in Syria and renamed it "Islamic State of Iraq and al-Sham," or ISIS (al-Sham means Levant or greater Syria). In 2014, al-Qa'ida formally disavowed all affiliation with ISIS. By June 2014, al-Baghdadi renamed ISIS the Islamic State (IS). Al-Baghdadi then declared himself Caliph of all Islam (Shatz & Johnston, 2015).

An ISIS attack behavior is very similar to the western style of "shock and awe" in capturing or overwhelming targets. ISIS attack behaviors operate without restraint; however, they follow a repetitive execution. ISIS ensures that their battles are on flat ground and that the supply lines of opposing forces are over-stretched. The attack behaviors are:

1. Arrive in over-whelming numbers.
2. Only at night.
3. Distribute forces in small cells.
4. "Melt" into the human landscape.

The problem then becomes one of adversarial field classification. The western forces cannot differentiate between the ISIS fighters from civilians (Jasper & Moreland, 2014). Ashour (2015) documented an ISIS attack on an Iraqi Security Forces garrison. The ISIS fighters won even though they were outnumbered 20:1. Many variables were used to explain their success. However, an insight emerged that the focus should be to numerically quantify the effects of tactics and strategy to explain geographic successes (Ashour, 2015).

ISIS infiltrates an area they want to control in places where there are ineffective governments or ones with historic social schisms. Once they infiltrate, only their network remains as a well-established underground. Intelligence gathering is their greatest weapon after leaving an area. They attack only at night, inflict maximum casualties, produce tremendous fear, and then create a sterile environment. A razed territory does not have to be governed (Shatz & Johnston 2015).

After an attack, ISIS establishes regional sustainability by strategically preserving key components of infrastructure. They avoid the destruction of roads, communications, and power sources. This demonstration of restraint is used as a marketing or recruitment tool. The display of "disciplined" aggression appears to be particularly admired by the disfranchised and the disaffected (Hoffman, 2014).

ISIS acquires skills in tactics and strategies from four categories: (a) former members of regular armed forces (i.e., Special Forces, republican guard) with skills in intelligence, artillery, and policing; (b) battle-harden guerrillas with experiences from Afghanistan or Iraq; (c) local incumbents with decades of logistical support networks; and (d) criminals. The integration of diverse skills, regional sustainability, and targeted destruction are all being executed with the acumen of an adaptive learning organization (Ionita & Aanitei, 2015; Jasper & Moreland, 2014).

ISIS is resilient and executes a financial strategy of sustainability. This is partly due to raising money through black market transactions. The business model protects organizational autonomy with the following internal department heads: (a) security, (b)

Sharia, (c) military, and (d) administrative for each geographic area. This structure has the potential to be the foundation of a proto-state (Kumar, 2015).

ISIS justifies its existence as a reaction to the U.S. policy of spreading global democracy. ISIS submits that they are promoting Islamic Universalism to contest the West for cultural superiority in the Middle East. ISIS rationalizes that their use of violence will initiate Islamic order. Democracy is an anathema to their cultural tenets (Nuruzzaman, 2015).

There is a knowledge gap in the discipline. It exists for several reasons. First, the United States has an over-dependence on technology. In this region, the gap was assisted by a reliance on what could be extracted from environmental sensors and satellites. If the military could have real-time situational awareness, they did not perceive a need for analysis. The consequence is that the United States simply lacked the contextual understanding to construct a policy strategy for the region (Bouzis, 2016; Eisenstadt, 2014; Gulmohamad, 2014).

Second, terroristic violence is too multi-dimensional for academics. The research literature, through the funding landscape, has disagreements about analytical methodologies or a lack of understanding of empirical utility in analyzing terrorism. The consequence has created “disjointed scholarship” when it comes to the best way to analyze terrorism. Additionally, the United States viewed terrorism with indifference until the 9/11 attacks. The attacks on American soil initiated an impetus for analysis with an over-reliance on qualitative or journalistic approaches driven by the media. These approaches lacked both academic validity and reliability (Sageman, 2014).

Third, there was a shift in where and who created datasets like the RAND-MIPT or University of Maryland's Global terrorism databases. Scholarship on terrorism before the 9/11 attacks did not rely on primary research. The gap evolved into descriptive trends with a western bias. English speaking countries dominated preselected themes to analyze with no variation in methodologies or inclusion of quantitative analysis (Gutiérrez-Sanín & Wood, 2017). This analysis was needed because the United States is executing policies that are inappropriate for combating modern terrorism.

Problem Statement

The research problem in this study was the ISIS attack behavior in Syria, which was examined through a non-experimental synchronic retrospective analysis. This analysis accomplished this by an application identified by Cioffi-Revilla and Romero (2017), who demonstrated that distributions for fatalities that occur in riots, warfare, or organizational turn-over are best expressed in terms of statistical approximates by their relative frequencies. Their peer-reviewed publication under the subject of computational social science provided the computational formulas for the intensity of an attack. The ratio of the probability density function to the cumulative density function represents the intensity of fatalities or HF analysis defined formally by the following equation, where P(x) and Φ(x) are the p.d.f. and c.d.f., respectively:

$$H(x) = \frac{P(x)}{[1 - \Phi(x)]}$$

This analysis computationally models adversarial attacks. The intensity of an attack extracts patterns from empirically reduced independent variables. What this analysis discovered was adversarial learning when dividing the data into segments of

time. Reducing adversarial behaviors numerically to distance, fatalities, time, and HF provided greater insight (Cioffi-Revilla & Romero, 2017).

This analysis addressed these gaps as an exemplar for greater integration of iterative, quantitative approaches. The discipline improves with this advocating for empirical testing of assumptions, addressing uncertainties, and quantifying the results.

Purpose of the Analysis

The purpose of this quantitative analysis, using multiple linear regression, was to extract the relationship between the distance, fatalities, and time (independent variables) to the HF (dependent variable) executed by ISIS in Syria between the years 2007 to 2015. This analysis was conducted synchronically by splitting the data into years.

Numerically reduced adversarial behaviors were the independent variables: distance, fatalities, and time. The HF was the dependent variable derived from the ratio of the probability density function to the cumulative density function. Multiple linear regression was utilized as a peer-reviewed method to uncover patterns, numeric trends, or the relationship of the independent variables to the dependent variable. This augmentative methodology has the potential, with future qualitative analyses, to extract robust meaning necessary for greater precision in policy creation (Rudestam & Newton, 2014).

Research Question(s) and Hypotheses

This analysis demonstrated the applicability of multiple linear regression with numerically reduced independent variables to ISIS. The research questions (RQs)included the following:

RQ1: What is the relationship between the frequency of attacks and distance to high value targets?

RQ2: How are the frequencies of attacks differing based on the type of target?

RQ3: How are ratios of attacks, to be used as a precursor of behavior?

The RQs reframed or translated into testable alternative research hypotheses as follows:

Hypothesis: There is a relationship between the intensity of fatalities increasing with decreasing distance to high value targets.

Alternative Hypothesis: There is not a relationship between the intensity of fatalities increasing with decreasing distance to high value targets.

Null Hypothesis: The intensity of fatalities is unchanged with distance.

The independent variables were (a) distance measured in miles, (b) time measured as days, and (c) fatalities measured as number of persons killed per attack. The dependent variable was the intensity of fatalities measured as HF.

Theoretical Foundation

Applied gaming theory has been one of the best formal approaches to analyze terrorism. Sole qualitative methodologies targeting ethnic, historic, regional, or religious differences were simply measuring the wrong phenomena as stated by Ozekin and Akkas (2014). It is one of the few approaches to empirically represent a broad range of adversarial interactions. Applied gaming theory is capable of explaining an adversarial rational choice even after they have adapted to a new operational environment (Tuyls et al. 2017).

In 1928, John von Neumann created game theory; it became a unique discipline to model the outcome of consequences between competing rational actors. Each actor wants to maximize their choices. This is traditionally represented as mathematical utility. Based on a perspective of equilibrium, the maximum utility depends not only on the winning actions of an actor, but also on the losing actions their adversary (Chenoweth et al., 2019; Drexel University & Swarthmore College, 2018).

This analysis' theoretical foundation was based on symmetrical and asymmetrical applied gaming theory because it differentiates between adversarial sizes and strategies. Applied gaming theory submits that the potential between two attacks is rational because: (a) adversaries are receptive to incentives; and (b) between any two choices (A and B), the outcome is determined by the rational preference when the ratio of value of B over A is greater than A over B. Each decision is executed for maximum gain and with incomplete information (Fuka 2015).

The researchers Cioffi-Revilla and Romero (2017) executed the tenets of applied game theory within a conceptual framework found in computational social science (CSS). CSS, as a computational application, provided the methodological formulation to compute the intensity of an attack.

The CSS framework introduces a fundamental approach for understanding social complexity through computation methodology. This analysis' approach relates to the framework in the following ways:

1. The applied gaming theory rational preference can actually be measured. Cioffi-Revilla and Romero (2017) provided the methodological formula that has been tested with warfare and organizational turn-overs similar to ISIS.
2. The applied gaming theory explains that each adversary makes a decision with incomplete information. The ignorance of the adversary creates the unintended consequence of escalation (Fuka 2015).
3. Multiple linear regression is an optimal methodology to test the research question, to extract significance, and is commonly used to analyze data in studies with non-experimental designs (Green & Salkind, 2014).
4. This conceptual framework provides a vehicle by which the null hypothesis can be rejected.

Nature of the Analysis

This analysis used multiple linear regression to explore the relationship between the independent and dependent variables. Multiple linear regression controls for validity, addresses spuriousness and has time-order determination for causality. The framework ensures that, with hypothesis testing, the dependent variable is not caused by another variable and can assess the contribution with a combination of variables.

In this analysis, numerically reduced adversarial behaviors were the independent variables: (a) distance, (b) fatalities, and (c) time. Distance was measured as miles, fatalities were measured as number of persons killed per attack, and time was measured as days. The dependent variable was the intensity of fatalities measured as HF. This analysis was executed as a non-experimental synchronic retrospective analysis. This was

in recognition that the attacks in Syria had already occurred. By examining past events, this analysis:

1. Benefited from an unique data set created by an authoritative source.
2. Identified potential independent variables for future analysis.
3. Quantified a terrorist organization that never had this research methodology applied to them.
4. Initiated potential contextual understanding for strategic policy construction.

The data was produced by the United States Government agency JIDO. JIDO is the singular United States authority that field collected the data. The data collected had the attributes capable of answering the research questions.

Definitions

Asymmetric: In military operations the application of dissimilar strategies, tactics, capabilities, and methods to circumvent or negate an opponent's strengths while exploiting his weaknesses (Department of Defense Dictionary of Military and Associated Terms, 2016).

Combatant commands: Comprised of at least two military departments to provide effective command and control of U.S. military forces organized by geography or function (Department of Defense, 2018).

Department of Homeland Security: The United States agency charged with preventing terrorism and enhancing security, managing borders, administering

immigration laws, securing cyberspace, and ensuring disaster resilience (Department of Homeland Security, 2018).

Government Accounting Office: An independent, nonpartisan agency that works for Congress, referred to as the "congressional watchdog." GAO investigates and provides timely information that must be objective, fact-based, nonpartisan, and balanced (Government Accountability Office, 2018).

High value target (HVT): A target the enemy commander requires for the successful completion of the mission. (Department of Defense Dictionary of Military and Associated Terms, 2016).

JIEDDO: Joint Improvised Explosive Device Defeat Organization (Joint Improvised Threat Defeat Organization, 2018).

JIDO: Joint Improvised Threat Defeat Organization counters improvised-threats with tactical responsiveness, rapid solution development and delivery, to support the Combatant Commands (Joint Improvised Threat Defeat Organization, 2018).

Operational environment: A composite of the conditions, circumstances, and influences that affect the employment of capabilities and bear on the decisions of the commander (Department of Defense Dictionary of Military and Associated Terms, 2016).

Terrorism: The unlawful use of violence or threat of violence, often motivated by religious, political, or other ideological beliefs, to instill fear and coerce governments or societies in pursuit of goals that are usually political (Department of Defense Dictionary of Military and Associated Terms, 2016).

Shock and awe: A military strategy based on achieving rapid dominance over an adversary by the initial imposition of overwhelming force and firepower ("Shock and awe," n.d.).

Assumptions

JIDO is the singular United States authority that field collected the data used in this analysis. The major assumption is that the data is reflective of the events' ground truth. Additionally, non-U.S. personnel, attached to private or for-profit organizations, have tried to replicate the collection of the events.

This is normally accomplished by organizations aggregating newspaper articles, NGO's reports, or witness accounts. There is too much variability, inaccuracy, or repetition in this type of collection from those sources. The assumption is that the JIDO collected data is more accurate, reflects greater ground truth, and possesses greater validity.

There is an assumption that this analysis will make a contribution to public policy because quantification is under-represented for terrorism in the discipline. It is an assumption that improperly measured policies can be one factor that induces terrorism.

The financial crisis of 2008-2009 was analyzed by the International Monetary Fund and the World Bank through a quantitative exploration of economic data. One conclusion was that the overall effect of socio-political problems was a consequence of globalization. Globalization led to grievance, which led to insurgent uprisings and finally terrorism. This analysis' assumption is that an increase of empirical studies is necessary

before the United States engages in operational environments of which there is no contextual understanding (Ozekin & Akkas, 2014).

There were four main assumptions for this analysis: (a) the authoritative source is valid (b) quantification makes a contribution to the discipline, (c) improperly constructed policy causes conflict, and (d) empirical studies should be conducted before entering operational environments.

Scope and Delimitations

The scope of the research question was limited to the 2007 to 2015 attacks in Syria. This temporal range was determined by the data source provider. Probable changes in operations, collection strategies, or data requirements determined the nature of the data (i.e., change in policy, battle tempo, technological, etc.).

This analysis acquired the data from an organization that specializes in data collection, operational reliability, and in the validity of measurements (Walden University IRB approval number: 01-31-19-039-0559). External validity is realized from the statistical significance, and the capability to be generalized beyond this analysis. In order to maintain validity, independent variables measured maintained the time order to the dependent variable.

The data set included the records for 20 countries under the jurisdiction United States Central Command. During the time period of this analysis, ISIS was active in Syria and Iraq. Through a review of the literature, I identified that a different set of variables were needed to analyze Iraq. Iraq made a legal request for assistance to the United States,

as described by Mills et al. (2015). The legal request brought more resources in Iraq because it was believed that it was the new terrorist's haven.

The United States could not legally enter Syria. This opened an unimpeded opportunity for ISIS to attack in Syria (CRS-R43612, 2014). Additionally, the data collected was generated from the requirements and political boundaries established by the United States Combat Commands. The scope of this analysis could not anticipate the operational variability of their operational landscape.

Ionita and Aanitei (2015) described how during December 2011, the United States withdrew of from Iraq and supported a Shia government with biased policies against Sunni citizens. Please note that the dynamic relationship between Shia and Sunni was not examined because the history and complexity of inter-ethnic conflict is beyond the scope of this analysis. There were four main scopes and delimitations for this analysis:

1. The authoritative source set the collection requirements that determined the validity and reliability of the data.
2. The authoritative source set the temporal limit and stopped collecting.
3. Data collected for Iraq was ignore because it was not part of the research question and did not share the same dynamics occurring in Syria.
4. The inter-ethnic conflict between Shia and Sunni was beyond this analysis.

Limitations

In the literature, ISIS has been described as a novel adversary, ascending from an optimal environment with great complexity with the ability to aggregated regional

grievances (Ionita & Aanitei, 2015; Siniver & Lucas 2016). These attributes are an impetus to an examination centered on resolution. The data set has recorded data point events and centers on regional behaviors. The entire data set is a record of past events and more robustly analyzed retrospectively. An optimal methodology is needed to extract significance and to analyze data with non-experimental designs. Therefore, the research questions should be directed more in an exploration of those events. A retrospective examination using multiple linear regression of peer reviewed suggested variables provided a path for analysis. This quantitative methodology supports data set novelty and provides a mathematical description of patterns (Cioffi-Revilla & Romero, 2017).

The potential methodological weakness is in temporal resolution. This came from an initial bias of thinking that the over-all data set was a complete set of continuous events. This bias existed because of a belief that the authoritative source started collecting data from a universally accepted starting point. As ISIS acquired recognition, it was biased to think that all appropriate variables needed for researchers would be present. The data set has gaps, blanks, misspellings, etcetera.

This analysis parsed or split the data into years when the independent variable of time did not initially show significance when examined by days. The ISIS fighters engaged targets sporadically. Additionally, through the literature review, I identified that the fighters were picking up weapons and equipment from the Iraqi Security Forces supplied from U.S. led coalition forces (Ashour, 2015).

The conclusion is that the variability in the time stamps of the recorded data could not be explained due to the variables that were not recorded in the data. This analysis

could not account for breaks in supplies, injuries, or in seasonal weather. When the attributes are optimal for their attacks, the significance of the independent variables to the dependent variable has reliability and can be generalized beyond this analysis.

There were four main limitations for this analysis:

1. The subject matter is capable of a multi-facet analysis.
2. There is a potential disconnect between the data and literature review in resolution for analysis.
3. Not all variables have been recorded about the adversary.
4. Bifurcation of data is necessary for extracting significance and patterns.

Significance

This analysis addresses a knowledge gap in the discipline by demonstrating the significance of quantitative methodologies augmenting the body of qualitative work. A greater utilization of integrated analyses has the capacity to contribute to a lacked of contextual understanding in policy construction.

Policy makers will have an increased potential to impede conflicts by computationally extracting adversarial vulnerabilities from real-world datasets with validity and reliability. Adversarial behavior can be quantified to extract insights about the nature of their operational successes. Patterns of vulnerability can lead to policies that can be used to accelerate, increase failure, or remove adversarial advantage.

Positive social change is realized through quantifiable inputs to improve measured policies, strategic insights, structuring resource allocation, or in providing advanced planning before entering adversarial environments. Positive social change is created

when quantitative computational tools extract the nuances essential for more robust policy options other than war.

Summary

In this chapter, I addressed the attributes and structure of analysis for this analysis. Unsustainability, ISIS's background, and unintended consequences are the main themes. Adversarial behaviors reduced by empirical observation provide the insight that terrorist actions restricted by temporal component demonstrates significance. This analysis executed a synchronic analysis that extracted a pattern and suggests that the insight from computational methodologies to mitigate modern terrorists can be used to create policy with greater efficacy.

In Chapter 2, I summarize the peer-viewed literature related to ISIS. It is an overview on the lack of representation of a quantitative measurement of terrorism. It has changed and is now emerging as a discipline, particularly after the 9/11 attacks. Chapter 2 includes a synthesis of why there is a bias in analysis methodologies on terrorism and how this can lead to ineffective policies.

Chapter 2: Literature Review

Literature Search Strategy

In this analysis, I was examined the ISIS attack behaviors in Syria through a non-experimental synchronic retrospective analysis. The problem is relevant because it addresses how asymmetric conflicts cause a larger adversary to be "gamed" into resource exhaustion. This is an impetus, in the larger adversary, to self-imposed strategies that are unsustainable. A greater integration of quantitative tools and qualitative studies is necessary to improve the United States' terrorism policies. A benefit of this study is that it may provide strategic insights for addressing modern conflicts.

The purpose of this quantitative analysis, using multiple linear regression, was to extract the relationship between the distance, fatalities, and time (independent variables) to the HF (dependent variable) executed by ISIS in Syria between the years 2007 to 2015. This analysis was conducted synchronically by splitting the data into years.

In the literature review, peer-reviewed articles were used from the Walden University Library, which were found in the following research databases: Academic Search Complete, Military & Government, Homeland Security Digital Library, International Security and Counter Terrorism, and Sage Journals. The following search terms were used: *computational social science, conflict, conflict analysis, conflict resolution, game theory, guerrilla, counterinsurgency, diachronic, international conflict, ISIS, IS, Islamic State,* and *Hazard force analysis*. Additional resources used included the following: Computational Social Science, Jane's Intelligence Review, Journal of Peace Research, Journal of Strategic Studies, Middle East Quarterly, Small Wars & Insurgence,

Studies in Conflict & Terrorism, Terrorism & Political Violence, and West Point's Combating Terrorism Center website.

This chapter was arranged to present the current modeling environment towards adversarial conflict. The main topics include: (a) the Theoretical Foundation, (b) the Conceptual Foundation, (c) the Literature Review, and (d) Summary. Materials that were used were from the past 5 years and were applicable to this analysis' research questions. However, it was necessary to investigate references, articles, and books older than 5 years in order to formulate a full modern contextual presentation.

Theoretical Foundation

In applied game theory, symmetric and asymmetric approaches use computational methodologies to quantify strategic interactions. In 1928, John von Neumann modeled the outcome of consequences between competing rational actors. Additionally, this application has demonstrated utility to model adversarial intent.

In this analysis, rational choice is modeled with a specific math function called HF. It represents a terrorist maximizing their rational utility. This alignment is based on a perspective, in applied game theory, of equilibrium by which one gains while the other loses. This has been applied successfully in real-world situations involving nuclear weapon deterrence and corporate banking (Chenoweth et al., 2019).

In applied game theory, asymmetric situations accompany strategies with a different asymmetric payoff or utility. Asymmetric interactions demonstrated an evolutionary adaptation or learning. An evolving adversary transforms a symmetric game into an asymmetric one because, with new strategies, they maximize rational utility or

payoffs. The opposing adversary cannot construct a new symmetric game or evolve fast enough before their strategies are recognized as being impractical or unsustainable (Tuyls et.al. 2017).

The rationale for this theory was corroborated from the execution of adversarial innovation. This is why symmetrical and asymmetrical applied gaming theory was utilized for this analysis. Ashour (2015) submits that ISIS gained a selected advantage over a larger adversary because they modified the Game with an innovative tactic.

The acquisition of territory dynamically changed the game by initiating cost consequences. Additionally, applied gaming theory addresses the unintended consequence when each adversary makes a decision with incomplete information. The ignorance of an adversary is the cause of conflict escalation (Fuka, 2015).

For this analysis, applied game theory was used because of the computational applicability to quantify past adversarial outcomes. This is significant because the modern adversary is not responding as expected when military force is executed (GAO-17-68, 2017).

The modern adversary is adapting in unanticipated ways. However, applied game theory provides contextual insight on what should be quantified in adversarial behaviors. The theory has demonstrated that regardless of strategy, an adversary tries to improve on selfish outcomes to the detriment of an opponent. Each adversary has a limited set of strategies that are “fixed” by the boundaries of a game. The limited number of probable strategies become a forecasting tool because there are a limited number of optimal

strategies to achieve rational maximum utility or payoff (Drexel University & Swarthmore College, 2018).

Conceptual Framework

Cioffi-Revilla and Romero (2017) provided the conceptual framework of computational social science (CSS) to execute the tenets of applied game theory. In 2017, computational social science emerged as a formal interdisciplinary application of computation. It provides the methodological formulas to compute the potential or intensity of an attack. This tool has been tested with warfare and organizational turn-overs similar to ISIS.

The CSS framework introduces a fundamental approach for understanding social complexity through computation methodology. Cioffi-Revilla & Romero (2017) have demonstrated peer-reviewed applicability with CSS in:

1. Understanding population dynamics of New Orleans during Hurricane Katina.
2. Empirically modelling the Arab spring social network in the Middle East.
3. High fidelity modeling of New York City neighborhoods.
4. Crisis dynamics of crowd behavior to first responders.
5. Leaderless decision-making emerging in autonomous communities.

Literature Review

Ionita and Aanitei (2015) stated that in 2005, U.S. policy executed a strategy to democratize the Middle East. Declaring a global war on terror (GWOT) created an initial precursor from which ISIS would rise. The policy language used embodied ISIS to

become a global organization because the term “global-war-on-terror” was a promise of projected United States’ military power.

Alderson (2010) submits that the unsustainability in responding to a GWOT policy is multifaceted. One aspect is an inability to adapt an outdated policy model created by the British in the 1800s. The “hearts and minds” strategy was never adapted to a modern operational environment or adversary.

Antal (2009) identified that the strategy was unsustainable because it only had applicability for a Malaysian insurgency during the 1950s. Western militaries have continued to use this strategy to create a perception of legitimacy with indigenous populations. However, there is no empirical evidence substantiating its validity (Egnell 2010).

As a policy, the hearts and minds strategy is ineffective because it bifurcates objectives, and produces no stable political structures in areas with histories of conflict. These attributes increase policy unsustainability because of a reliance on singular military responses, and over-extending resources (Angstrom, 2011; Ford, 2012; Mumford, 2010).

Egnell (2010) noted that an unintended consequence of the U.S. military surge extended the War in Iraq unnecessarily for 10 years. United States’ policy ignored the variations of history and based a strategy on the wrong assumptions. The problem was relying solely on a military mindset. The deficiency produced a lack contextual understanding for the region (Alderson, 2010; Antal, 2009; Egnell, 2010; Jones, Smith, & Stone, 2010).

As submitted by Gambhir (2015), another unintended consequence was the potential increase of proxy wars. Future policy considerations should reduce adversarial options for increasing political complexity. Additionally, policy initiatives must anticipate the unintended consequences of an adversary evolving greater capabilities. These potential adversarial outcomes are best addressed with applied gaming theory. Applied gaming theory explains why a limited number of probable strategies are optimal for the modern adversary (Drexel University & Swarthmore College, 2018).

ISIS experiences successes in operationally blind spots of United States' policy. The successes are asymmetrically in their favor partly because the attacks occur in marginal regions. The literature suggested that the U.S. policy maker has a tolerance to violence that occurs in marginal regions of the world. The significance of this bias produces a "psychological numbing" that impedes policy vehicles from extracting the nuance or contextual understanding of an operational environment (Gambhir, 2015; Kumar, 2015).

Attributes listed in the CIA World Book (2019) suggest why an U.S. policy maker might think of Syria as a marginalize area. The attributes are: (a) deforestation, (b) desertification, (c) overgrazing, (d) petroleum refining wastes, (e) soil erosion, and (f) water that is depleted or polluted from raw sewage.

ISIS also relies on the West over-reacting to their attacks. This tactic is executed to invoke emotions of Muslim alienation for providing inspiration to a global audience. Policy makers must also have a contextual understanding with an adversary's perception of conflict. ISIS perceives the conflict with the West in the framework of an unending

war. Military engagements are not sustainable for United States' forces. The U.S. policy maker must maintain an awareness of adversarial capabilities, their evolution, and must embrace empirical forecasting to initiate robust policy alternatives (Gambhir, 2015; Robinson, 2015).

The financial crisis of 2008-9 is an example of a problem that an U.S. policy maker should have maintain an awareness. The modern adversary will exploit this type of economic problem. The crisis was analyzed by the International Monetary Fund and The World Bank. They noted that negative economic trends are correlated with a complexity of historically combined grievances.

They executed a quantitative exploration of economic data for insurgent uprisings. Their conclusion was that the overall effect of socio-political problems, expressed as grievance, was a consequence of the negative effects of globalization. An increase of empirical studies has been suggested by both organizations to evaluate operational environments (Ozekin & Akkas, 2014).

ISIS attracts followers to the ideal of an Islamic Caliphate because it removes, for many affected by globalization, the uncertainty in their lives. Their ability to reach other countries with their message is an unintended consequence of globalization. From an environment primed for radicalism, ISIS has learned how to aggregated regional grievances (Ionita &Aanitei, 2015; Siniver & Lucas 2016).

As submitted by Gambhir (2015), U.S. policy should not declare war without understanding the complexities of an adversary. If an enemy emerges in an unexpected organizational structure, the problem will become worse. The variables that lead to the

containment or failure of an adversary must be understood before effective policy can be created (Harrison, 2014).

Ozekin and Akkas (2014) criticized qualitative methodologies on terrorism targeting ethnic, historic, regional, or religious differences. They challenge the effectiveness of this avenue of academic analysis. They have documented that quantitative rigor is required for the application of action to abate terrorism. Diverging from journalistic analysis, the quantification of data creates the ability to detect changes by the change in frequency of behaviors (Ozekin & Akkas, 2014).

Before the 9/11 attacks computational methods were restricted to conflicts in Conflict studies. A sample of the pre-9/11 quantitative methodologies, as submitted by Intriligator (1982) are:

1. Differential equations – used differential equation for phenomena that changed over time.
2. Decision theory – studied one actor maximizing their selfish utility.
3. Game theory – two or more actors executing a set of choice alternatives to maximize their rational utility.
4. Bargaining theory – interaction of agreements benefiting all actors.
5. Uncertainty – consequences of actions with unknown probabilities. When the probabilities are known then it called risk theory.
6. Stability theory – Equilibrium of systems.
7. Action-reaction models – Interaction or reaction among agents.

Game theory emerging from economics to conflict studies has the potential to model modern conflicts. Game theory was chosen for this analysis because, it represents the strategic interactions between adversaries. The utility is the ability to model adversarial outcomes based on rational choice. Rational choice is modeled with a specific math function that maximizes utility (Chenoweth et al., 2019).

The repercussion is that adversarial behavior can be extracted from quantifiable variables to provide understanding and insight. Adversarial behaviors can be modeled to forecast intent. A strategy could then be used to calculate a timely forecast to protect finite resources or to mitigate conflict (Siebeneck, Medina, Yamada, & Hepner, 2009).

Paul, Colin, Clarke, and Grill (2010) submitted that qualitative studies do not address how to end conflicts. Quantitative methodologies can augment the qualitative body of work by extracting empirical variability from reduced human behaviors. Adversarial behavior can be quantified to extract insights about the nature of their operational successes. Quantitative analysis provides the potential to impede conflicts by exposing adversarial vulnerabilities.

Patterns of vulnerability can be used to accelerate adversarial failure. The utility of complementing previous qualitative methods is significant because it creates inputs to improve policies, have strategic insights, or in re-structuring resource allocation addressing modern conflicts (Egnell, 2010; Jones et al., 2010).

Rosenau (2009) submits that greater efficacy is needed to understand adversarial behaviors, their motives, needs, and methods because these attributes are obscured. If

their abilities or mechanics were understood, their weaknesses could be targeted with greater precision (Hughes 2001; Rosenau, 2009).

The International Crisis Group (2006) and Feller (1968) suggests viewing the differentiation of frequencies depicting adversarial behavior as a measure of their competence over distance. The differentiation is referred to as a statistical epoch. Breaks in frequencies represent a change in a behavior. Epochs should be viewed as significant changes in organizational social structure demonstrating fundament transitions (Cioffi-Revilla, 2009).

Tuyls et.al. (2017) submits that the evolutionary dynamics of adversarial learning can result in a self-defeating competition. It results with the larger adversary fighting its own anchoring bias. The larger adversary will increase its investment on expelling larger resources into the ineffective strategies. This investment combines into a new equilibrium of the asymmetric game and becomes a new normal. The larger adversary has increased in operational size and in the attributes by which the nimbler adversary can take advantage.

As a game dynamically modifies, the larger adversary increases resources to the same ineffective behaviors. Applied game theory explains why tactical interactions lead to escalation and why nimbler adaptation occurs only in the smaller adversary. The larger adversary is destined to resource exhaustion, then to unsustainability. In order to defeat ISIS, or any adversary that learns, it is necessary to stop the speed of their adaptation. (Hashim & Kagan, 2014; Katagiri, 2015; Knight, 2014; Terrill, 2014).

Zhao (2013) has the point of view that improper strategy is the main failing. A strategy fails because it does not offer inoculation from operational corruption, it over-extends resources, and it reduces tactical capabilities. Applied gaming theory resonates with this analytical point of view because the frequency of adaption suggests an adversary that is responsive to change. All that is needed is a dynamic change directed towards their failure (Egnell, 2010; Zhao, 2013).

Summary

This analysis addresses one gap by demonstrating the significance of an approach that allows for empirical modeling of ISIS attacks. Applied gaming theory is one of the best formal approaches to analyze terrorism. It is one of the few approaches to empirically represent a broad range of modern adversarial interactions. It is capable of measuring an adversarial rational choice especially when adapting to novel operational environments.

Hazelton (2017) submits that the west is a victim to antiquated thinking. This academic criticism is a multi-year philosophical disagreement with the U.S. government. It suggests an explanation for a nonalignment in research protocols. Sageman (2014) stated that “we have a system of terrorism research in which government analysts know everything but understand nothing, while academics understand everything but know nothing.” (p. 576)

The Government’s strategy manifests as a refusal to share accumulated data with academia. This has created a split in acumen and analytical resource allocations. Antiquated thinking or operational responses from Government analysts do not often

have the methodological concepts or the time to synthesize data from multiple sources (Sageman, 2014). The result is: (a) no methodological training, (b) investigations that leads only to confirmation biases, (c) no understanding of rare events, and (e) a perception that analysis was not needed.

Future analytical policy considerations should include the sharing of singular governmental data and empirical tools to reduce political complexity in adversarial conflicts. Policy initiatives must anticipate unintended consequences that allow an adversary to evolve or escalate greater capabilities for violence.

In Chapter 3, I discuss the methodology used to find significance with the independent variables to the dependent variable: distance, fatalities, and time to HF, respectively. Significance was demonstrated where $p < .001$ for the variables. Significance was uncovered in the latter years of ISIS' existence. This statistical discovery within the data has been interpreted as adversarial learning.

Chapter 3: Research Method

Introduction

The purpose of this quantitative analysis, using multiple linear regression, was to extract the relationship between the distance, fatalities, and time (independent variables) to the HF (dependent variable) executed by ISIS in Syria between the years 2007 to 2015. This analysis was conducted synchronically by splitting the data into years.

This chapter is structured to present the methodology used to find significance with the independent variables to the dependent variables of (a) distance, (b) fatalities, and (c) time to HF, respectively. This quantitative analysis demonstrated significance where ($p < .001$) for the variables. However, the variable of time was analyzed as a split file. Significance was uncovered in the latter years of ISIS' existence. The main sections of this chapter are Research Design and Rationale, Methodology, Independent Variable Manipulation, Threats to Validity, Ethical Procedures, and Summary.

Research Design and Rationale

In this analysis, numerically reduced adversarial behaviors were the independent variables of (a) distance, (b) fatalities, and (c) time. Distance was measured as miles, time was measured as days, and fatalities were measured as number of persons killed per attack. The dependent variable was measured as the intensity of fatalities measured as HF.

Multiple linear regression has demonstrated the capability to extract significant insight from empirical data. As an optimal methodology, it is commonly used to analyze data with non-experimental designs (Green & Salkind, 2014). In this analysis, the

numeric relationship between the independent variables to the dependent variable was extracted. Empirical analysis makes a contribution by quantifying nuance. Quantification can be integrated to be timely, precise, or to negate policy over-reactions. These attributes advance the discipline.

The rationale for this theory and conceptual design is the existence of adversarial innovation. Unsustainability is an indication that an adversary is demonstrating adaptation. They are "gaming" the larger adversary into resource exhaustion. The United States does not evolve fast enough with terrorists and will continue executing ineffective policies. This analysis can advance knowledge to the discipline especially when asymmetric situations manifest. Computations of behavior will create the recognition indicators policy makers need when strategies are impractical (Tuyls et.al. 2017).

Methodology

The focus of this study was the Syrian attacks executed by ISIS between the years 2007 to 2015. Initially, the data set, collected by of the United States Central Command, contained 22,006 records for 20 countries under their jurisdiction. The data is a record of the attacks in all 20 countries committed by U.S adversaries. The United States Central Command determined the temporal range (2007 to 2015) for data collection. It is probable that the temporal range began with operational requirements and ended due to changes in collection formats (i.e., change in policy, battle tempo, technological, etc.) Limited temporal ranges are a common occurrence with adversarial data collection (Gutiérrez-Sanín & Wood, 2017).

The data was reduced to the countries of Syria and Iraq, resulting in 12,326 records. This reduction was executed because during the time that the United States collected data, ISIS was only active in these two countries. To answer the research question, I bifurcated the data because the literature review identified that a different set of behaviors were occurring in Iraq than Syria. Iraq made a legal request to the United States for assistance, Syria did not. During the temporal range of data collection, the United States could not legally enter Syria. This allowed ISIS to conduct attacks in Syria unencumbered (Mills et al., 2015).

The data acquired for this analysis was generated from the United States Government agency JIDO. Permission to use this data set emanates from Walden University's IRB, a document submitted separately (approval number: 01-31-19-039-0559). In order to acquire access to the data, a formal request for access was sent to the JIDO's Data Analysis Research and Collaboration (DARC) Branch. It was reviewed by (a) the DARC Branch Chief, (b) the DARC Senior Pattern Analyst, and (c) the Deputy General Counsel.

The data was filtered to remove any classified or personally identifiable information. The data was sent to this researcher through unclassified email. A copy of the request was included with all documentation submitted separately to the Institutional Review Board (IRB).

The two tools that operationalize the methodology and are appropriate for this analysis are: (a) Multiple linear regression developed by Sir Francis Galton in 1875 and (b) Hazard Force Analysis develop by Cioffi-Revilla & Romero (2017).

Stanton (2001) documented that Sir Francis Galton with Karl Pearson (Pearson Correlation) worked on graphing the growth of sweets peas in 1875. Galton used simplified graphs to chart the growth of the offspring (X-axis) to the growth of the parent (Y-axis). He documented how the offspring never truly achieved the growth of the parent, but "regressed" to a mean.

Two insights emerged from Galton and Pearson's work related to this analysis: 1) If association, between two variables, is constant, the slope of the regression explains variability. 2) The sweet peas had multiple progenitors leading to the idea that a variable could be influenced by multiple causes. This can then be determined by multiple regression. The rigor was provided and published by Karl Pearson in 1896 (Stanton, 2001).

Cioffi-Revilla & Romero's (2017) book on Computational Social Science published the methodological formula to compute the intensity of an attack or Hazard Force Analysis. Their formula has been tested with real-world warfare data and organizational turn-overs similar to ISIS (Cioffi-Revilla & Romero, 2009).

Two insights that emerged from their work relevant to this analysis: (1) In Iraq's Diyala province (2003 to 2006), they demonstrated that numerically representing attacks increased the efficacy of the analysis. Their work was statistically significant at confidence level of 1%; SE for the constant and slope were 0.0198 and 0.0299, respectively, and $R^2 = 0.9$. (2) There is a potential to forecast the onset of an attack by calculating adversarial intensity. Computational methods executed prior to an attack could be used as a mitigation tool. In this analysis, the combination of both

methodologies discovered adversarial learning when dividing the data into segments of time.

Independent Variable Manipulation

The independent variables in this study were (a) distance measured in miles, (b) time measured as days, and (c) fatalities measured as number of persons killed per attack. The dependent variable was the intensity of fatalities measured as HF. Where: $P(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-u)^2/(2\sigma^2)}$, and 1 – Φ(x) are the probability density function (pdf) and cumulative density function (cdf), respectfully. Additionally, x is the value from the data set, μ is the MEAN, and σ is the standard deviation. Therefore, HF is defined as the following: *H(x) = pdf/cdf.*

$$H(x) = \frac{P(x)}{[1 - \Phi(x)]}$$

In this analysis, the probability density function (pdf) was calculated in Excel using the following formula command: =NORMDIST (x, mean, standard dev, False), where x is the value entered from the cell designated.

The MEAN and STANDARD DEVIATION are obtained from the Descriptive Statistics command in the software SPSS. By typing in FALSE, it produces a value for PDF. This command was then copied for the entire Excel data set.

In this analysis, the cumulative density function (cdf) was calculated in excel using the formula command: =NORMDIST (x, mean, standard dev, True).

The procedure was repeated for entering X, MEAN, and STANDARD DEVIATION as listed above. By typing in TRUE, it produces a value for cdf. When

TRUE is entered, the formula is the integral from negative infinity to x. Both excel commands placed the values for pdf and cdf in new column. A third column was created using a ratio formula of = (pdf/cdf) to produce a column of HF.

The attack data was recorded as longitude and latitude in decimal degrees. To calculate the distance between any two points, the ArcGIS software uses the Pythagorean theorem. As submitted by Gowers (2008), the Pythagorean theorem (see Figure 1) states that the square of the hypotenuse (side C) of a right-angled triangle, is equivalent to the sum of the squares of (A and B), the other two sides. The Pythagorean theorem can be used to find the distance between any two points by executing the following steps:(1) Use the known vertices to calculate the distance of sides A and B. (2) Substitute the longitude and latitude coordinates from vertices A and B. (3) Solve for the unknown distance (hypotenuse, i.e. *d*).

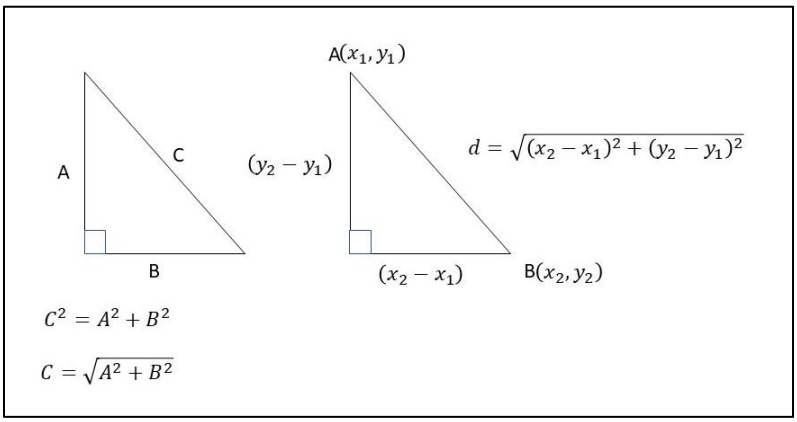

Figure 1. Applying the Pythagorean Theorem.

Data Analysis Plan

The software packages used to process and visualize the data results were:

1. *Excel*: (Microsoft Office Professional Plus 2013)

2. *SPSS*: A software platform that offers advanced statistical analysis.
    a. Retrieved from https://www.ibm.com/analytics/spss-statistics-software
3. *ArcGIS*: ArcGIS is a geographic information system for working with maps and geographic information. Retrieved from https://www.arcgis.com/features/index.html

In this analysis, the research questions (RQs) were the following:

RQ1: What is the relationship between the frequency of attacks and distance to high value targets?

RQ2: How are the frequencies of attacks differing based on the type of target?

RQ3: How are ratios of attacks, to be used as a precursor of behavior?

The research questions (RQs) reframed into testable alternative research hypotheses are as follows:

Hypothesis: There is a relationship between the intensity of fatalities increasing with decreasing distance to high value targets.

Alternative Hypothesis: There is not a relationship between the intensity of fatalities increasing with decreasing distance to high value targets.

Null Hypothesis: The intensity of fatalities is unchanged with distance.

This analysis used multiple linear regression to exam pre-existing attack events recorded by the United States Government. A synchronic examination was conducted by splitting the date into years. The results were interpreted with the estimates, model fit, confidence intervals, the R squared change and descriptive statistics. Using SPSS

software, it was accomplished in the following steps as outlined by Green and Salkind (2014):

1. Open SPSS software.
2. Click Analyze, click Regression, and click Linear.
3. Click Hazard Force, and move place it in the Dependent box.
4. Hold down CTRL key, click distance, fatalities, time of event. Place them into the Independent box.
5. Click Statistics, ensure Estimates and Model Fit are selected.
6. Click Confidence intervals, Descriptive, and Part and partial correlations.
7. Click Continue and OK.

Splitting the date fie was accomplish with the following steps outlined by Green and Salkind (2014):

1. Open SPSS software.
2. Click Data, then Split File.
3. Click Organize Output by Groups.
4. Double click “Year.”
5. Click Ok.

Threats to Validity

This quantitative analysis, using multiple linear regression, extracted the relationship between the distance, fatalities, and time (independent variables) to the HF (dependent variable) executed by ISIS in Syria, between the years 2007 to 2015. This analysis was conducted synchronically by splitting the data into years.

This analysis describing the relationship of the variables occurred without any interference from the researcher, any change in the conditions of the phenomena being studied or with any randomization.

In order to maintain an integrity of occurrence in the data set, the time order of the independent variables to the dependent variable was preserved before statistical analysis. The analysis is descriptive resulting in an interpretation of the data, as it occurred. The variables were not manipulated. However, they were formatted to be executed in the SPSS software or to match peer-review studies of similar characteristics or attribution (Rudestam & Newton, 2014).

Validity, in a non-experimental analysis, is addressed through the validity of the measurements of the data. This analysis acquired the data from the United States Government agency JIDO. This agency specializes in data field collection and possess personnel that are specifically trained in operational reliability and in the validity of measurements.

If this was an experimental design, then it would be more appropriate to account for the effects of causal relationships between variables. This analysis, as a non-experimental design, is only answering the research questions as a descriptive analysis. Conclusions about causal relationships between the variables are beyond the scope of this analysis and should be executed Post Hoc with a different research question and appropriate analytical tool (Salkind, 2010).

Ethical Procedures

The acquisition of JIDO data was initiated from a formal request. A request for access was sent to the DARC branch. The request was reviewed and granted by the following senior executives: (a) The branch chief, (b) the senior pattern analyst, and (c) the deputy general counsel.

Permission to use this data set was acquired from the Walden University IRB application, document submitted separately. Once the data was "scrubbed" or filtered to remove any classified or personally identifiable information, the data was sent to this researcher through unclassified email. A copy of the request was included with all documentation submitted separately to the IRB.

The data is to be used only for academic research. If there is a need to use the data beyond its intended use, the DARC branch has stipulated that a new request must be submitted for any new research. The data provided is stored on a password protected hard-drive for this analysis.

Summary

This analysis is a non-experimental synchronic retrospective analysis. The two tools that operationalize the methodologies and are appropriate for this analysis are: (a) Multiple linear regression developed by Sir Francis Galton in 1875, and (b) Hazard Force Analysis develop by Cioffi-Revilla & Romero (2017).

The method of inquiry is executing Multiple linear regression to examine the research questions. Multiple linear regression is an optimal methodology, and is commonly used to analyze data in studies with non-experimental designs. HF, as a

published, peer-viewed, methodological formula to compute the intensity of an attack, has been tested with real-world warfare data similar to ISIS.

The method of inquiry is being used to find significance with the independent variables to the dependent variable only as a descriptive analysis with the variable of time analyzed as a split file. Significance was uncovered in the latter years of ISIS' existence. In this chapter, I discussed the research design and rationale, methodology, independent variable manipulation, threats to validity, and ethical procedures. Chapter 4 is a structured presentation of the statistical results. The results are presented as the estimates, model fit, confidence intervals, the R squared change, and descriptive statistics using SPSS software.

Chapter 4: Results

Introduction

The purpose of this quantitative analysis, using multiple linear regression, is to extract the relationship between the distance, fatalities, and time (independent variables) to the HF (dependent variable) executed by ISIS in Syria between the years 2007 to 2015. This analysis was conducted synchronically by splitting the data into years.

The research questions (RQs) included the following:

RQ1: What is the relationship between the frequency of attacks and distance to high value targets?

RQ2: How are the frequencies of attacks differing based on the type of target?

RQ3: How are ratios of attacks, to be used as a precursor of behavior?

The RQs reframed or translated into testable alternative research hypotheses, as follows:

Hypothesis: There is a relationship between the intensity of fatalities increasing with decreasing distance to high value targets.

Alternative Hypothesis: There is not a relationship between the intensity of fatalities increasing with decreasing distance to high value targets.

Null Hypothesis: The intensity of fatalities is unchanged with distance.

In Chapter 4, I present the statistical results. The main sections are data collection, results, and summary. The results of the estimates, model fit, confidence intervals, the R squared change and descriptive statistics were generated using SPSS software.

Data Collection

The data set of 22,006 records for 20 countries, under the jurisdiction of the United States Central Command, was acquired for this analysis. It was reduced to 12,326 records for the countries of Syria and Iraq. The derivatives, in name and structural organization, for ISIS contained 1,409 records. The data is a record of all situational reports classified as adversarial attack events. These attacks were recorded between the years 2007 to 2015.

The temporal range from 2007 to 2015 exists as an attribute assigned by the United States when the data was operationally collected. At that time, there was no requirement or anticipated duration of the attacks. It is probable, however, that there was an operational change to the collection formats (i.e., change in policy, battle tempo, technological, etc.).

Syria was the stronghold for ISIS and was a natural focus for analysis during the temporal range. By capturing all the naming derivatives of structural organization, the ISIS data resulted in 1,409 records. The impact was that the finalized Syrian data set provided the most unadulterated record to analyze based on descriptions in the literature review and to answers the RQs.

The final data set contained 71 columns reduced to the three independent variables identified in the literature: (a) fatalities, (b) time between fatalities, and (c) distance from a high value target. The data set contained gaps, blanks, and misspellings. The data set spanned a temporal range covering 8 years (2007–2015). Once the procedure

of splitting the file was executed into years, the temporal range was reduced to 5 years (2011–2015).

Results of the Study

Descriptive statistics are included in Table 1.

Table 1

Descriptive Statistics

Var	Mean	St. Dev.	ValidN	Min	Max	Skew	Kurtosis
Distance	11	11.5212	1409	0	49.325	1.159	.752
Time	640	393.228	1409	0	999.00	-.029	-.719
Fatalities	14.99	45.748	1409	0	854.00	8.092	104.935

To address if "There is a relationship between the intensity of fatalities increasing with decreasing distance to high value targets," a multiple linear regression analysis was conducted to evaluate the prediction of HF from fatalities, time, and distance.

The results of the multiple linear regression analysis revealed that time was not a statistically significant predictor to the model ($p > .05$). However, the results of the multiple linear regression analysis revealed a statistically significant association between fatalities and distance.

Controlling for fatalities and distance, the regression coefficient [B = -.481, 95% C.I. (-.484, -.481) $p < .05$] associated with fatalities suggests that with each additional fatality, the HF increases by approximately [.025]. The R^2 value of [0.242] associated with this regression model suggests that the fatalities accounts for [24.2%] of the

variation in HF, which means that [75.8%] of the variation in HF cannot be explained by fatalities alone. The confidence interval associated with the regression analysis does not contain 0, which means that the null hypothesis can be rejected. Similar results were found for distance.

Controlling for fatalities and time, the regression coefficient [B = -.483, 95% C.I. (-.484, -.481) $p > .05$] associated with fatalities suggests that with each additional time interval, the HF decreases by approximately [.026]. The R^2 value of [0.26] associated with this regression model suggests that the fatalities accounts for [26%] of the variation in HF which means that [74%] of the variation cannot be explained by fatalities and time alone. The confidence interval associated with the regression analysis does not contain 0, which means the null hypothesis can be rejected. Similar results were not found for time.

Controlling for distance and time and the regression coefficient [B = .115, 95% C.I. (.111, .111) $p < .05$] associated with distance suggests that with each additional distance, the HF increases by approximately [.022]. The R^2 value of [.012] associated with this regression model suggests that the distance accounts for [1.2%] of the variation in HF. This means that [98.8%] of the variation in income cannot be explained by distance and time alone. The confidence interval associated with the regression analysis does not contain 0, which means the null hypothesis can be rejected. Similar results were not found for Time.

In “Controlling for” the individual variables with the multiple linear regression, the variable Fatalities made the largest contribution as indicated from the coefficients and

could explain [26%] of the variation in this case. Time was executed at the measurement level of days, as suggested by the literature review. It has proven not to be significant.

However, this data set, acquired in a real-world setting, did not just occur over days. The phenomena of ISIS endured for years. By utilizing the same model, the variable time was addressed by splitting the data file as outlined in Green and Salkind (2014) and controlling for fatalities and time (measured as years).

The following Pearson Coefficient values (Table 2) correspond with the appropriate year. What it demonstrates is significance when the variable is parsed by years:

Table 2

Pearson Coefficient

Years	Pearson (P)
2011	.349
2012	.741
2013	0.0
2014	.014
2015	0.0

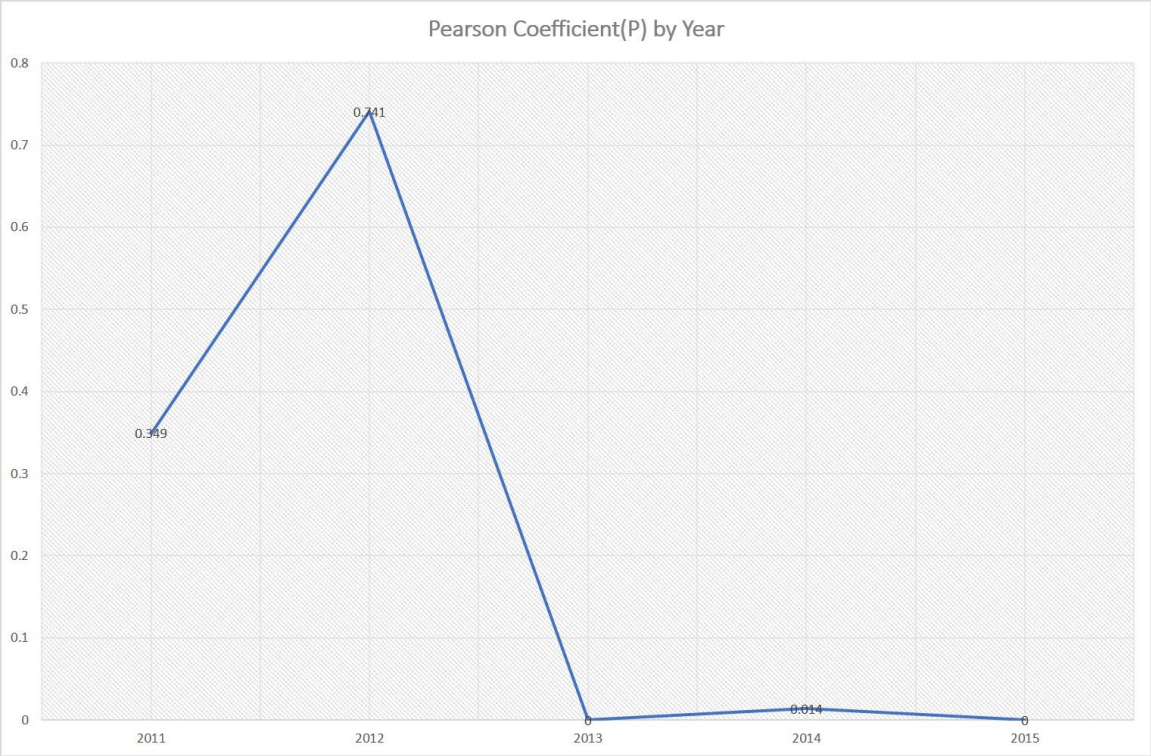

Figure 2. Pearson coefficient versus time.

Summary

The answers to the research questions can best be summarized as the following: (a) The relationship between the frequency of attacks and distance to high value targets does exist. (b) The relationship is an increase in organizational social structure as the distance is reduced. (c) The frequencies of attack towards a high value target increase with adversarial competence. This is demonstrated through the Pearson coefficient for significance where ($p < 0.05$) for 2013 to 2015. The ratios of attacks can be used as a precursor of adaptive change and suggests adversarial learning.

In Chapter 5, I present the interpretation of the data. This analysis executed a synchronic analysis. It was conducted on real-world data collected by the United States

government. The methodology extracted patterns of behavior computationally by examining the relationship of the independent to the dependent variables. Splitting the file was a divergence from the literature's suggestion in measuring time. This analysis modified the independent variable of time by changing the resolution from days into years. The modification highlighted an increasing structural organization of behavior or adaptive learning by the adversary.

Chapter 5: Discussion, Recommendations, and Conclusions

Introduction

The purpose of this quantitative analysis was to conduct a non-experimental synchronic retrospective analysis by using multiple linear regression to exam pre-existing attack events recorded by the United States Government. This analysis examined the adversarial attack data synchronically by splitting the time variable.

Numerically reduced adversarial behaviors were reduced to independent variables represented as: (a) distance, (b) fatalities, and (c) time. This analysis was conducted because the United States is executing analytical methodologies that are inappropriate for combating modern terrorism. Policy makers can quantify adversarial behavior to extract insights about their successes and vulnerabilities to create policies capable of accelerating, increasing failure or removing adversarial advantage.

The key findings of this analysis are: (a) quantitative approaches can contribute in assessing the modern adversary, (b) multiple linear regression can be used to uncover adversarial patterns, (c) the ratio of HF is a robust application of applied gaming theory, (d) adversarial learning was discovered by dividing the data synchronically, and (e) the Pearson coefficient can be used to quantify the speed of adaptation or learning (see Figure 2).

Interpretation of the Findings

This analysis' approach has been confirmed by measuring applied gaming theory's rational preference with Cioffi-Revilla & Romero's (2017) methodological formula to compute intensity of an attack. The review of the literature provided examples

in which applied gaming theory was tested in warfare and organizational turn-overs. Tuyls et al. (2017) suggested that gaming theory is capable of measuring an adversarial rational choice. Qualitative methodologies for combating terrorism, targeting ethnic, historic, regional, or religious differences are measuring the wrong phenomena (Ozekin & Akkas, 2014).

Cioffi-Revilla and Romero (2017) provided the methodological formula to compute the potential or intensity of an attack. Measuring the speed of the modern attacking adversary adaptation must be executed in the appropriate time quanta (synchronically) to detect changes (Knight, 2014; Terrill, 2014).

The change in their attacks or the frequencies of attack are explained with applied gaming theory. Adversaries' rational decisions are made with incomplete information and their changes are in response to unanticipated variables in the environment. Ashour (2015) suggested that researchers should numerically quantify attributes of the operational environment and the effects from geography, regional landscapes, hydrology or military tactics.

Diverging from journalistic analysis, the quantification of data creates the ability to detect changes by the change in frequency of behaviors. This is important because ISIS, as a modern adversary, is operating with the acumen of an adaptive learning organization (Ionita and Aanitei, 2015; Jasper & Moreland, 2014).

This analysis demonstrated significance for 2013 to 2015 ($p < .001$) when the variable of time was analyzed as a split file (see Figure 2). Once the adversary has adapted to a new operational environment, new computations should be executed because

the new numerical values are a measure of the speed of their adaptation. This statistical discovery within the data is interpreted as adversarial learning. Applied gaming theory's symmetric and asymmetric approaches use computational methodologies to quantify strategic interactions. Multiple linear regression uncovered the relationship in the adversarial variables. The Pearson coefficient quantified the speed of their adaptation or a measure of adversarial learning.

This analysis' interpretation is in alignment with peer-reviewed descriptions of statistical epochs, as suggested by the International Crisis Group (2006) and Feller (1968). Figure 3 depicts the fatalities and its density. The graphic demonstrates an increase in frequencies as distance is reduced to zero, the location of a high value target. Three statistical epochs have been identified in the red boxes. An epoch should be viewed as a fundament significant transitions of statistical change in the organizational social structure (Cioffi-Revilla, 2009). For this analysis, the epochs are described by their appropriate phases (see Figure 3).

In Phase 1, the adversary has little coordination, no structural organization, and demonstrates a lack of expertise. In Phase 2, the adversary consolidates, small successful groups merge and a greater frequency of attacks increases. In Phase 3, the adversary has increased organizational capacities and competence.

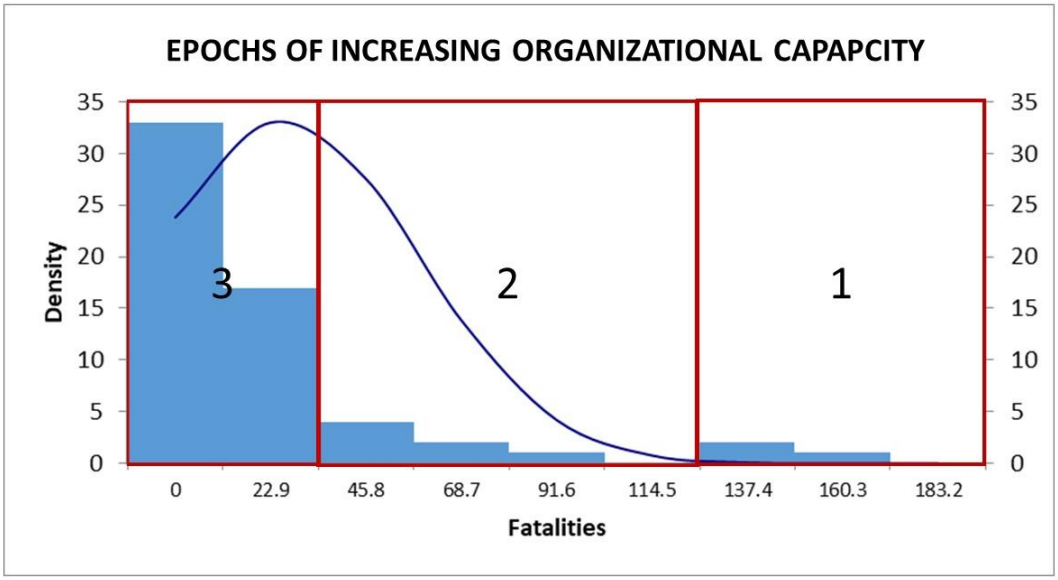

Figure 3. Epochs of significant transitions.

Limitations of the Analysis

A limitation for this analysis was the misalignment in temporal resolution between what the literature suggested and real-world data. This came from a bias, in initial thinking, that the over-all data set was a complete set of continuous events. Another limitation was a bias in thinking that the authoritative source started collecting data from a universality accepted starting point and that all appropriate variables needed for researchers would have been recorded. The data set has gaps, blanks, misspellings, etcetera.

The analysis parsed or split the data by years when the independent variable of time did not initially show significance. One justification for doing this is a bias in thinking that fighting was continuous. Ashour (2015) suggested that events could not be continuous because of the break in fighting tempo identified when ISIS fighters were

picking up weapons and equipment from the Iraqi Security Forces supplied from U.S. led coalition forces (Ashour, 2015).

An aggregate of limitation are things that cannot be explained due to the variables that were not recorded. The conclusion is that documentation of ISIS events was probably recorded sporadically. This analysis could not account for breaks in supplies, injuries, or in seasonal weather. When the attributes were optimal for their attacks, the significance of the independent variables to the dependent variable has reliability and validity from the data.

A limitation for this analysis was the skewed methodologies of previous studies which translate into how past data sets were created (Chenoweth et. al, 2019). This produced non-exploitable data sets for the research questions posed in this analysis. In the beginning of the literature search, one data candidate was identified, but was rejected due to the journalistic attribution of the data events. Additionally, the candidate organization invested intensive labor into the creation of their database. The natural result was that their investment was considered proprietary.

Recommendations

Future research construction of policy can only benefit from better integrations of theory, measurements, and computational tools. There must be a greater engagement between qualitative and quantitative tools for analysis. Qualitative theory generation could create improve models with quantitative simulations to identify trends, intent, or untended consequences for conflicts. Effective policies have the potential to influence human behavior on multiple scales.

For future practitioners, it will be necessary to have data collected on variables that are not currently being recorded. Or they will have to orchestrate between models, different phenomena, or multiple temporal scales. New data sets potentially should have variables capable of qualitative and quantitative analysis with sensitivity to rates of change. Indicators triggering policy stop gaps for mitigation should have the potential to interfere with cascading failures and rare events.

In my opinion, the discipline could benefit in the following ways:

1. Forensic analyses examining past events testing newly integrated theories and computational tools to gain historic insights.
2. Greater measurements for forecasting the efficacy of military interventions compared to more diplomatic approaches or "Controlling for" doing nothing.
3. An examination of how adversarial adaptation degrades U.S. policies.
4. Operational feedback loops that monitor frequency changes for causal variables.
5. Research on appropriate temporal resolutions for analysis.
6. Policy gap analysis that inadvertently create safe-havens, information sharing anomalies, jurisdiction conflicts, or unimpeded travel for terrorists.

Implications/Positive Social Change

Future policy practitioners might have to create conceptual hybrids to account for behaviors that have never been anticipated. The Fiscal Year 2018 total costs on terrorism is more than $5.6 trillion USD (Crawford, 2017). The GAO quantitatively demonstrated increases in military action, create increases in adversarial violence (GAO-17-68, 2017).

The positive social change is the objective assessment of cost vs. efficacy. In responding to modern terrorists, lone military courses of actions are not sustainable.

The existence of adversarial innovation is an indication that the United States does not evolve fast enough with terrorists. The modern adversary is demonstrating adaptation. Computations can provide the recognition indicators that policy makers need to avoid resource exhaustion.

Effective policies have the potential to create more appropriate humane responses. Quantitative computational tools extract the nuances essential for more robust policy options. The greater implication is that such a methodological structure can be applied with ubiquity when the research questions warrant their use.

Conclusion

Modern adversaries have been viewed with antiquated schools of thoughts and inappropriate methodologies. The failure to properly quantify, an adversary, creates an impotent or unsustainable counter-response to mitigate their behavior. The implication is that policies that are generated from this lack of contextual comprehension will initiate, prolong, or extend the longevity of conflict unnecessarily. This will waste resources both economic and human.

Adversarial intent, which is normally hidden, can be extracted empirically using computational methodologies. The insight that has emerged from this analysis is that an adversarial group must have time to create an organizational structure for group survival.

Regardless of the speed of an adversarial behavior, the attack events are best studied within the appropriate temporal resolution. In this analysis, precursors of

behaviors aligned with integrating modern theories, measurement, and computational tools to extract hidden behaviors.

This analysis, as a non-experimental synchronic retrospective analysis, used two tools that operationalize the methodology: (a) Multiple linear regression developed by Sir Francis Galton in 1875 and (b) Hazard Force Analysis develop by Cioffi-Revilla & Romero (2017).

Multiple linear regression is an optimal methodology, and is commonly used to analyze data in studies with non-experimental designs. HF, as a published, peer-viewed, methodological formula to compute the intensity of attacks.

The contribution is that robust policies focused, on terrorism, can emerge to accelerate failure, interrupted success, or disrupt the modern adversary. The economy of resources, for a decision maker, has the potential to provide insight on ending conflict more efficiently or to re-direct resources to more positive social endeavors.

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