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# Contemporary Terrorism Paradigm: Terrorist Attacks on Transportation Systems

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Contemporary Terrorism Paradigm: Attacks on Rail and Subway Transportation

# Contemporary Terrorism Paradigm: Terrorist Attacks on Transportation Systems

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## ABSTRACT

The Contemporary Terrorism Paradigm has been examined in concept, but little research has applied the theory to specific targeting of terrorist organizations. To build on this limited research, the current study analyzed the number of terrorist incidents targeting the transportation infrastructure in North America, Western Europe, and East Asia between 2001 and 2016 to ascertain if the Contemporary Terrorism Paradigm explains the variance between number of incidents and number of casualties. The use of North America, Western Europe, and East Asia created an opportunity to examine vulnerabilities in the transportation infrastructure and identify areas in the United States transportation infrastructure for target hardening. The incidents were subsequently divided into incidents targeting road transportation and rail transportation. However, some research questions address the transportation infrastructure. The study also examined weapon type and number of incidents resulting in casualty. The study found statistically significant results that support the application of the Contemporary Terrorism Paradigm to the targeting of the transportation infrastructure.

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# CHAPTER 1

# INTRODUCTION TO THE STUDY

## Introduction

The attacks of September 11, 2001 highlighted many vulnerabilities inside America's national security framework and caused a reorganization of many federal organizations under the Homeland Security Act of 2002. Shvetsov, Shvetsova, Kozyrev, Spharov, and Sheremet (2016) observed that "the frequency of terrorist attacks on transportation facilities has considerably increased since the end of the twentieth century and transportation has become one of the major targets of terrorists" (p. 2). While aviation is an important part of the US public transportation infrastructure, it does not account for the majority of travel in the United States. According to the Bureau of Transportation, 798.4 million passengers traveled by air in the 2015 fiscal year while 10.3 billion passengers travelled by bus, commuter rail, heavy rail, light rail, and streetcar over the same time-span. A secure and efficient transportation infrastructure is crucial to the United States economy.

The National Infrastructure Advisory Council (NIAC) advices the President of the United States on the security and resilience of critical infrastructure systems. The NIAC recognizes that each critical infrastructure is dependent on the resilience of the transportation infrastructure. In the executive summary of the 2015 publication *Transportation Sector Resilience,* the NIAC stated, "Without [the transportation infrastructure], most critical services would cease to function" (p. 1). The NIAC

recognized that growing interdependencies within regional infrastructures increases the reach of a localized disruption to surrounding infrastructures.

Research has shown that a delay in travel, either short-term or prolonged, has an effect on a local, a regional, and a national level. This cascading effect is due to interdependencies among critical infrastructures. Greenberg et al. (2013) constructed three simulation models to evaluate the economic effects of a short term and a prolonged delay in rail travel from Trenton, New Jersey to Penn Station, New York. Greenberg et al. (2013) identified effects ranging from the local level to the national level. Prolonged delay lasting weeks to months can have significant consequences to the local, regional, and national economy. Similarly, Ouyang (2014) applied an input-output inoperability model to the critical infrastructures in the United States to analyze various interdependencies of the transportation infrastructure. It was found that an attack on or damage to a part of the United States transportation infrastructure would have effects on various economic sectors. Likewise, Zhang and Peeta (2011) simulated a delay in rail transportation in Mainland China to find rippling effects on the nation's economy due to critical infrastructure interdependencies. As a result, researchers have observed various degrees of interdependencies among national critical infrastructures to learn the effects of a short term and prolonged delay in a part of the transportation infrastructure.

In addition to critical infrastructure interdependencies, research shows certain limitations in the implementation of enhanced security on surface public transportation. Aviation security was strengthened following September 11 by enhancing security at airports. The Transportation Security Administration (TSA) restricts free flow of people in an airport by enforcing security check points and screenings. Research conducted by

Levin (2016) found that such security would fail to be implemented into surface public transportation due its constriction of the free flow of people. Jenkins and Gerten (2001) agree that many stops and travel across vast territory make the implementation of security measures similar to those found at an airport relatively impossible. Jenkins and Gerten (2001) further asserted that such security measures would create extensive delays and would be cost prohibitive. Protecting transportation infrastructures is vital to a nation's economy and well-being; however, certain limitations in security implantation create vulnerabilities to be exploited by attackers.

Notable attacks in London in the late 20th century and in Japan in 1995 demonstrate the effects an attack or a prolonged attack can have both locally and nationally. Additionally, it is important to identify the lessons learned from key attacks on transportation. Over a span of twenty years, the Irish Republican Army (IRA) terrorized Britain. The IRA – armed insurgency that lead to the independence of Ireland – dates back to the 1920; however, Northern Ireland continued to be ruled by the British (Jenkins & Gerten, 2001). In the 1960s, the IRA broke into two groups, the Official IRA and the Provisional IRA. The Provisional IRA waged a terrorist campaign against England. The IRA systematically targeted Britain's transportation Infrastructure placing eighty-one explosive devices throughout London's Underground (Jenkins & Gerten, 2001). Jenkins and Gerten (2001) suggested that the IRA targeted Britain's transportation infrastructure due to its vulnerabilities. Jenkins and Gerten (2001) further asserted that the objective of these attacks was disruption. The disruption was both physical and psychological as it led to the creation of new security measures that

ultimately slowed down rail transport as well as psychological disruption in the number of passengers willing to take the London Underground.

Similar to IRA motives, Al Qaeda terrorists targeted Madrid's railway system days prior to Spain's 2004 election. On March 11, 2004 Al Qaeda terrorists coordinated simultaneous attacks on four trains and three stations killing 191 people and injuring over 2000 (Iatridis, 2012). Cortez et al. (2015) argued that the bombing caused an average 11.2 percent of Spanish people to change their vote. Cortez et al. (2015) further argued that PSOE – the socialist party – would not have won the election without the intervention of Al Qaeda on March 11. Overall, research suggests that the bombing campaign carried out against Madrid's railway system in 2004 was in order to influence government proceedings.

Contrary to the IRA's campaign against England, the Aum Shinrikyo, a religious cult operating in Japan, initiated a planned attack against Tokyo's subway system. On March 20, 1995, the Aum Shinrikyo targeted three subway lines and sixteen stations during the height of the morning rush (Jenkins & Gerten, 2001; Loukaitou-Sideris, Taylor, & Fink, 2006). The attack effected both rail passengers and transients on the surface leading to the hospitalization of over 5,500 Japanese civilians (Jenkins & Gerten, 2001). The sarin gas release on Tokyo's subways system was the first time a chemical agent was used as a weapon targeting a transportation infrastructure.

The planned attack on Tokyo's subway system lead to the creation of two different categories of antiterrorist measures for Japanese transit operators. The first measure identified concerned activities for the prevention of an attack (i.e. surveillance, technology, information, and design strategies). The second measure regarded emergency

preparedness and disaster response (Loukaitou-Sideris et al., 2006). Similarly, British transit officials established a layered security system aimed at the deterrence of terrorism targeting London's transportation infrastructure. Likewise, Spanish transit security increased police presence at stations and enhanced security for new stations. New guidelines for station security is seven-part: (a) the use of transparent materials, (b) the elimination of dark zones, (c) limitation of entrance points, (d) open platforms, corridors, and waiting areas, (e) the avoidance and elimination of underground passages, footbridges, and winding corridors, (f) panoramic elevators and (g) the elimination of space under and on top of vending machines (Loukaitou-Sideris, 2006). Evaluating an attack enhances an infrastructures resilience against future attacks.

Terrorists have targeted modes of public transportation due to the potential of destruction, disruption, and escape of perpetrator. Further, interdependencies between critical infrastructures make transportation infrastructures an attractive target to terrorists. In addition to interdependencies, surface public transportation is subject to certain inherent vulnerabilities. The free flow of people on surface public transportation presents a strategic challenge to security. Therefore, it is important to consider the vulnerabilities and interdependencies contained in the transportation infrastructure to enhance the critical infrastructures resilience.

## Conceptual Underpinning for Study

Contemporary Terrorism Paradigm addresses the notion that terrorist tactics, motives and targets have shifted from previous, pre-20th century terrorism. Terrorism as a concept has existed throughout history; however, technological advances and the invention of weapons of mass destruction have contributed to a shift in terrorist activity.

The concept of contemporary terrorism is not unanimously accepted in the discipline, nor is the date of its origin. Rapoport (2004), Laqueur (1996), and Strandberg (2013) dated contemporary terrorism to the 1880s as terrorist organizations made their first international attacks in Western Europe, Asia, and the Balkans. Conversely, Duyvesteyn (2004) questions new or modern as a label of today's terrorism.

Researchers of contemporary terrorism broadly agree on a shift in the role of religion, in target selection, and in tactics of operations. Rapoport (2004) identified religion as a driver/motive in both traditional terrorism and contemporary terrorism, but defined the current wave of religiously motived terrorism as a shift from the creation of secular states to justification and "organizing principles" of current terrorist organizations (p. 61). Hoffman (2006) went as far as to assert that "the religious imperative for terrorism is the most defining characteristic of terrorist activity today" (p. 130). Laqueur (1996) expands Hoffman's (2006) notion to identify a growth in religious terrorism in Christianity, Judaism, Hinduism as well as Islam.

## Statement of the Problem

The premise is that the United States transportation infrastructure, specifically rail transportation, is at risk for attack due to past attacks targeting transportation in Western Europe, East Asia, and North America. This study focused on the aforementioned regions due to their similarities in critical infrastructure operation and security. In addition, this study examined a trend in successful terrorist incidents in rail transportation to assess the relationship within terrorist incidents targeting transportation, weapon type, and number of incidents resulting in casualty. Narrowing down the final analysis to West Europe, East Asia, and North America allowed this study to draw close comparisons to potential

vulnerabilities in the United States transportation infrastructure. While much research has been done on vulnerabilities in public transportation, limited research exists on the application of the Contemporary Terrorism Paradigm to transportation infrastructure resilience. Thus, there is a need to conduct a study to identify whether the theory would accurately explain variation in number of terrorist incidents in weapon type and targeting of rail and metro transportation infrastructures.

## Purpose of the Study

With the research problem stated, it is necessary to list the specific research questions that were tested. These questions focus on the differences in attack on various modes of public transportation, specifically looking for differences in the number of incidents.

The hypotheses predict that the Contemporary Terrorism Paradigm would or would not apply to terrorist attacks that target transportation infrastructures. The null and alternative hypotheses for each question were mutually exclusive claims, where the data would indicate them as acceptable or rejectable. By testing each of these smaller hypotheses, the larger question of how the Contemporary Terrorism Paradigm applies to terrorist attacks targeting transportation infrastructures will be answered.

### Research Questions

1. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of terrorist incident between rail transportation and road transportation?
2. Is there a significant difference in the number of successful terrorist incidents between the three regions: Western Europe, East Asia, and North America?

3. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning weapon type?
4. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning casualty[1] rate?
5. Is there a significant difference in number of casualties between the three regions?
6. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of casualties by weapon type?

**Hypotheses**

$H_0$: Looking at the three regions collectively, there will be no difference in the number of successful incidents between rail transportation and road transportation.

$H_1$: Looking at the three regions collectively, rail transportation will yield a higher number of successful terrorist incidents.

$H_0$: There will be no significant difference in the number of terrorist incidents between Western Europe, East Asia, and North America.

$H_2$: There will be a significant difference in the number of terrorist incidents between Western Europe, East Asia, and North America.

$H_0$: Looking at the three regions collectively, there will be no significant difference in the number of terrorist incidents concerning weapon type.

[1] Defined as victims killed and wounded (Federal Bureau of Investigation, 2014).

$H_3$: Looking at the three regions collectively, incendiary will yield a higher number of terrorist incidents.

$H_0$: Looking at the three regions collectively, there will be no difference in the number of terrorist incidents concerning casualty.

$H_4$: Looking at the three regions collectively, there will be a significant difference in the number of terrorist incidents concerning casualty.

$H_0$: There will be no significant difference between the three regions and the number of terrorist incidents resulting in casualty.

$H_5$: There will be a significant difference between the three regions and the number of terrorist incidents resulting in casualty.

$H_0$: Looking at the three regions collectively, there will be no significant difference between weapon type and the number of incidents resulting in casualty.

$H_6$: Looking at the three regions collectively, there will be a significant difference between weapon type and the number of incidents resulting in casualty.

## Limitations and Assumptions

As with any academic study, this research is subject to certain limitations and assumptions. Understanding these issues is important as they will put the study's results into context. Ignoring the limitations and assumptions of a study would lead to false conclusions. This study will rely on data that has already been collected by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) in the Global Terrorism Database (GTD). The GTD does not report data for 2017 until the summer of 2018. Therefore, this study will include data up to 2017.

The limitations of this study primarily surround the data collection by START in the GTD. START collects data for the GTD from new outlets and open source reports. Incidents are updated as new information is learned. Additionally, reporting of facts by primary sources may be skewed or may have bias. Overall, the GTD attempts to verify all sources to report factual statistics and incident reports.

## Definition of Key Terms

The following key terms helped frame the topic of the study by creating a common understanding of some concepts and terms used.

Commuter rail – "A mode of transit service (also called metropolitan rail, regional rail, or suburban rail) characterized by an electric or diesel propelled railway for urban passenger train service consisting of local short distance travel operating between a central city and adjacent suburbs" (Bureau of Transportation).

Critical infrastructure – Infrastructures "whose incapacity or destruction would have a debilitating impact on our defense and economic security" (Rinaldi, Peerenboom, & Kelly, 2001, p. 12).

DOD – United States Department of Defense (Department of Defense, 2017).

Domestic terrorism – "The unlawful use, or threatened use, of force or violence by a group or individual based and operating entirely within the United States or Puerto Rico without foreign direction committed against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives" (Federal Bureau of Investigation).

FBI – United States Federal Bureau of Investigation (Federal Bureau of Investigation, 2014).

GTD – Global Terrorism Database (Greenberg et al., 2013)

Heavy rail – "A mode of transit service (also called metro, subway, rapid transit, or rapid rail) operating on an electric railway" (Bureau of Transportation).

IED – Improvised explosive device, "a homemade device that is designed to cause death or injury by using explosives" (Gill, Horgan, & Lovelace, 2011, p. 734).

Infrastructure – "A network of independent … man-made systems and processes that function collaboratively and synergistically to produce and distribute a continuous flow of essential goods and services" (Rinaldi et al., 2001, p. 12).

Infrastructure resilience – "The ability to reduce the magnitude or duration of disruptive events that is accomplished by anticipating, absorbing, adapting to, or rapidly recovering from the disruption" (National Infrastructure Advisory Council, 2015, p. 1).

International terrorism – "Violent acts or acts dangerous to human life that are a violation of the criminal laws of the United States or any state, or that would be a criminal violation if committed within the jurisdiction of the United States or any state … intended to intimidate or coerce a civilian population, influence the policy of government by intimidation or coercion, or affect the conduct of a government" (Federal Bureau of Investigation, 2014).

IRA – Irish Republican Army (Jenkins & Gerten, 2001).

Light rail – "A mode of transit service (also called street car, tramway, or trolley) operating passenger rail cars singly … on fixed rails" (Bureau of Transportation).

Resilience – "The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruption" (Department of Homeland Security).

START – The National Consortium for the Study of Terrorism and Responses to Terrorism (Jenkins & Gerten, 2001).

Terrorism – "The unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (Federal Bureau of Investigation, 2006).

TSA – United States Transportation Security Administration

Unlinked Passenger Trips – Refers to the number of passengers who board public transportation (Bureau of Transportation).

WMD – Weapons of Mass Destruction (Strandberg, 2013).

## Summary

Transportation infrastructures have been examined nationally and on a global scale; however, little research has been done to apply an academic theory to analyze attacks targeting transportation infrastructures. Much emphasis is placed on the importance of the transportation infrastructure due to interdependencies linking critical infrastructures to other infrastructures as well as a nation's economy. The National Infrastructure Advisory Council (NIAC) recognizes these interdependencies and states the economic consequences of an attack on the transportation infrastructure in the United States. However, to analyze the risk of an attack, the study will look at attacks on transportation infrastructures in Western Europe, East Asia, Oceania, and North America (excluding Mexico) from 2001 through 2016. By focusing on these individual regions, this study will evaluate the number of terrorist incidents as well as in weapon type and number of terrorist incidents resulting in casualty.

The proceeding chapters contain the culmination of the study. Chapter two discusses all relevant literature to this study. The review consists of an analysis of research related to interdependencies of critical infrastructures, vulnerabilities of surface public transportation, and weapon type. Chapter three describes the method used in this study in detail. The population and data collection procedures are described. The data analysis process is also discussed to explain how the research question will be answered and how hypotheses will be accepted or rejected. Chapter four presents the data of the study and either accepts or rejects the null hypothesis of each research question. Chapter five applies the Contemporary Terrorism Paradigm to data presented in chapter four to determine if it explains the trend in terrorist incidents targeting transportation systems.

# CHAPTER TWO

# REVIEW OF LITERATURE

## Introduction

This chapter will review relevant literature associated with transportation infrastructures globally to include railways rail transportation. An additional analysis is added to discuss potential weapon types such as explosive devices, chemicals, bioterrorism, sabotage equipment, and firearms. Each subsection includes prior academic research and builds towards the application of the Contemporary Terrorism Paradigm to the analysis of the United States transportation infrastructure.

The topic of this study was introduced in chapter one. This included the central question of whether the Contemporary Terrorism Paradigm explains which mode of transportation in the United States is at highest risk for attack. To examine this, attacks targeting transportation infrastructures regionally will be compared statistically and evaluated. Chapter one also laid the groundwork for the study by establishing the conceptual underpinning of the Contemporary Terrorism Paradigm. This framework is going to be used to evaluate if the hypotheses are accepted or rejected based on the analysis of data. The chapter concluded with definitions of key terms and a discussion of the study's limitations and assumptions. The research questions that this study will answer are as follows:

1. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of successful terrorist incident between rail transportation and road transportation?

2. Is there a significant difference in the number of successful terrorist incidents between the three regions: Western Europe, East Asia, and North America?
3. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning weapon type?
4. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning casualty[2] rate?
5. Is there a significant difference in number of casualties between the three regions?
6. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of casualties by weapon type?

This chapter's discussion of literature addresses several relevant subtopics. First, it looks at how the Contemporary Terrorism Paradigm is applied to the targeting of rail and subway transportation on a global platform. Then, the review assesses the literature on transportation infrastructure vulnerabilities, followed by a review of the literature on weapon type, globally and regionally specific. This section will conclude with general literature on the Contemporary Terrorism Paradigm.

## Contemporary Terrorism Paradigm

To understand the Contemporary Terrorism Paradigm, a definition must first be assigned to terrorism. The term terrorism was created during the French Revolution in the late 1700s; however, evidence of terrorism dates back to the 11th and 12th centuries with the Assassins (Moten, 2010). Terrorism as a term lacks a universal definition; however,

[2] Defined as victims killed and wounded (Federal Bureau of Investigation, 2014).

definitions by the U.S. State Department, the U.S. Department of Defense, and the Federal Bureau of Investigation are most commonly used. The United States State Department defines terrorism as, "Premeditated, politically motivated violence perpetrated against non-combatant targets [civilians; military personal not deployed in war zone or war like setting] by subnational groups or clandestine agents." The United States Department of Defense (DOD) extends motives of terrorism defined in U.S. State Department's definition. DOD defines as terrorism as "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, 2017). The Federal Bureau of Investigation adopted the Code of Federal Regulations definition of terrorism, "The unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives" (Federal Bureau of Investigation, 2006). The lack of unanimous definition allows for federal agencies to adopt their interpretation of terrorism to best fit their practices and purpose.

In addition to the lack of agreement on the federal level, there is an absence of a formal definition of terrorism on a state and local level. Freilich, Chermak, and Simone (2009) conducted a field study concerning a collective definition of terrorism on a state police level. The study attempted to reach all state police agencies; however, thirty-seven states participated to completion or partially completed the survey. Of those surveyed, Freilich and associates (2009) found that the two definitions most commonly recognized by state police officials surveyed are the Code of Federal Regulations definition adopted

by the FBI and U.S. State Department's definition. The study will refer to the definition of terrorism outlined by the FBI.

Kurtulus (2011), Duyvesteyn (2004), Strandberg (2013), Laqueur (1996), and Rapoport (2004) recognized a shift in strategy, motivation, and target from traditional terrorism to contemporary terrorism. Kurtulus (2011) argues against criticisms of the term contemporary terrorism citing four characteristic and categorical transformations contemporary terrorism has undergone. Interchanging "new terrorism" and contemporary terrorism, Kurtulus defines new terrorism as a "qualitative change in the nature of terrorism" and originates this transformation to the start of the 1900s (p. 477). In support, Strandberg (2013) reviewed scholarly literature about changes in the characteristics of terrorism and concluded that new/contemporary as seen in the 20th century strays from traditional terrorism in motivation, strategy, and target.

Modern terrorism began in the 1880s with a shift in strategy, motivation, and weapons (Laqueur, 1996; Rapoport, 2004). Rapoport (2004) categorized four "waves" modern terrorism underwent from the start of modern terrorism at the start of the 20th century to the current wave of terrorism. Rapoport (2004) defined a wave as "a cycle of activity in a given time period – a cycle characterized by expansion and contraction phases" (p. 47). Rapoport (2004) labeled the first wave starting in 1900 as the "Anarchist wave," recognizing it as the "first global or truly international terrorist experience in history" (p. 47). Anarchists primarily took part in assignations of political figures. The second wave, the "anticolonial wave," focused on military targets. Starting in the 1920s and lasting roughly 40 years, the anticolonial wave consisted of nationalist ideologies motivated by aspirations to gain territorial control. Rapoport (2004) referenced the Irish

Republican Army as an example of a terrorist organization that has carried out attacks through two waves of modern terrorism. Motivated by territorial prospects in Ireland, the IRA fought against British rule of the country.

The third wave of modern terrorism, the "New Left wave," sparked from the Vietnam War (Rapoport, 2004). New Left wave terrorist organizations used assassination and hostage taking. Like the anarchist wave, the New Left wave returned to assassination as a means of creating terror; however, the New Left wave used assassinations as a mode of punishment rather than the targeting of public officials (Rapoport, 2004). The fourth and current wave of modern terrorism is the "religious wave" (Rapoport, 2004). Recognizing religion as an element of terrorism throughout history, it is important to note the shift in its role in terrorism. Prior religious motivations "aimed to create secular states," whereas current religious motivations create "justifications and organize[e] principles for states" (Rapoport, 2004, p. 61). Rapoport (2004) named Islam as the center of the religious wave and credits Islamic groups as those that conduct the deadliest and international attacks.

Rapoport's (2004) suggestion of the religious wave aligns with scholarly research concerning a shift from traditional terrorism to modern or contemporary terrorism. In support, analysts at the Naval Postgraduate School (1999) asserted that the "changes in organization, doctrine, strategy, and technology… speak to the emergence of a 'new terrorism'" (p. 76). Kurtulus (2011) categorizes these changes into four claims: (a) "New terrorism has religious or mystical motivation," (b) "New terrorist organizations consist of horizontal networks," (c) "New terrorism is characterized by indiscriminate attacks

aimed at causing high number casualties," (d) "New terrorist organizations have the intention … [to] use Weapons of Mass Destruction" (p. 478).

Kurtulus (2011) recognized a shift from secular terrorism to religious terrorism. In agreement, Cronin (2002) noted that religion "has become a central characteristic of a growing international trend" that "overshadow[s] the nationalist or leftist revolutionary ethos of earlier terrorist phases" (p. 38). Cronin's (2002) and Kurtulus' (2011) position stating a shift in religious importance in terrorist motivations and trends is indicative of Rapoport's (2004) analysis of modern terrorism "waves." Rapoport (2004) cited a shift from the third wave – the New Left wave – to the fourth wave – the religious wave. Capell and Sahliyeh (2007) further suggested that the increase of attacks and lethality of attacks is due to the inclusion of religion into terrorist motives. Rapoport (2004) linked a growing trend in contemporary terrorism to Islam, Christianity, Judaism, and Hinduism.

To Kurtulus' (2011) second claim, new or contemporary terrorism has shifted from a hierarchal organizational structure to a horizontal network structure. Strandberg (2013) wrote in support that contemporary terrorism and current terrorist organizations act in a network structure. Duyvesteyn (2004) argued against the "new" movement away from a hierarchal structure citing the anarchist movement active in Russia and France during the 19th century. Contending that the anarchist movement acted against heads of states, the movement followed a network structure. Additionally, Duyvesteyn (2004) referenced the PLO and Hezbollah as terrorist organizations operating in the 20th century with a network structure. However, with the exception to few terrorist organizations, Kurtulus (2011) and Strandberg (2013) contended that there is a broad shift in organizational structure away from a hierarchal structure to a horizontal network

structure indicating a "new" or contemporary terrorism different from traditional terrorism.

Contemporary terrorism is also credited with a shift in use of violence. Kurtulus (2011) differentiates contemporary terrorism from traditional terrorism by the increase of violence and use of nonselective targeting. Traditional terrorism is characterized as being "selective in its targeting and surgical in its use of violence" while "new terrorism is characterized by indiscriminate attacks aimed at causing high number of casualties" (Kurtulus, 2011, p. 478). Further, Strandberg (2013) cited indiscriminate violence as a defining aspect of contemporary terrorism. Contemporary terrorism in contrast to traditional terrorism is focused on mass casualty and impact rather than the political or social persuasion of the attack.

In addition to a shift in target, contemporary terrorism is more likely to utilize weapons of mass destruction, i.e. chemical, biological, radiological, and nuclear weapons (Kurtulus, 2011). To Kurtulus' (2011) fourth claim regarding the use of weapons of mass destruction, Cronin (2002) writes in support that "globalization makes CBNR (chemical, biological, radiological and nuclear) weapons increasingly available to terrorist organizations" (p. 48). Further, Laqueur (1996) acknowledged the availability of mail-order catalogs that supply conventional and unconventional weapons. Referencing the Aum Shinrikyo attack on Tokyo's subway in 1995, the use of sarin, a "chemical warfare agent classified as a nerve agent," injured over 5,000 citizens (Center for Disease Control and Prevention, 2013; Jenkins & Gerten, 2001). Including Kurtulus' (2011) claim regarding religious motivations, Capell and Sahliyeh (2007) credited religiously

motivated terrorist organizations with the increased likelihood of using weapons of mass destruction.

Kurtulus (2011) asserted four main claims supporting a shift in terrorism from traditional to contemporary. First, contemporary terrorism moved away from secular terrorism to religiously motivated terrorism. Rapoport (2004) defined this shift as the fourth and current wave modern terrorism has undergone, the religious wave. Broadly defining the current wave, Rapoport asserted that the religious wave contains other changes, but the main theme of the current wave of modern terrorism holds a religious focus. Second, contemporary terrorism utilizes a horizontal network structure in contrast to a hierarchal structure. Duyvesteyn (2004) argued that a horizontal structure has been used by terrorist organizations prior to the time period outlined in contemporary terrorism. Duyvesteyn (2004) further asserted that few terrorist organizations operating today use a hierarchal structure. However, Kurtulus (2011) and Strandberg (2013) contended that while this shift in organizational structure is not present in all current terrorist organizations, the general shift away from a hierarchal structure to a horizontal network structure is seen. Third, Kurtulus (2011) and Strandberg (2013) argued that contemporary terrorism widely conducts indiscriminate attacks contrary to attacks targeting military/law enforcement officers and public officials. In addition to the incorporation of indiscriminate killing, contemporary terrorism is more likely to use weapons of mass destruction, i.e. chemical, biological, radiological, and nuclear. Laqueur (1996) and Cronin (2002) credited this shift to the globalization and the accessibility of such weapons.

## Contemporary Terrorism Paradigm: Attacks on Rail Transportation

The safety and stability of a nation is predicated by its ability to respond, mitigate, and deter terrorist activity. Research has been done on the Contemporary Terrorism Paradigm regarding rail transportation; however, there is a limited amount of research on the application of the Contemporary Terrorism Paradigm to rail transportation on a global scale. Additional research is done concerning weapon type to identify specific security concerns in reference to rail transportation in the United States. The rest of this chapter will build the context necessary for the study to fit into the ongoing conversation concerning terrorism and national security.

## Economic Importance of the Transportation Infrastructure

Transportation infrastructures support the expansion of a national economy through the movement of goods and people. A qualitative study by Zhang, Li, and Li (2014) found that transportation infrastructures are vital to economic development and indicate potential economic growth. The importance of the transportation infrastructure does not solely rely on the movement of goods and people, but on the interdependencies linking the transportation infrastructure to other critical infrastructures. A delay in rail transportation could have economic consequences reaching from the local level through the regional level to the national level.

### Interdependencies

In the United States, food and water systems, healthcare systems, emergency services, banking and finance, information technology, communication, energy, transportation, chemical and defense industries, postal and shipping entities, and agriculture make up the critical infrastructures in place. Further, these individual

infrastructures are not independent but are interdependent through a mutual interaction phenomenon (Zhang, Li, and Li, 2014). Zhang et al (2014) predict a continuous expansion in complexity and size of critical infrastructures which in turn increases interdependence and vulnerability. When discussing in detail interdependencies between infrastructures, there are disagreements in principle classes. Zhang and Peeta (2011) outlined four classes of interdependencies: (a) functional (i.e., the functioning of one system requires inputs from another system, or can be substituted to a certain extent, by the other system); (b) physical (i.e., infrastructure systems are coupled through shared physical attributes, so that a strong linkage exists when infrastructure systems share flow right of way, leading to joint capacity constraints); (c) budgetary (i.e., infrastructure systems involve some level of public financing, especially under a centrally-controlled economy or during disaster recovery); and (d) market and economy (i.e., infrastructure systems interact with each other in the same economic system or serve the same end users … and impact the individual systems through policy, legislation, or financial means such as taxation or investment) (Ouyang, 2014). Although each class of interdependencies is distinct in type and characteristic, they are not mutually exclusive.

In a similar class structure, Dudenhoeffer, Permann, and Boring (2006) identified four principle classes: (a) physical (i.e., the direct linkage between infrastructure systems from a supply/consumption/production relationship); (b) geospatial (i.e., there is a co-location of infrastructure components within the same footprint); (c) policy (i.e., there is a binding of infrastructure components due to policy or high level decisions); and (d) informational (i.e., there is a binding or reliance on information flow between infrastructure systems) (Ouyang, 2014).

Separately, Zimmerman (2004) identified two principle classes of interdependency: (a) functional (i.e., the operation of one infrastructure system is necessary for the operation of another infrastructure system); and (b) spatial (i.e., refers to proximity between infrastructure systems) (Ouyang, 2014). Zimmerman's (2004) class structure of interdependency offered a simple explanation of mutual reliance and cooperation between functionality and spatial. Similarly, Zhang and Peeta (2011) identified four principle classes of interdependency: (a) functional (i.e. the functioning of one system requires input from another system, or can be substituted … by another system); (b) physical (i.e. some infrastructure systems are coupled through shared physical attributes); (c) budgetary (i.e. shared public financial and budget allocation); and (d) market and economy (i.e. implies that all systems are interacting sectors in the same economic system) (Zhang & Peeta, 2011). In reference to the transportation infrastructure, a functional interdependency exists between the energy infrastructure and the operation of the transportation infrastructure. Additionally, there is a physical interdependency for systems that share "flow right of way" or systems that operate on the same grid (Zhang & Peeta, 2011). For the purposes of this study, Zhang and Peeta's (2011) model is used to analyze the vulnerabilities of the transportation infrastructures on a global platform and vulnerabilities specific to the United States.

Technical and economic protection of the transportation infrastructure in the United States is relatively impossible due to scale and federal budget. Recognizing this limitation, it is necessary to prioritize the vulnerabilities inside the transportation infrastructure. Concerning size and capacity of railway infrastructures, target hardening is necessary to protect specific vulnerabilities inside the infrastructure. Railways deliver and

distribute millions of tons of goods and billions of passengers each year making it an attractive target for attack (Zhang et al, 2014). The National Infrastructure Advisory Council predicted a twenty percent increase, an additional sixty-six million passengers, over the next twenty-five years. The NIAC further stresses transportation infrastructure resilience citing its importance to the U.S. economy and overall quality of life. Referencing the Zhang et al (2014) qualitative study, it was found that "if a portion of the railway infrastructure is damaged or destroyed due to … operation factors, or malevolent human acts, there is a distinct possibility that cascading failures could propagate to multiple interconnected infrastructures" due to the phenomena of interdependency (Zhang et al, 2014, p. 14). The concept of interdependency specifically concerning railway infrastructure is further tested by Greenberg et al. (2013).

Greenberg et al. (2013) constructed three simulation models to evaluate interdependencies surrounding rail transit. The regional economic impact simulation model estimated prolonged effects of a rail-related disruption between Trenton, New Jersey and Penn Station, New York to assess local and regional economic consequences. Greenberg et al. (2013) found that a prolonged disruption would increase traffic congestion potentially leading to an increase in local oil and gasoline prices. Additionally, if the disrupted rail line carried fright, local businesses would suffer from a lack of product. Prolonged disruption resulting in a delay of products would further cause a decrease in government tax collection consequently reducing worker earnings (Greenberg et al., 2013). Similar findings were illustrated in Zhang et al.'s (2014) simulation model in Mainland China. Consequences of a rail-related disruption effected "the economy, employment, trade and social activities at the local, regional and national

levels" (Zhang et al., 2014, p. 14). A delay in rail transportation as simulated by Greenberg et al. (2013) and Zhang et al. (2014) exemplifies the interdependencies of the transportation infrastructure to the local, regional, and national economy. Respectively, a delay in rail transportation would affect each principle class of Zhang and Peeta's (2011) interdependency model.

Looking broadly at the scope and impact of the public transportation infrastructure in the United States, the American Public Transportation Association studied the demographic of those who use public transportation such as the metro and railway. The APTA is a nonprofit international association who engages in all aspects of public transit – bus, paratransit, light rail, subways, waterborne services, and intercity and high-speed passenger rail. Regarding the aforementioned modes of public transit, the APTA (2017) found that eighty-seven percent of public transportation trips contribute to the local and national economy. Respectively, forty-nine percent of trips involve getting to or from work, twenty-one percent of trips are for the purpose of shopping, and seventeen percent of trips are for recreation spending in the local economy (APTA, 2017). The use of and the transportation of goods and people contribute to all aspects of a local, regional, and national economy.

## Weapon Type

Research suggests that attacks targeting transportation infrastructures yield a higher fatality rate. START's publication *Terrorism in Belgium and Western Europe; Attacks Against Transportation Targets; Coordinated Terrorist Attacks,* states that attacks targeting public transportation yield a twenty-two percent higher lethality rate than attacks on other targets. Shvetsov et al. (2016) agreed that terrorist attacks against

transportation result in a significantly higher fatality rate than terrorist attacks in general. Shvetsov et al. (2016) further asserted that transportation infrastructures are subject to the same weaponry as other terrorist operations to include explosive devices, firearms, incendiary, melee, chemical weaponry, and biological weaponry as well as train derailment as a weapon choice.

Research shows that common terrorist tactics utilize explosive devices. Shvetsov et al. (2016) state that the most common weapon type used in a terrorist attack is an explosive device. Likewise, Gill, Horgan, and Lovelace (2011) recognized a significant increase in the use of explosive devices in terrorist attacks. Wilson, Jackson, Eisman, Steinberk, and Riley (2007) further asserted that the prevalence of explosive devices in past terrorist attacks suggest that future attacks will primarily feature explosive devices. An explosive device used by terrorists is commonly termed an improvised explosive device (IED).

The term IED is widely defined. Gill, Horgan, and Lovelace (2011) defined an improvised explosive device as "a homemade device that is designed to cause death or injury by using explosives" (p. 734). In contrast, Keyes, Burstein, Schwartz, and Swienton (2005) defined an IED through technical terminology, "IEDs have a main charge, which is attached to a fuse, which is attached to a trigger" (Gill et at., 2011, p. 734). Similarly, the US Department of Justice defines an IED through its intricacies and its manufacture:

> A destructive explosive device capable of causing bodily harm, great bodily harm, death, or property damage; with some type of explosive material and a means of detonating the explosive material, directly, remotely, or with a timer either present

> or readily capable of being inserted or attached: which may include pip or similar casing, with the ends of the pipe or causing capped, plugged or crimping and a fuse or similar object sticking out of the pipe or casing; and made by a person not engaged in the legitimate manufacture or legitimate use of explosives, or otherwise authorized by the law to do so. (Gill et al., 2011, p. 735).

The Department of Homeland Security puts forth a definition that combines Keyes et al. and the US Department of Justice, "The use of a homemade bomb and/or destructive device to destroy, incapacitate, harass, or distract … IEDs can be carried or delivered in a vehicle; carried, placed, or thrown by a person; delivered in a package; or concealed on the roadside." For the purpose of this study, the study will use the Department of Homeland Security's definition of an IED.

Broadly, an IED needs a fuel and an oxidizer (Department of Homeland Security). Chemical composition of an improvised explosive device is divided into two sections: high explosives and low explosives. The Department of Homeland Security regards the following chemical compositions as high explosives: (a) ammonium nitrate and fuel oil (ANFO); (b) Triacetone Triperoxide (TATP); (c) Semtex, C-4; (d) ethylene glycol dinitrate (EGDN); and (e) urea nitrate. IEDs consisting of ammonium nitrate and fuel oil are often used for mining and blasting. However, Timothy McVeigh used ammonium nitrate and fuel oil in the 1995 Oklahoma City Bombing. Triacetone Triperoxide does not have a common use. This chemical mixture was used by al Qaeda terrorist against the London Underground in 2005. Semtex, C-4, is primarily used by military operatives. C-4 was the primary method of IRA bombings against London from the 1970s to the late 1990s. Ethylene glycol dinitrate is typically a component found in low freezing dynamite.

The Millennium Bomber, Ahmed Ressam, planned to detonate an IED consisting of ethylene glycol dinitrate at the Los Angeles International Airport in 1999 (Johnson, 2012). Finally, urea nitrate, often found in fertilizer, was used in the 1993 World Trade Center bombing. The Department of homeland security considers a low explosive as smokeless powder. Smokeless powder is most commonly found in ammunition; however, smokeless powder was used in the 1996 Olympic Park bombings

The Global Terrorism Database defines a chemical weapon (CW) as "a weapon produced from toxic chemicals that is contained in a delivery system and dispersed as a liquid, vapor, or aerosol." Chemical warfare was present during the Middle Ages and Renaissance; however, it was not used extensively until World War I (Ganesan et al., 2010). In recent history, Aum Shinrikyo used Sarin to attack Tokyo's subway system in 1995. Ganesan, Raza, and Vijayaraghavan (2010) indicate three primary reasons chemical weapons are attractive to terrorists: (a) "chemical weapons are cost effective," (b) the can be used in small doses to cause mass panic and disorder, and (c) dissemination and release of the chemical agent can be accomplished easily and discretely.

Chemical weapon agents fall into seven classifications – nerve agents, vesicants, blood agents, choking agents, riot-control agents, psychomimetic agents, and toxins. Nerve agents affect the nervous system. Further, nerve agents are considered the most toxic chemical weapon agent classification due to ability to their high toxicity (Ganesan et al., 2010). Vesicants, or blistering agents, produce skin lesions similar to that of a burn. Blood agents prevent the absorption of oxygen by body tissues. Choking agents target the respiratory system i.e. the nose throat, and lungs. Psychomimetic agents "produce changes in thought, perception and mood, without causing any major disturbances in the

autonomic nervous system." Finally, toxins are a chemical compound created by bacteria, fungi, terrestrial, or marine animals (Ganesan et al., 2010).

Bioterrorism is the "intentional or threatened [use] of microorganisms or toxins derived from living organisms to cause death or disease in humans, animals or plants on which we depend" (Bossi et al., 2006, p. 2196). Bioterrorism currently poses an increased risk to national security based on the notion "that biology and related disciplines are becoming 'easier', more predictable, and more prevalent around the globe" (Revill & Jefferson 2013, p. 597). However, bioterrorism is not a new tactic. In 1346, Tatar infected enemy soldiers with Yersinia pestis – the Plague (Bossi et al., 2006). The use of Yersinia pestis caused the second outbreak of the plague ultimately leading to the death of one-third of the European population (Bossi et al., 2006). In the United States, Bacillus anthracis – anthrax – was released via mail following the September 11, 2001 attacks on the World Trade Centers leading to the death of five United States citizens (Bossi et al., 2006). Revill and Jefferson (2013) further credit the release of anthrax following September 11, 2001 indicated the increasing threat of bioterrorism to security.

The Center for Disease Control and Prevention (CDC) emphasizes the threat of bioterrorism to national security due to its accessibility and the lack of specialized knowledge required. Over 180 pathogens – "a specific causative agent of disease" – exist as potential agents of bioterrorism (Bossi et al., 2006; Merriam-Webster Dictionary). The Center for Disease Control and Preparedness establishes three categories of bioterrorism agents/disease. Category A agents/diseases are high-priority agents that threaten national security. The CDC recognizes Anthrax (Bacillus anthracis), Botulism (Clostridium botulinum toxin), Plague (Yersinia pestis), Smallpox (variola major), Tularemia

(Francisella tularensis) and viral hemorrhagic fevers as Category A agents/diseases. Anthrax and Smallpox are currently recognized as the two highest priority agents/diseases by the CDC. The aforementioned bioterrorism agents pose a risk to national security because they (a) "can be easily disseminated or transmitted from person to person," (b) "result in high mortality rates and have the potential for major public heath impact," (c) "might cause public panic and social disruption," and (d) "require special action for public health preparedness." Category B agents/diseases are the second highest priority because they are "moderately easy to disseminate," produce moderate fatality rates, and require specialized training and knowledge (CDC Bioterrorism Agents). Category C agents/diseases are the third highest priority due to the possibility of future advancements in science that allows for accessibility, production, and potential of high fatalities rates (CDC Bioterrorism Agents).

Train derailment has the potential to cause casualty and harm to the environment. In the United States, Liu, Saat, and Barkan (2012) stated that derailment is the leading cause of train accident. The Federal Railroad Administration (FRA) organizes train derailment into five categories: (a) track, roadbed, and structure, (b) signal and communication, (c) mechanical and electrical failures, (d) human factors, and (e) miscellaneous causes not otherwise listed (Department of Transportation, 2011). Under each broad category, the FRA identifies "cause codes" as subcategories. Liu, Saat, and Barkan (2012) simplified the categories defined by the FRA as (a) track, (b) signal, (c) equipment, (d) human factors, (e) and miscellaneous.

Recognizing Liu, Saat, and Barkan's (2012) findings that train derailment is most often caused by human factors, attention needs to be given to sabotage equipment – "A

weapon that is used in the demolition or destruction of property" (National Consortium for the Study of Terrorism and Responses to Terrorism, 2017, p. 28). In July of 2017, the Islamic State of Iraq and Syria (ISIS) published the 17th edition of *Inspire* which highlighted the ease and importance of train derailment operations as a mode of terrorism. Ibrahim Ibn Hassan Al-Asiri (2017) writes, "Modern means of transportation are considered to be the lifeblood of our civil life" (Lone Jihad Operations Guidance Team, 2017, p. 9). The 17th edition of Inspire serves as a how-to guide to derail rail transportation in western countries. The publication highlights the ability to make an effective train derailment tool using easily accessible materials such as cardboard, Styrofoam, and concrete (Lone Jihad Operations Guidance Team, 2017). Train derailment as a weapon type is cheap, easy to construct, and highly destructive.

## Summary

In this chapter, relevant research was thoroughly explored. Research regarding the economic importance of transportation infrastructures was discussed. Additionally, literature was reviewed concerning common weapon types used to target transportation infrastructures. Relevant research helped place this study in relation to earlier research.

The rest of this study is built on the literature review. Chapter three outlines the study's methodology in which the data collection procedures will be identified. The data analysis process is discussed to explain how the research questions were answered and hypotheses accepted or rejected. Chapter four presents the data of the study and either accepts or rejects the null hypothesis of each research question. Chapter five applies the Contemporary Terrorism Paradigm to data presented in chapter four to determine if it explains the trend in terrorist incidents targeting transportation systems.

# CHAPTER 3

# RESEARCH DESIGN AND METHODOLOGY

## Introduction

This chapter focuses on the research design and method for the study. This chapter will provide the framework for how the research problem, questions, and hypothesis introduced in chapter one was evaluated. The original research problem is whether the Contemporary Terrorism Paradigm will explain varying incident rated in attacks targeting transportation infrastructures as well as in weapon type. The research questions that will guide this study are:

**Research Questions**

1. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of terrorist incident between rail transportation and road transportation?
2. Is there a significant difference in the number of successful terrorist incidents between the three regions: Western Europe, East Asia, and North America?
3. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning weapon type?
4. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning casualty[3] rate?

[3] Defined as victims killed and wounded (Federal Bureau of Investigation, 2014).

5. Is there a significant difference in number of casualties between the three regions?
6. Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of casualties by weapon type?

**Hypotheses**

$H_0$: Looking at the three regions collectively, there will be no difference in the number of successful incidents between rail transportation and road transportation.

$H_1$: Looking at the three regions collectively, rail transportation will yield a higher number of successful terrorist incidents.

$H_0$: There will be no significant difference in the number of terrorist incidents between Western Europe, East Asia, and North America.

$H_2$: There will be a significant difference in the number of terrorist incidents between Western Europe, East Asia, and North America.

$H_0$: Looking at the three regions collectively, there will be no significant difference in the number of terrorist incidents concerning weapon type.

$H_3$: Looking at the three regions collectively, incendiary will yield a higher number of terrorist incidents.

$H_0$: Looking at the three regions collectively, there will be no difference in the number of terrorist incidents concerning casualty.

$H_4$: Looking at the three regions collectively, there will be a significant difference in the number of terrorist incidents concerning casualty.

$H_0$: There will be no significant difference between the three regions and the number of terrorist incidents resulting in casualty.

$H_5$: There will be a significant difference between the three regions and the number of terrorist incidents resulting in casualty.

$H_0$: Looking at the three regions collectively, there will be no significant difference between weapon type and the number of incidents resulting in casualty.

$H_6$: Looking at the three regions collectively, there will be a significant difference between weapon type and the number of incidents resulting in casualty.

## Data

This study is based on data collected by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) and published in the Global Terrorism Database (GTD). The GTD is an open-source database for information on global terrorist attacks from 1970 through December 2016. Statistical information represented in the GTD is collected from reports and open media sources. Due to the nature of this type of data collection method, some attacks may be attributed to a certain organization based on media reports. Additionally, a certain percentage of incidents reported on the GTD are unclaimed – an attack not attributed to a certain terrorist organization. The data has not been analyzed or examined, rather it is simply sorted by terrorist organization, country, attack type, target type, weapon type, perpetrator, casualties, fatalities, injuries, and region. While the GTD collects data on all aspects of an incident, the study only examines incidents in Western Europe, East Asia, Oceania, and North America (excluding Mexico). These regions were selected due to their similarity in critical transportation infrastructure operations and maintenance as that present in the United States.

Countries examined in Western Europe include: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Spain, Sweden, Switzerland, and the United Kingdom. Countries in East Asia include: China, Japan, and Taiwan. The final region considered in this study is North America. This category includes: The United States and Canada. For the purposes of this study, Mexico is excluded from the analysis. This study excludes attacks in Mexico due to their incompatible rail and road transportation method as compared to the United States. Countries included in this study represent similar transportation infrastructures to the United States to provide a more accurate analysis.

In addition to concentrating the study to specific regions, this study is limited to specific weapon types used in the attacks. These weapons are: biological, chemical, explosives/bombs/dynamite, fake weapons, firearms, and sabotage equipment.

The Global Terrorism Database also records the number of fatalities and wounded per incident. This information is again subject to media count and report. For the purpose of this study, fatality and wounded is used to assess the number of casualties of an attack against transportation.

## Measures

### Dependent Variable

There are three dependent variables in this study. First, number of incidents, was measured by the number of terrorist events/incidents that occurred at the various transportation systems within the countries included in the analysis.

Second, *fatality,* identifies the total number of fatalities per incident. Fatality was dichotomously measured as: 0 = no fatality (incidents that resulted in no fatal injuries) and 1 = fatality (incidents that resulted in at least one fatality).

Third, *wounded,* was presented in the GTD as a numerical variable representing the number of wounded per incident. Wounded was recoded as follows: (0) no wounded: accounting for incidents that did not indicate a wounding and (1) wounded: incidents that indicate at least one wounded. *Fatality* and *wounded* serve as dependent variables for research question four and as independent variables for research questions five and six.

**Independent Variable**

There are three independent variables employed in this study. First, *weapon* type measured as a categorical variable. The GTD identified seven categories: explosives/bombs/dynamite, incendiary, melee, firearms, sabotage equipment, other, and unknown. These were then recoded as follows: (1) explosive: consolidated the original title explosives/bombs/dynamite, (2) incendiary, (3) melee, and (4) other: absorbed other, firearms, sabotage equipment, and unknown.

Second, transportation measured as a dichotomous variable, 0 = *road transportation* and 1 = *rail transportation.* The GTD divided transportation into five categories: bus, taxi/rickshaw, highway/road/toll/traffic signal, subway, and train/train tracks/trolley. These were recoded to recognize rail transportation and road transportation, the categories measured were as follows: road absorbed categories bus, taxi/rickshaw, and highway/road/toll/traffic signal and rail absorbed categories subway and train/train tracks/trolley.

Third, *region,* which indicates the location of the country where the attack(s) took place. This was measured categorically as (1) Western Europe, (2) East Asia, (3) North America.

## Plan of Analysis

The presentation of the data as both region and weapon, along with the number of successful terrorist incidents allowed for deeper analysis. The data has been reported both in terms of successful and unsuccessful so that the incident success rate for rail transportation and road transportation can be compared. For the first research question the total number of terrorist incidents and the mode of transportation, i.e. road or rail, were analyzed. The first research question used the Pearson Chi-Square test to determine goodness of fit. The Pearson Chi-Square test determines whether the observed distribution fits with the expected distribution. After analysis of Chi-Square test, an Independent Samples T test was run to determine a significant relationship in incident between rail transportation and road transportation. The second research question analyzed the total number of terrorist incidents and the region of the incident. The third research question analyzed the success rate and incident rate of weapon type. Research questions two and three were analyzed using two and three factor analyses of variance. Research questions two and three then used the Bonferroni post-hoc test to assess between-groups significance. Research questions four through six addressed the number of incidents that resulting in casualty on regional terms, by weapon type, and collectively. Research question four used an independent samples t test to determine a significant relationship between the number of incidents resulting in fatality and the number of total incidents. A second independent samples t test was run to determine a significant difference between the number of incidents that resulted in wounding and the number of total incidents. The combination of fatality and wounding compose the total number of casualties. Research question five and six were analyzed using two and three factor

analyses of variance. Research questions five and six then used the Bonferroni post-hoc test to assess between-groups significance.

## Summary

This chapter has thoroughly explained the methodology for the study. It established four regions that the study will examine. The regions selected for the study were carefully considered for their similarities in infrastructure operation and maintenance. Two independent variables were established and coded for the purpose of this study. Data from the Global Terrorism Database reported by the National Consortium for the Study of Terrorism and Responses to Terrorism was used. Data was coded and condensed into region and weapon type. Chapter five will assess the data presented in chapter four and will work to apply the Contemporary Terrorism Paradigm to the study results.

# CHAPTER 4

# STUDY RESULTS

## Introduction

This chapter presents the results of the analysis. All analyses were conducted using SPSS. These statistics were all based on the original purpose of the study; thus, to evaluate if the Contemporary Terrorism Paradigm explained any significant variation among the number of incidents between rail and road transportation. To accomplish this, secondary data consolidated by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) and published in the Global Terrorism Database (GTD) were analyzed.

## Descriptive Statistics

The data that was analyzed was the number of number of terrorist incidents for each country. To establish this, three pieces of information were needed from each country, the number of incidents that occurred, whether the incident was classified as successful or unsuccessful, and what weapon was used. Table 1 presents the number of incidents in each country. The data excludes incidents prior to 2001 and is limited to incidents against transportation. It can be noticed that not all countries experienced terrorist incidents against each mode of transportation. While some countries, such as Canada, China, Ireland, Spain, and the United Kingdom experienced terrorist events across the two modes of transportation, others such as Belgium, Denmark, Finland, France, Sweden, Taiwan, and the United States experienced terrorism at only one of the transportation modes being studied. Overall, there were one hundred and five recorded terrorist incidents across the various transportation modes in all the 15 countries from

2001 to 2016. More than two-thirds (2/3) of these events happened at rail stations or were rail related incidents.

***Table 1:*** *Incidents Per Country 2001-2016*

| | Road | Rail | Total |
|---|---|---|---|
| Belgium | 0 | 1 | 1 |
| Canada | 1 | 2 | 3 |
| China | 7 | 6 | 13 |
| Denmark | 1 | 0 | 1 |
| Finland | 1 | 0 | 1 |
| France | 0 | 2 | 2 |
| Germany | 0 | 8 | 8 |
| Ireland | 1 | 2 | 3 |
| Italy | 0 | 5 | 5 |
| Japan | 0 | 7 | 7 |
| Spain | 13 | 20 | 33 |
| Sweden | 0 | 1 | 1 |
| Taiwan | 0 | 2 | 2 |
| United Kingdom | 7 | 14 | 21 |
| United States | 0 | 4 | 4 |
| Total | 31 | 74 | 105 |

Table 2 displays the number of incidents by region. The numbers were further categorized by transportation. The table shows each region and the number of incidents by transportation Each region experienced at least one terrorist incident on each mode of transportation. Of the seven terrorist incidents experienced in North America, only one of these events occurred on road transportation. In East Asia, more than two-thirds (2/3) of these events happened at rail stations or were rail related incidents. Similarly, more than

two-thirds (2/3) of incidents recorded in Western Europe occurred at rail stations or were rail related incidents.

***Table 2:*** *Incidents Per Region 2001-2016*

| | Road | Rail | Total |
|---|---|---|---|
| North America | 1 | 6 | 7 |
| East Asia | 7 | 15 | 22 |
| Western Europe | 23 | 53 | 76 |
| Total | 31 | 74 | 105 |

Table 3 presents the number of incidents that lead to fatalities sorted by the target type: road transportation and rail transportation. Of the total number of terrorist incidents against road transportation, three-fourths (3/4) were non-fatal. Terrorist incidents against both road transportation and rail transportation were fatal almost one-fourth (1/4) of the time.

***Table 3:*** *Fatality of Incidents 2001-2016*

| | Road | Rail | Total |
|---|---|---|---|
| Fatality | 8 | 13 | 21 |
| No Fatality | 23 | 61 | 84 |
| Total | 31 | 74 | 105 |

Table 4 presents the results of a cross-tabulation of the number of fatal and non-fatal incidents per region by mode of transportation: road transportation and rail transportation. Of the total number of fatal attacks against road transportation, East Asia accounted for three-fourths (3/4) incidents. Of the total number of non-fatal attacks against road transportation, Western Europe accounted for more than nine-tenths (9/10) incidents; however, Western Europe accounted for almost two-thirds (2/3) incidents of

fatal attacks against rail transportation. Broadly, roughly one-half (1/2) fatal terrorist incidents against transportation occurred in East Asia. More than three-fourths (3/4) non-fatal terrorist incidents against transportation occurred in Western Europe.

***Table 4:*** *Fatal Incidents Per Region by Mode of Transportation 2001-2016*

| | | | No Fatality | Fatality | Total |
|---|---|---|---|---|---|
| Road Transportation | | North America | 0 | 1 | 1 |
| | | East Asia | 1 | 6 | 7 |
| | | Western Europe | 22 | 1 | 23 |
| | Total | | 23 | 8 | 31 |
| Rail Transportation | | North America | 6 | 0 | 6 |
| | | East Asia | 10 | 5 | 15 |
| | | Western Europe | 45 | 8 | 53 |
| | Total | | 61 | 13 | 74 |
| Total | | North America | 6 | 1 | 7 |
| | | East Asia | 11 | 11 | 22 |
| | | Western Europe | 67 | 9 | 76 |
| | *Total* | | *84* | *21* | 105 |

Table 5 presents the number of terrorist incidents that incurred wounds sorted by the target type: road transportation and rail transportation. Of the total number of terrorist incidents against transportation in 2001 and 2016, roughly one-fourth (1/4) wounded individuals.

***Table 5:*** *Incidents That Incurred Wounds 2001-2016*

| | Road | Rail | Total |
|---|---|---|---|
| Wounded | 10 | 15 | 25 |
| Not Wounded | 21 | 59 | 80 |
| Total | 31 | 74 | 105 |

Table 6 shows the results of the number of wounding and non-wounding terrorist incidents per region by mode of transportation: road transportation and rail transportation. North America and East Asia had no terrorist incidents against road transportation that did not incur wounded. Wounding terrorist incidents against road transportation in East Asia accounts for seven-tenths (7/10) incidents. Terrorist incidents in East Asia against both road transportation and rail transportation lead to wounding in almost one-half (1/2) incidents. Western Europe accounts for more than three-fourths (3/4) incidents not leading to wounding in road transportation and rail transportation combine.

***Table 6:*** *Wounding Incidents Per Region by Mode of Transportation 2001-2016*

| | | | Not Wounded | Wounded | Total |
|---|---|---|---|---|---|
| Road Transportation | | North America | 0 | 1 | 1 |
| | | East Asia | 0 | 7 | 7 |
| | | Western Europe | 21 | 2 | 23 |
| | Total | | 21 | 10 | 31 |
| Rail Transportation | | North America | 6 | 0 | 6 |
| | | East Asia | 10 | 5 | 15 |
| | | Western Europe | 43 | 10 | 53 |
| | Total | | 59 | 15 | 74 |
| Total | | North America | 6 | 1 | 7 |
| | | East Asia | 10 | 12 | 22 |
| | | Western Europe | 64 | 12 | 76 |
| | *Total* | | *80* | *25* | 105 |

Table 7 is similar to Tables 1 and 2 as it shows incidents by transportation type but differs in that it is categorized by weapon type. While melee and other were used in terrorist incidents, explosive and incendiary were collectively used in over three-fourths (3/4) of incidents against road and rail transportation. Independently, explosive was used against both road and rail collectively in almost two-thirds (2/3) of all 105 incidents recorded.

***Table 7:*** *Incidents by Weapon Type 2001-2016*

| | Road | Rail | Total |
|---|---|---|---|
| Explosive | 17 | 49 | 66 |
| Incendiary | 10 | 18 | 28 |
| Melee | 2 | 5 | 7 |
| Other | 2 | 2 | 4 |
| Total | 31 | 74 | 105 |

Table 8 shows the number of terrorist incidents per region by weapon type. Not all regions had incidents by each weapon type, in that occasion the weapon type was excluded from the table. While Western Europe experienced a terrorist incident that involved each weapon type against each mode of transportation, North America and East Asia did not. North America experienced a terrorist incident that utilized an explosive against both road transportation and rail transportation; however, road transportation in North America did not experience an attack that utilized incendiary, melee, or other. Rail transportation in North America was attacked using an explosive, incendiary and other, but not melee. No incident recorded in North America utilized melee. Of the seven incidents recorded in North America, almost three-fourths (3/4) used explosive as a weapon type.

East Asia experienced a terrorist incident that used explosives, incendiary, and melee, but not other. While rail transportation in East Asia recorded attacks using explosive, incendiary, and melee; however, road transportation in East Asia was attacked using explosive and incendiary. Of the total twenty-two recorded incidents in East Asia, almost one-half (1/5) utilized incendiary and just over one-third (1/3) utilized explosive.

Western Europe experienced terrorist incidents that utilized each weapon type: explosive, incendiary, melee, and other. In addition, both road transportation and rail transportation experienced incidents that utilized each weapon type. Of the seventy-six incidents recorded in Western Europe, over two-thirds (2/3) utilized explosive. Incendiary, the next most used weapon type in incidents against transportation in Western Europe, only accounted for just under one-fourth (1/4). Rail transportation in Western Europe experienced fifty-three total incidents between 2001 and 2016. Of those recorded incidents, explosive accounted for over three-fourths (3/4) of all attacks against rail transportation in Western Europe.

***Table 8:*** *Incidents Per Region by Weapon Type 2001-2016*

| | | | Road Transportation | Rail Transportation | Total |
|---|---|---|---|---|---|
| North America | | Explosive | 1 | 4 | 5 |
| | | Incendiary | 0 | 1 | 1 |
| | | Other | 0 | 1 | 1 |
| | Total | | 1 | 6 | 7 |
| East Asia | | Explosive | 4 | 4 | 8 |
| | | Incendiary | 3 | 7 | 10 |
| | | Melee | 0 | 4 | 4 |
| | Total | | 7 | 15 | 22 |
| Western Europe | | Explosive | 12 | 41 | 53 |
| | | Incendiary | 7 | 10 | 17 |
| | | Melee | 2 | 1 | 3 |
| | | Other | 2 | 1 | 3 |
| | Total | | 23 | 53 | 76 |
| Total | | Explosive | 17 | 49 | 66 |
| | | Incendiary | 10 | 18 | 28 |
| | | Melee | 2 | 5 | 7 |
| | | Other | 2 | 2 | 4 |
| | Total | | 31 | 74 | 105 |

Table 9 presents the number of fatalities per weapon type sorted by mode of transportation: road transportation and rail transportation. Of the twenty-one terrorist incidents that lead to fatality in attacks against transportation, explosive was used in over three-fourths (3/4) terrorist incidents. Of the sixty-one non-fatal terrorist incidents against rail transportation, explosive was used in almost two-thirds (2/3) terrorist incidents. In

terrorist incidents against road transportation that lead to fatalities, explosive was used in two-thirds (2/3) incidents. In terrorist incidents against road transportation that did not lead to fatalities, explosive was used in roughly one-half (1/2) incidents.

Broadly, weapon type explosive accounted for almost three-fourths (3/4) of all incidents against transportation that lead to fatalities whereas in terrorist incidents that did not lead to fatality, explosive was used in just under two-thirds (2/3) incidents. Followed second by incendiary, incendiary accounted for almost one-third (1/3) of incidents that I did not lead to fatality.

***Table 9:*** *Fatality Per Weapon Type by Mode of Transportation 2001-2016*

| | | | Fatality | No Fatality | Total |
|---|---|---|---|---|---|
| Road Transportation | | Explosive | 5 | 12 | 17 |
| | | Incendiary | 3 | 7 | 10 |
| | | Melee | 0 | 2 | 2 |
| | | Other | 0 | 2 | 2 |
| | Total | | 8 | 23 | 31 |
| Rail Transportation | | Explosive | 10 | 39 | 49 |
| | | Incendiary | 0 | 18 | 18 |
| | | Melee | 3 | 2 | 5 |
| | | Other | 0 | 2 | 2 |
| | Total | | 13 | 61 | 74 |
| Total | | Explosive | 15 | 51 | 66 |
| | | Incendiary | 3 | 25 | 28 |
| | | Melee | 3 | 4 | 7 |
| | | Other | 0 | 4 | 4 |
| | *Total* | | *21* | *84* | 105 |

Data from Table 5 and Table 7 are combined and sorted by transportation is presented in Table 10. Of the total terrorist incidents against rail transportation that resulted in wounding, explosive was used in two-thirds (2/3) incidents. Similarly, in road transportation, explosive was used in almost two-thirds (2/3) incidents that lead to wounding.

***Table 10:*** Wounding Per Weapon Type by Mode of Transportation 2001-2016

| | | | Wounded | Not Wounded | Total |
|---|---|---|---|---|---|
| Road Transportation | | Explosive | 6 | 11 | 17 |
| | | Incendiary | 3 | 7 | 10 |
| | | Melee | 1 | 1 | 2 |
| | | Other | 0 | 2 | 2 |
| | Total | | 10 | 21 | 31 |
| Rail Transportation | | Explosive | 10 | 39 | 49 |
| | | Incendiary | 0 | 18 | 18 |
| | | Melee | 4 | 1 | 5 |
| | | Other | 1 | 1 | 2 |
| | Total | | 15 | 59 | 74 |
| Total | | Explosive | 16 | 50 | 66 |
| | | Incendiary | 3 | 25 | 28 |
| | | Melee | 5 | 2 | 7 |
| | | Other | 1 | 3 | 4 |
| | *Total* | | *25* | *80* | 105 |

The number of terrorist incidents for each county and for each weapon type provided the pool of data that created the foundation of the data analysis.

## T-Test Analysis

Research Question 1 – Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of successful terrorist incident between rail transportation and road transportation?

$H_0$: Looking at the three regions collectively, there will be no difference in the number of successful incidents between rail transportation and road transportation.

$H_1$: Looking at the three regions collectively, rail transportation will yield a higher number of successful terrorist incidents.

Table 11 depicts the results of the crosstabulation used to analyze the relationship between mode of transportation – rail transportation and road transportation – and incident success rate A significant relationship was found indicating that rail transportation was attacked successfully more frequently than road transportation.

***Table 11:*** *Crosstabulation for Research Question 1*

| | Road Transportation | Rail Transportation | Total |
|---|---|---|---|
| Unsuccessful | 4 | 29 | 33 |
| Successful | 27 | 45 | 72 |
| Total | 31 | 74 | 105 |
| Pearson Chi-Square | | | 7.005* |
| d.f. | | | 1 |
| N | | | 105 |

*p<.05, **p<.01, *** p <.001

Research Question 2 – Is there a significant difference in the number of successful terrorist incidents between the three regions: Western Europe, East Asia, and North America?

$H_0$: There will be no significant difference in the number of terrorist incidents between Western Europe, East Asia, and North America.

$H_2$: There will be a significant difference in the number of terrorist incidents between Western Europe, East Asia, and North America.

These findings reject the null hypothesis that there is no significant difference in incident rate concerning region – Western Europe, East Asia, and North America. The results of the factor analysis of variance test that was used to test the null hypothesis of no difference in incident rate between regions – Western Europe, East Asia, and North America – is reported in Table 12. Table 12 reports a significant relationship. East Asia reports a significant relationship between region and incident rate.

***Table 12:*** *Relationship Between Western Europe, East Asia, and North America*

| | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|
| North America | 7 | .4286 | .53452 | .20203 |
| East Asia | 22 | .9091 | .29424 | .06273 |
| Western Europe | 76 | .6447 | .48177 | .05526 |
| Total | 105 | .6857 | .46646 | .04552 |

Note: $f(2, 102) = 4.11$, $p < .05$

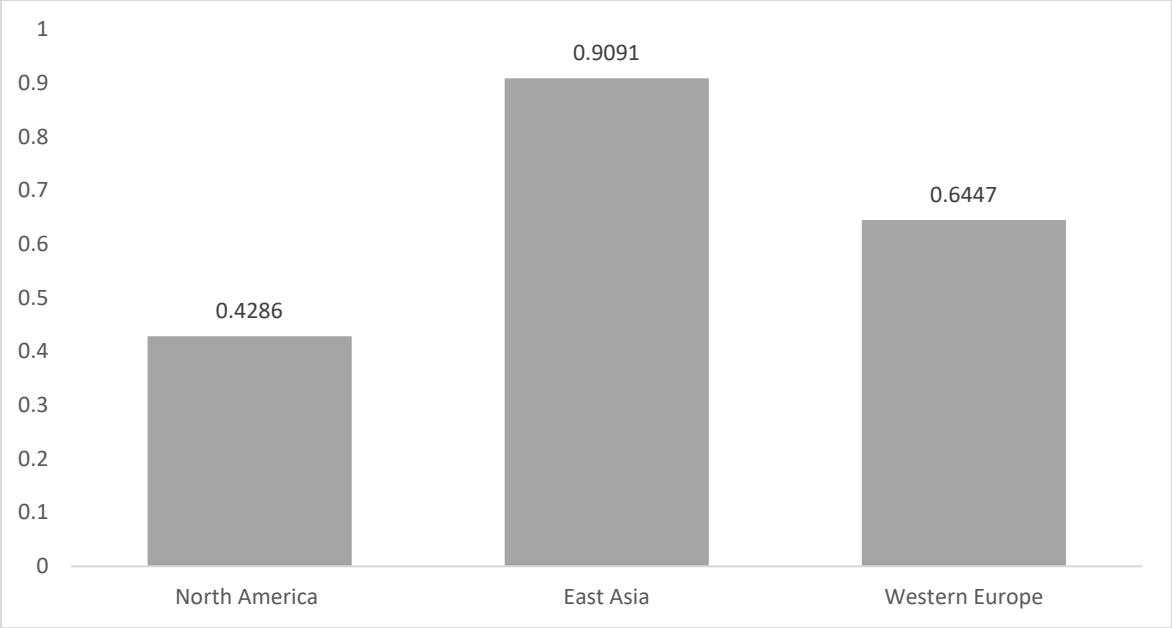
The Bonferroni post-hoc test was used to identify between group differences in region. Table 13 and figure 1 both illustrate the results of the Bonferroni post-hoc tests. There is a statistically significant relationship between East Asia and North America. In this statistically significant relationship, East Asia experienced a higher mean incident rate than North America. There is no significant relationship between the other region comparisons.

***Table 13:*** *Significance of Post-Hoc tests: Region*

| (I) Region | (J) Region | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|
| North America | East Asia | -.48052* | .19662 | .049 |
| | Western Europe | -.21617 | .17897 | .690 |
| East Asia | North America | .48052* | .19662 | .049 |
| | Western Europe | .26435 | .10970 | .053 |
| Western Europe | North America | .21617 | .17897 | .690 |
| | *East Asia* | *-.26435* | *.10970* | *.053* |

*p<.05, **p<.01, *** p <.001

***Figure 1:*** *Mean of Region Number of Terrorist Incidents*




Research Question 3 – Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning weapon type?

$H_0$: Looking at the three regions collectively, there will be no significant difference in the number of terrorist incidents concerning weapon type.

$H_3$: Looking at the three regions collectively, incendiary will yield a higher number of terrorist incidents.

These finding led to the rejection of the null hypothesis that there was not a significant difference in weapon type – explosive, incendiary, melee, and other. The results of the analysis of variance test are presented in Table 14. The Table shows a significant relationship between weapon type and incident rate, with majority of the incidents committed using incendiary devices, followed by melee, and then other weapons apart from explosives.

***Table 14:*** *Relationship Between Weapon Type and Incident Rate of Terrorism*

| | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|
| Explosive | 66 | .5455 | .50175 | .06176 |
| Incendiary | 28 | .9643 | .18898 | .03571 |
| Melee | 7 | .8571 | .37796 | .14286 |
| Other | 4 | .7500 | .50000 | .25000 |
| Total | 105 | .6857 | .46646 | .04552 |

Note: $f(3, 101) = 6.567$, $p < .01$

A Bonferroni post-hoc test revealed a significant relationship between incendiary and explosives. Compared to explosives, incendiary devices/weapons are more likely to be used in committing terrorist acts. Table 15 depicts the between group differences.

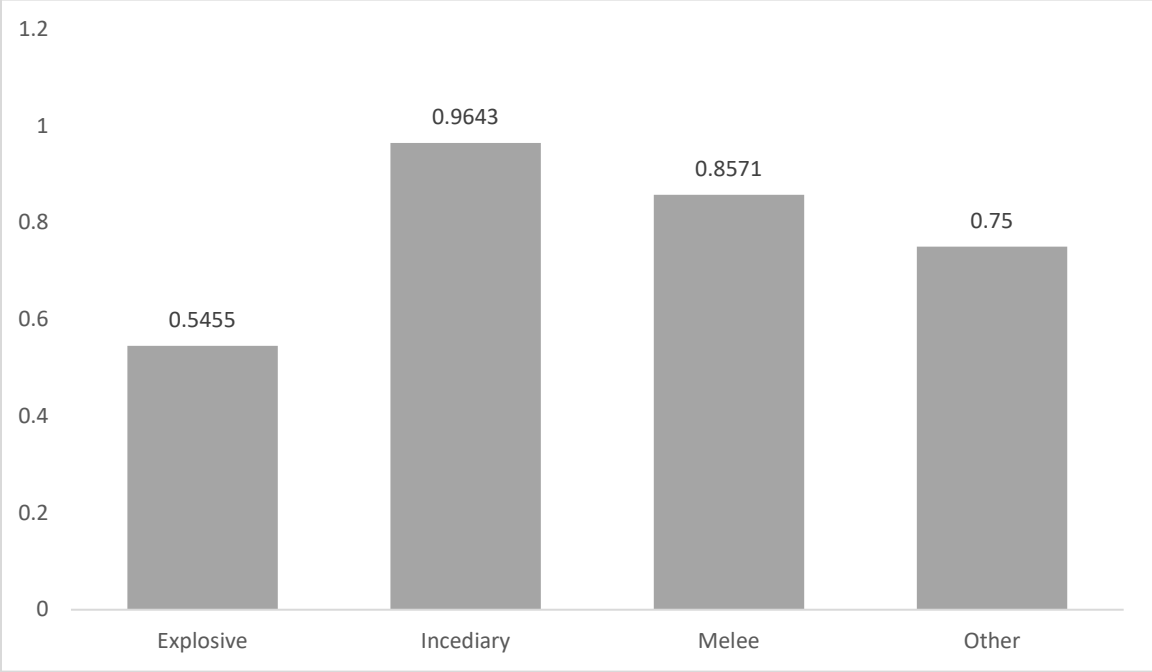
***Table 15:*** *Significance of Post-Hoc Tests: Weapon Type*

| (I) Weapon Type | (J) Weapon Type | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|
| Explosive | Incendiary | -.41883* | .09765 | .000 |
| | Melee | -.31169 | .17211 | .439 |
| | Other | -.20455 | .22296 | 1.000 |
| Incendiary | Explosive | .41883* | .09765 | .000 |
| | Melee | .10714 | .18297 | 1.000 |
| | Other | .21429 | .23144 | 1.000 |
| Melee | Explosive | .31169 | .17211 | .439 |
| | Incendiary | -.10714 | .18297 | 1.000 |
| | Other | .10714 | .27139 | 1.000 |
| Other | Explosive | .20455 | .22296 | 1.000 |
| | Incendiary | -.21429 | .23144 | 1.000 |
| | Melee | -.10714 | .27139 | 1.000 |

* $p < .05$

Figure 2 illustrates the difference in means for the Bonferroni post-hoc tests for weapon type. There is a statistically significant relationship between incendiary and explosives. In the statistically significant relationship, incendiary experienced a higher mean incident rate than explosives. There is no significant relationship between the other weapon types.

***Figure 2:*** *Mean of Weapon Type Per Number of Incidents*




Research Question 4 – Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in the number of terrorist incidents concerning casualty[4] rate?

$H_0$: Looking at the three regions collectively, there will be no difference in the number of terrorist incidents concerning casualty.

$H_4$: Looking at the three regions collectively, there will be a significant difference in the number of terrorist incidents concerning casualty.

The results of the independent samples T tests that were used to test the null hypothesis of no difference in number of incidents resulting in casualty is reported in Table 16 and Table 17. The null hypothesis is rejected showing a statistically significant relationship between incident rate and fatality as well as incident rate and wounding.

[4] Defined as victims killed and wounded (Federal Bureau of Investigation, 2014).

Table 16 shows a significant relationship was found indicating fatal incidents occur more often than non-fatal incidents.

***Table 16:*** *Significance of Independent Samples T-test for Fatality Rate*

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Fatality | 21 | .9524*** | .21822 | .04762 |
| No Fatality | 84 | .6190 | .48854 | .05330 |

*p<.05, **p<.01, *** p <.001

Table 17 presents a significant relationship found indicating that wounding incidents occur statistically more often than non-wounding incidents.

***Table 17:*** *Significance of Independent Samples T-test for Wounding Rate*

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Wounded | 25 | 1.000* | .00000 | .00000 |
| Not Wounded | 80 | .5875 | .49539 | .05539 |

*p<.05, **p<.01, *** p <.001

Research Question 5 – Is there a significant difference between the three region and number of incidents resulting in casualty?

$H_0$: There will be no significant difference between the three regions and the number of terrorist incidents resulting in casualty.

$H_5$: There will be a significant difference between the three regions and the number of terrorist incidents resulting in casualty.

The results of the analysis of variance tests that were used to test the null hypothesis of no difference in region and number of incidents resulting in casualty are reported in Tables 18, 19, 20, and 21. The null hypothesis is rejected showing a

statistically significant relationship between region and number of incidents resulting in casualty. Table 18 reports a statistically significant relationship in region and wounded rate.

***Table 18:*** *Relationship Between Wounded Rate and Region*

| | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|
| North America | 7 | .1429 | .37796 | .14286 |
| East Asia | 22 | .5455 | .50965 | .10866 |
| Western Europe | 76 | .1579 | .37796 | .36707 |
| Total | 105 | .2381 | .42796 | .04176 |

Note: f(2, 102) = 8.172, p < .05

Table 19 and figure 3 both illustrate the differences in the mean for the significant Bonferroni post-hoc test. There is a statistically significant relationship between East Asia and Western Europe. East Asia experienced a higher mean wounded rate than Western Europe. There is no significant relationship between the other region comparisons.

***Table 19:*** *Significance of Post-Hoc Tests: Wound Rate by Region*

| (I) Region | (J) Region | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|
| North America | East Asia | -.40260 | .17409 | .068 |
| | Western Europe | -.01504 | .15846 | 1.000 |
| East Asia | North America | .40260 | .17409 | .068 |
| | Western Europe | .38756* | .09713 | .000 |
| Western Europe | North America | .01504 | .15846 | 1.000 |
| | East Asia | -.38756* | .09713 | .000 |

*p<.05, **p<.01, *** p <.001

***Figure 3:*** *Means of Region by Wounding*

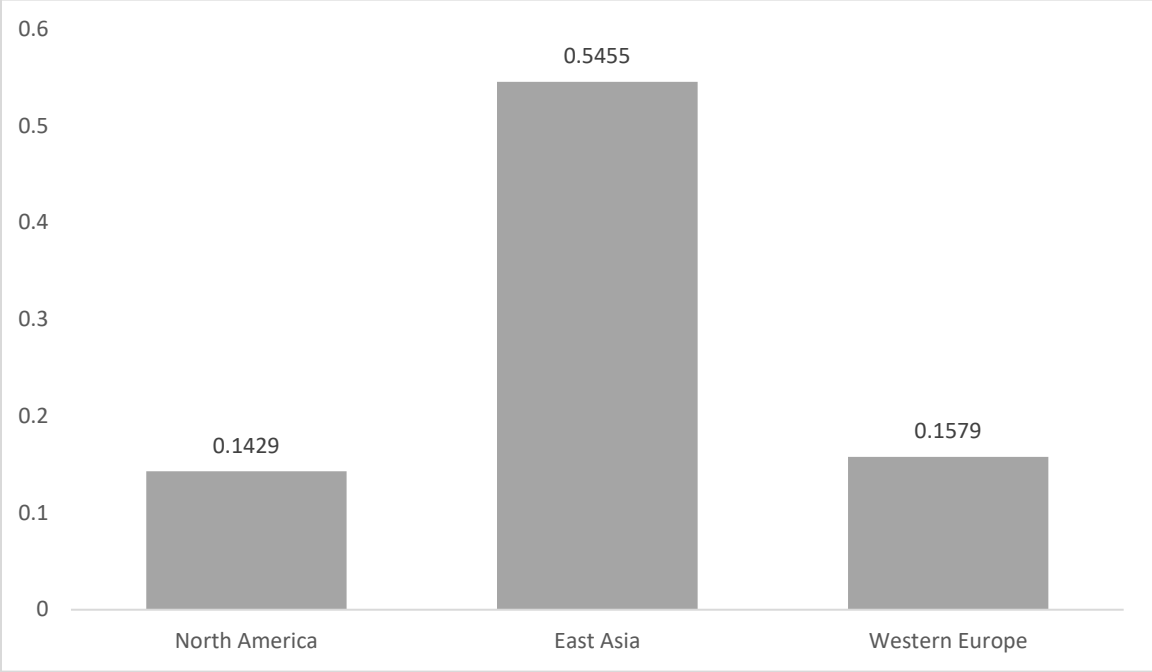



Table 20 presents a subcategory of casualty – fatality rate. The null hypothesis is rejected showing a statistically significant relationship between region and number of incidents resulting in casualty. Table 20 reports a statistically significant relationship in region and fatality rate.

***Table 20:*** *Relationship Between Fatality Rate and Region*

| | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|
| North America | 7 | .1429 | .37796 | .14286 |
| East Asia | 22 | .5000 | .51177 | .10911 |
| Western Europe | 76 | .1184 | .32525 | .03731 |
| Total | 105 | .2000 | .40192 | .03922 |

Note: $f(2, 102) = 8.952$, $p < .001$

Table 21 and figure 4 both illustrate the differences in the mean for the significant Bonferroni post-hoc test. There is a statistically significant relationship between East

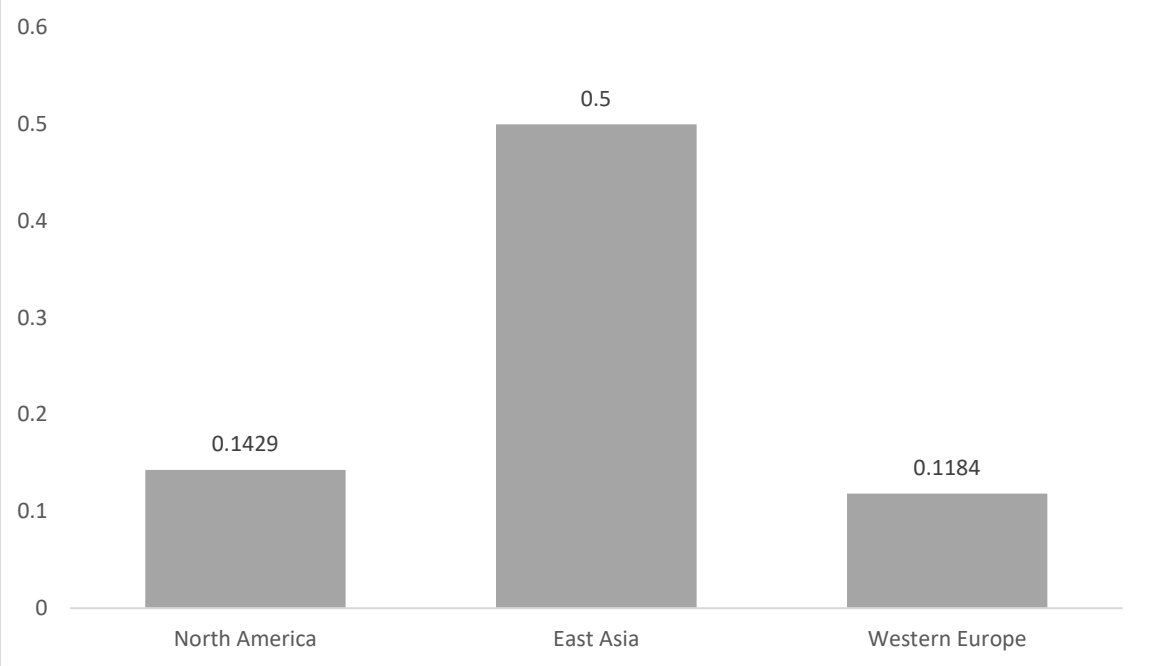
Asia and Western Europe. There is no statistically significant relationship between the other regions.

***Table 21:*** *Significance of Post-Hoc Tests: Fatality Rate by Region*

| (I) Region | (J) Region | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|
| North America | East Asia | -.35714 | .16243 | .090 |
| | Western Europe | .02444 | .14785 | 1.000 |
| East Asia | North America | .35714 | .16243 | .090 |
| | Western Europe | .38158* | .09062 | .000 |
| Western Europe | North America | -.02444 | .14785 | 1.000 |
| | East Asia | -.38158* | .09062 | .000 |

*p<.05, **p<.01, *** p <.001

***Figure 4:*** *Mean Incidents of Fatality by Region*




Research Question 6 – Looking at Western Europe, East Asia, and North America collectively, is there a significant difference in number of casualties by weapon type?

$H_0$: Looking at the three regions collectively, there will be no significant difference between weapon type and the number of incidents resulting in casualty.

$H_6$: Looking at the three regions collectively, there will be a significant difference between weapon type and the number of incidents resulting in casualty.

Factor analysis of variance tests were used to test the null hypothesis of no difference in weapon type and number of incidents resulting in casualty. There is no statistically significant relationship between weapon type and fatality rate. A statistically significant relationship was found between weapon type and wound rate. Table 22 presents the mean values of the statically significant factor analysis of variance test used to test the relationship between weapon type and wound rate.

***Table 22:*** *Relationship Between Wounded Rate and Weapon Type*

| | N | Mean | Std. Deviation | Std. Error |
|---|---|---|---|---|
| Explosive | 66 | .2424 | .43183 | .05316 |
| Incendiary | 28 | .1071 | .31497 | .05952 |
| Melee | 7 | .7143 | .48795 | .18443 |
| Other | 4 | .2500 | .50000 | .25000 |
| Total | 105 | .2381 | .42796 | .04176 |

Note: $f(1, 101) = 4.103$, $p < .05$

The Bonferroni post-hoc test was used to identify between group differences in weapon type per wound rate. A significant relationship was found between melee and explosive as well as between melee and incendiary. No other significant relationship was found between the other weapon types. Table 23 illustrates the between group differences.

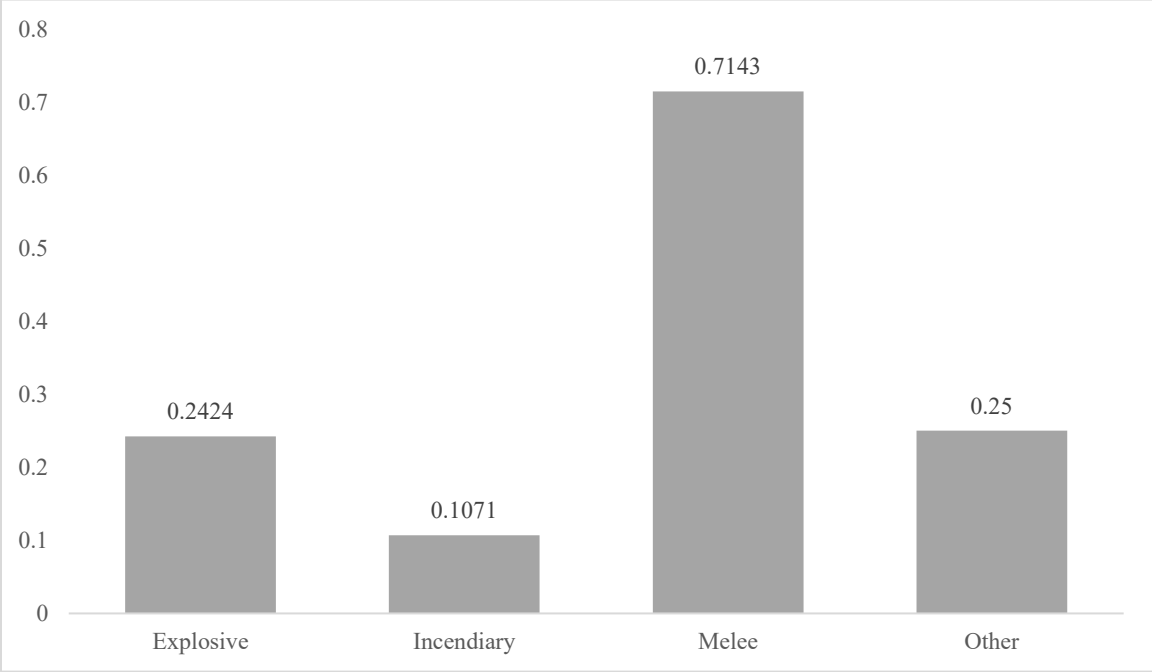
***Table 23:*** *Significance of Post-Hoc Tests: Wound Rate by Weapon Type*

| (I) Weapon Type | (J) Weapon Type | Mean Difference (I-J) | Std. Error | Sig. |
|---|---|---|---|---|
| Explosive | Incendiary | .13528 | .09247 | .879 |
| | Melee | -.47186* | .16298 | .028 |
| | Other | -.00758 | .21112 | 1.000 |
| Incendiary | Explosive | -.13528 | .09247 | .879 |
| | Melee | -.90714* | .17326 | .004 |
| | Other | -.14286 | .21916 | 1.000 |
| Melee | Explosive | .47186* | .16298 | .028 |
| | Incendiary | .60714* | .17326 | .028 |
| | Other | .46429 | .25698 | .443 |
| Other | Explosive | .00758 | .21112 | 1.000 |
| | Incendiary | .14286 | .21916 | 1.000 |
| | Melee | -.46429 | .25698 | .443 |

*p<.05, **p<.01, *** p <.001

Figure 5 depicts the differences in means for the Bonferroni post-hoc test for weapon type per wound rate. One statistically significant relationship is found between melee and explosive. In this significant relationship, terrorist incidents involving melee have a higher wound rate than incidents utilizing explosive. A second statistically significant relationship was found between melee and incendiary. This significant relationship finds that terrorist incidents using melee has a higher wound rate than incidents involving incendiary.

***Figure 5:*** *Mean Number of Incidents of Wounding by Weapon Type*




## Summary

Chapter four answered the three research questions by assessing the null and alternative hypotheses of each research question through statistical analysis. Questions one, two, and three rejected the null hypothesis. Question one established a significant relationship between number of terrorist incidents of rail transportation and road transportation. Question two established a significant relationship between regions and incident rate. There was a statistically significant relationship between East Asia and North America. East Asia had a statistically significant higher mean incident rate than North America. There was no statistically significant relationship between East Asia and Western Europe or Western Europe and North America. Question three established a significant relationship between weapon type and incident rate. There was a statically significant relationship between incendiary and explosives. Incendiary had a statistically significant higher mean incident rate than explosives. There was no statistically

significant relationship between (a) explosive and melee, (b) explosive and other, (c) incendiary and melee, (d) incendiary and other, or (e) melee and other. These conclusions and their implications will be explained thoroughly in chapter five.

Chapter five will explore how the answers to these three research questions answered the broader question of how well the Contemporary Terrorism Paradigm relates to the terrorist number of terrorist incidents of rail transportation. The conclusions will be related to the specific research questions. From these conclusions, implications will be drawn which will lead to ideas for future research. The chapter and the study will then be concluded with a final summary.

# CHAPTER 5

## DISCUSSION, CONCLUSIONS, AND IMPLICATIONS

### Introduction

This chapter will answer the research question, does the Contemporary Terrorism Paradigm explain the variance in number of terrorist incidents in different modes of transportation in the regions analyzed, by assessing the findings presented in chapter four. The conclusions to this problem will have implications for both the security of the transportation infrastructure and for criminology. The conclusion section also discusses future research into the issue to expand our knowledge of the Contemporary Terrorism Paradigm and transportation security and safety.

### Discussion of Study Findings

The purpose of this study was to gain a better understanding of the applicability of the Contemporary Terrorism Paradigm to terrorist incidents involving transportation. Specifically, the study examined if the Contemporary Terrorism Paradigm explained the differences in number of terrorist incidents among different modes of transportation. This was assessed by evaluating the two different modes of transportation: road transportation and rail transportation. The National Consortium for the Study of Terrorism and Responses to Terrorism kept a detailed record for incidents of terrorism in every country and against every target type published in the Global Terrorism Database. This raw data was cleaned to only include terrorist incidents in North America[5], East Asia, and Western Europe and that targeted the transportation infrastructure of those regions. In addition,

[5] Excluding Mexico.

data concerning weapon type was also included. This secondary data allowed insight into which mode of transportation and weapon type was most often used and later specified to each region. This study sought to interpret this information through the lens of the Contemporary Terrorism Paradigm.

The 1880s shows a shift in terrorism from traditional terrorism to contemporary terrorism (Rapoport, 2004). This shift is recognized as the Contemporary Terrorism Paradigm. Kurtulus (2011) and others (Duyvesteyn,2004: Laqueur, 1996; and Rapoport, 2004; Strandberg,2013) have attributed this fundamental shift in terrorism to a change in strategy, motives, and target. Kurtulus (2011) hypothesized that four main factors identify a shift to contemporary terrorism: religious or mystical motivation, horizontal network structure, indiscriminate/nonselective targeting leading to mass casualty, and the use of weapons of mass destruction (p. 478). While the concept of "contemporary" or "new" terrorism is still debated, Strandberg (2013) tried to understand terrorist targeting of rail transportation through the purview of Contemporary Terrorism Paradigm. Strandberg (2013) analyzed terrorist attacks from 1970 to 2010 to understand incidence trends in terrorist targeting, specifically targeting of transportation. While research has been conducted examining the nature of attacks against transportation and the impact a large scale or minor attack would have on infrastructure interdependency, little research has applied the Contemporary Terrorism Paradigm to the targeting of rail transportation. Strandberg (2013) found that the high number of casualties among rail transportation terrorist incidents indicates a trend that aligns with the indiscriminate aspect of the Contemporary Terrorism Paradigm. This study attempted to address six thought-

provoking questions and also tested six hypotheses. The following are some of the key observations made in the study.

The first research question addressed the difference between successes in terrorist incidents against road transportation and rail transportation. There was a statistically significant difference between mode of transportation and number of successful attacks. This finding lead to the first conclusion that as rail transportation is attacked more often, the number of successful terrorist incidents against rail transportation will simultaneously increase. Rail transportation has a high number of vulnerabilities across a multitude of platforms, i.e. tracks, station, cab, etc. The significance in number of successful attacks to rail transportation highlights these vulnerabilities and indicates the accessibility and ease of targeting rail transportation.

The second research question assessed the significant difference between region and number of terrorist incidents. The non-parametric statistics found a statistically significant difference between the number of incidents in East Asia and North America. It is important to note that while the transportation infrastructure in the aforementioned countries are similar, the prevalence of rail transportation is lower in North America compared to other regions studied.

With regards to weapon type, research question three analyzed the significant difference in weapon type: explosive, incendiary, melee, and other. The non-parametric statistics found a statistically significant difference among weapon type. The Bonferroni post-hoc tests were used to assess the between-group differences to find a statistically significant difference between incendiary and explosive. Both incendiary and explosive yielded the highest frequency of use in terrorist incidents against transportation. The

conclusion from these results was that when it came to incidents against transportation, incendiary constituted a statistically higher number of attacks than explosive. There was not a statistically significant difference regarding comparison of the other studied weapon types.

The Contemporary Terrorism Paradigm most directly applies to the results of research questions four through six. These three research questions can be grouped together because of their relationship to indiscriminate killing and weapon type. Research question four identified a statistically significant relationship between number of terrorist incidents against transportation and the number of incidents resulting in casualty. This finding is consistent with Strandberg's (2013) findings as well as the assumptions made in the Contemporary Terrorism Paradigm. To Kurtulus' (2011) third characterization of contemporary terrorism, "indiscriminate attacks aimed at causing high number casualties," the results of research question four indicate a higher number of incidents resulting in casualty for terrorism incidents against transportation (p. 478). While the number of incidents resulting in casualty were not compared to terrorist incidents against other targets, the significant result that terrorist incidents are likely to result in casualty lead to the conclusion that contemporary terrorism is likely to target the transportation infrastructure due to its high ability to result in mass casualty.

This conclusion is extended in research question five: Is there a significant difference between region and number of incidents resulting in casualty. The results rejected the null hypothesis and found a significant relationship between incidents in East Asia and the number of incidents resulting in casualty. East Asia yielded the highest number of incidents against transportation between 2001 and 2016. Of these incidents,

they were more likely to result in casualty. According to Strandberg (2013) and Kurtulus (2011), incidents against transportation in this new Contemporary Terrorism Paradigm will yield a higher number of incidents resulting in casualty.

The final research question applies Kurtulus' (2011) tactical change in terrorism to the use of weapons in terrorist incidents targeting transportation. Research question six examines the significant relationship between terrorist incidents resulting in casualty and weapon type. Kurtulus (2011) asserted that terrorist incidents occurring post 1880 will more likely utilize weapons of mass destruction as well as differ in weapon choice from traditional terrorism. Traditional terrorism used weapons for selective killing, whereas contemporary terrorism uses weapons for mass casualty and indiscriminate killing (Kurtulus 2011; Laqueur, 1996). The results of this study concerning the significant relationship between weapon type and incidents resulting in casualty confirm this characterization of contemporary terrorism.

## Implications

Chapter four presented the collected and processed data and addressed the research questions along with their hypotheses. Research questions one, three, four, and six used the countries collectively to analyze significant differences in number of terrorist incidents between weapon type, success v unsuccessful, and number of casualties. Research questions two and five analyzed significant differences in number of terrorist incidents between region and number of successes as well as region and number of incidents that incurred casualties. With these specific questions answered and the appropriate hypotheses rejected, conclusions could be drawn from the findings about the relationship between the Contemporary Terrorism Paradigm and terrorist incidents

targeting transportation. Moreover, the findings also have several direct theoretical and practical implications for the transportation infrastructure in the United States. The Contemporary Terrorism Paradigm accounted for the high likelihood of incidents resulting in casualty and the frequency of using weapons that primary result in indiscriminate killing. These results can be attributed to the globalization and horizontal network structure aspects of the Contemporary Terrorism Paradigm as well as the characterization of nonselective killing and mass casualty. Incidents that target the transportation infrastructure are likely to be successful and likely to result in casualty. While there was not a distinct relationship found between the number of incidents and the mode of transportation, there was a significant relationship between the mode of transportation and the likelihood of its success. Rail transportation lead to a higher number of successful terrorist incidents than road transportation. With other research indicating the likelihood of incidents against transportation to be more likely to result in casualty than attacks against other targets, the results of this study can be put into context. This study found a significant relationship between number of incidents resulting in casualty against the transportation infrastructure. This conclusion aligns with and supports the findings of other, larger-scale studies.

Following the attacks of September 11, 2001, the federal government enacted several security measures to harden airport security. With the results of this study showing a trend in successful, casualty resulting incidents against the transportation infrastructure in North America, Western Europe, and East Asia, it is important to examine the various vulnerabilities of the current infrastructure in the United States. As previously discussed in chapter two, implements the similar security measures as that

present in airports and airways would be practically impossible to do cost and the prevention of the free flow of people (Jenkins & Gerten, 2001; Levin, 2016). However, it is important to consider the threat of attack targeting the transportation infrastructure in the United States. The results of this study show that attacks targeting transportation are likely to be successful and likely to result in casualty – aspects important to the goals of contemporary terrorist organizations. These finds are especially interesting due to ISIS' most recent publication suggesting jihadists target transportation in Western nations. This terrorist organizations identified the vulnerabilities of the transportation infrastructure and highlighted the ease of an attack and the mass casualty it is likely to result in.

## Future Research

Future research is needed to better understand if the Contemporary Terrorism Paradigm has a role in terrorist incidents targeting transportation in other regions/countries. The current study was launched to apply the theory to terrorist incidents targeting transportation in regions with similar infrastructures to that present in the United States. The results of this study raised several questions that deserve further investigation. The sample size of this study did not test the validity of this theory in other regions of the world or in comparison to other target types, i.e. business, police, military, political figures, etc.

The study only examined terrorist incidents between 2001 and 2016. This time period was narrowed down to examine the transportation infrastructure post September 11. The Contemporary Terrorism Paradigm states that the new/contemporary terrorism experienced today has been ongoing since the start of the 20$^{th}$ century (Laqueur, 1996; Rapoport, 2004; Strandberg, 2013). A wider timeframe examining attacks targeting

transportation would better assess the applicability of the Contemporary Terrorism Paradigm to the current trend in the target selection of terrorist organizations. The Global Terrorism Database is the most expansive and inclusive database concerning terrorism. The GTD includes incidents dating back to 1970. A study with a wider period, particularly one starting in 1970, would better examine the Contemporary Terrorism Paradigm's applicability

The sample size of this study only contained countries with similar transportation infrastructures to the United States and that experienced at least one terrorist incident targeting transportation between 2001 and 2016. A more inclusive and in-depth study would consider examining attacks against transportation globally; however, it is impossible that such results would be skewed due to disproportionate availability of transportation in various countries and regions. Several countries in the Middle East and Africa either do not have rail transportation, or it is seldom used or accessible. Such variability would provide an inaccurate assessment comparison of road transportation v rail transportation. However, a study that grouped road transportation and rail transportation to assess attacks against transportation as a whole may allow for a wider, more inclusive study.

As previously explained, the results of this study suggest that the Contemporary Terrorism Paradigm plays a key factor in the targeting of transportation. However, this study is small-scale to only include Belgium, Canada, China, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Spain, Sweden, Taiwan, United Kingdom, and United States – countries that experienced terrorist incidents targeting transportation and that occurred between 2001 and 2016. Future research may examine a wider time period as

well as a larger sample size – country selection – to more accurately assess the role of the Contemporary Terrorism Paradigm to the targeting of the transportation infrastructure.

## Summary

The Contemporary Terrorism Paradigm is a controversial theory. Duyvesteyn (2004) challenges the notion that terrorism experienced today is "new" compared to the what is termed "traditional terrorism." With that said, scholarly research across a spectrum of targeting analysis suggests that there is a fundament shift in strategy, motivation, and targeting (Kurtulus, 2011; Laqueur, 1996; Strandberg, 2013; Rapoport, 2014). This study sought to examine its applicability to attacks targeting the transportation infrastructure in North America, Western Europe, and East Asia between 2001 and 2016. The findings and conclusions that were drawn from them better defined the role of the Contemporary Terrorism Paradigm in terrorist target selection of transportation.

The findings were reported in response to the six specific research questions. The first research question examined the success of attacks targeting road transportation and rail transportation to conclude that the more terrorist incidents that rail transportation experiences, the more likely those incidents are to be successful. The second research question looked to find significant differences in the targeting of transportation between regions: North America, Western Europe, and East Asia. The conclusion drawn was that East Asia experienced the most terrorist incidents targeting transportation in comparison to North America. The third research question looked specifically at weapon type to find a significant difference between incendiary and explosive. Both were used more commonly in attacks against transportation in a collective analysis of all designated

regions. Research questions four through six looked specifically at the number of incidents resulting in casualty. Research question four found that there is a significant relationship between attacks targeting transportation and the number of incidents resulting in casualty. The fifth research question looked at the significant difference between region and number of incidents resulting in casualty to find a significant relationship between East Asia and incidents resulting in casualty. The final research question compared the number of incidents resulting in casualty to the number of incidents per weapon type to find a significant difference between melee and incendiary as well as between melee and explosive. These findings created the basis of the conclusions of the study.

The main conclusion of the was that the Contemporary Terrorism Paradigm was a good explanation of the differences in weapon type and targeting in the transportation infrastructure in North America, Western Europe, and East Asia between 2001 and 2016. This conclusion was supported by the rejection of all six null hypotheses. The differences in weapon type and number of casualties demonstrates the assumptions of the Contemporary Terrorism Paradigm as outlined by Kurtulus (2011), Laqueur (1996), Rapoport (2004), and Strandberg (2013). In summary, the fact that incidents targeting transportation are related to higher number of incidents resulting in casualty suggests that the Contemporary Terrorism Paradigm applies to the targeting of transportation as a tactic of terrorist organizations.

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