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Determining the Value of Less Lethal Weapons through Monte Carlo Simulation

June 2024

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Prepared for the Naval Postgraduate School, Monterey, CA 93943.

ACQUISITION RESEARCH PROGRAM
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NAVAL POSTGRADUATE SCHOOL

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ABSTRACT

With the Navy and Marine Corps shifting their focus towards the Pacific Theater, there arises a crucial question: Do the operational forces possess the requisite less lethal weapon (LLW) capabilities to effectively execute various mission types such as stability operations, counterinsurgency, noncombatant evacuation operations, or policing operations? Especially in contested environments, the ability to swiftly transition from less-lethal to lethal force may become imperative. While there is a growing interest in deploying efficient LLWs, research indicates that the available capabilities are perceived as cumbersome. Introducing a single-shot attachment that facilitates rapid transition from less lethal to lethal force could furnish the DOD and other governmental bodies with a capability that fills the void in the continuum of force, thereby fostering increased trust from civilian populations, reducing lethality, diminishing legal expenses, and potentially yielding other unforeseen benefits. Utilizing Monte Carlo stochastic modeling of police violence data, interviewing subject matter experts, and applying a RAND logic model, the perceived value of LLWs was assessed. Stochastic modeling demonstrates that single-shot bullet-capture projectile attachments can generate a return on investment of up to 1800%. Given the uncertainties faced by military forces and civil law enforcement agencies, this capability enhancement will augment a unit's capacity to fulfill its mission.

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LIST OF ACRONYMS AND ABBREVIATIONS

CED	conducted energy device
COIN	counterinsurgency
CONOPS	concept of operations
DOD	Department of Defense
EABO	expeditionary advance base operations
FBI	Federal Bureau of Investigation
IFC	intermediate force capability
KLE	key leader engagement
LLW	less lethal weapon
NLW	non-lethal weapon
NATO	North Atlantic Treaty Organization
NEO	noncombatant evacuation operations
NIJ	National Institute of Justice
ROE	rules of engagement
ROI	return on investment
SOF	special operations forces
SOP	standard operating procedure
TTPs	tactics, techniques, and procedures
USMC	United States Marine Corps

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I. INTRODUCTION

The use of lethal force by law enforcement agencies has been a contentious topic in recent years as a result of multiple incidents of police brutality and excessive force that have drawn public attention. These incidents have raised interest in less-lethal weapons (LLWs) as a substitute for traditional firearms. Whenever feasible, LLWs are intended to incapacitate a criminal or suspect without resulting in death or serious injury.

Furthermore, since the early 2000s, the United States military has been engaged in counterinsurgency (COIN) operations, mostly in the Middle East. Many incidents of needless use of deadly force have occurred throughout this time. The deaths of civilian noncombatants were a common outcome of these situations. The objective of gaining the hearts and minds of the local inhabitants was ultimately damaged by these killings, which weakened the faith of the civilian population in the intentions of the U.S. military. As the strategic focus of the Navy and Marine Corps changes to the Pacific Theater, the missions that the military will have to execute will differ widely from the previous ones, ranging from policing of internal forces to noncombatant evacuation operations (NEO), to training host nations in policing operations. All of these activities may call for the use of some degree of physical force to ensure the safety of the personnel involved or to ensure the operation's effectiveness. The mismanagement of this necessary physical force could lead the Department of Defense (DOD) into undesirable circumstances at the strategic level.

In 2020, the then-Commandant of the Marine Corps, General David Berger, was also serving as the DOD's executive agent for the non-lethal weapons (NLWs) program. During this time, he published the planning guidance the DOD is currently using that laid the pathway the organization plans to take for the further research and development of LLWs. The guidance clearly shows a growing desire to develop more capabilities to be given to the operating forces. Specifically, Task 2 from the guidance reads as follows: "We will work across DOD to conduct the analysis—with an emphasis on wargaming—necessary to support force design of, and investment in, intermediate force capabilities" (Department of Defense [DOD], 2018, p. 5). As the operating environment becomes

increasingly complex, operating forces will need different capabilities to handle novel situations in novel environments.

The Thurgood Marshall Institute found that from 2003 to 2023, there were 167 publicly disclosed settlements totaling $2.24 billion in compensation between law enforcement agencies and gunshot victims and their families (National Police Funding Database, 2023). Furthermore, comprehensive settlements made by people as well as settlements connected to police officer misconduct are available in the Institute's National Police Funding Database. For a variety of shooting incidents that occurred between 2005 and 2020, 42 nonfederal police officers were found guilty: five for murder, two for reckless homicide, three for negligent homicide, eleven for manslaughter, five for voluntary manslaughter, six for involuntary manslaughter, eight for misconduct, and two each for aggravated assault and reckless firearm discharge (National Police Funding Database, 2023).

News of these police shootings floods the Internet and airwaves when they happen; a compelling *Scientific American* article stated that

> on Tuesday, August 6, 2019, police shot and killed a schoolteacher outside his home in Shaler Township, Pennsylvania. He had reportedly pointed a gun at the officers. In Grants Pass, Oregon, that same day, a 39-year-old man was shot and killed after an altercation with police in the state police office. And in Henderson, Nevada, that evening, an officer shot and injured a 15-year-old suspected of robbing a convenience store. The boy reportedly had an object in his hand that the police later confirmed was not a deadly weapon. In the United States, police officers fatally shoot about three people per day on average, a number that's close to the yearly totals for other wealthy nations. A pair of high-profile killings of unarmed black men by the police pushed this reality into the headlines in the summer of 2014. Waves of public protests broke out after the fatal shooting of Michael Brown in Ferguson, Missouri, and the death by the chokehold of Eric Garner in New York City. (Peeples, 2019)

However, in order to maintain neighborhood safety, police officers and armed federal field agents must arrest dangerous offenders while also maintaining their own safety and that of any bystanders. The Federal Bureau of Investigation (FBI) released figures that serve as a startling reminder of just how perilous law enforcement employment can be. According to Mun et. al (2024), in 2021 the FBI reported that

- 59 police officers were killed in the line of duty from January 2021 to September 2021. This includes two special agents from the FBI's Miami Field Office.
- 60,105 officers were assaulted in 2020; 18,568 (30.9%) of them sustained injuries.
    - 44,421 officers were assaulted with personal weapons (e.g., hands, fists, or feet); 25.8% of these officers were injured.
    - 2,744 officers were assaulted with firearms; 6.1% of these officers were injured.
    - 1,180 officers were assaulted with knives or other cutting instruments; 9.7% of these officers were injured.
    - The remaining 11,760 officers were assaulted with other types of dangerous weapons; 16.8% of these officers were injured. (FBI, 2021)

Less-lethal weapons lower risks, but there is no assurance that their use will stop fatalities or serious injuries or lower criminal responsibility while safeguarding the police officer. If it can be shown that the officer or service member behaved within the bounds of his or her official duties and that the performance of said duties is within standard operating procedures, then it is considered that neither the officer or the service member nor the federal agency will be held accountable for civil or criminal action. The amount of money awarded to victims and their families for the careless use of lethal force by police officers is likely to be significantly reduced with proper training and the implementation of less-lethal technology.

Similarly, if the military is called to act as a policing force or to train a policing force, policing capabilities must be pre-established and trained for before the need arises. Along this vein, LLWs are a large part of establishing an effective policing force. The

military will need to have these LLW capabilities on hand and have subject matter experts within the ranks to train others and operate the equipment.

A range of nonlethal munitions intended to disable targets without killing or seriously injuring them are included in the category of LLWs. Every existing LLW capability is intended to function as a stand-alone platform, and each LLW is intended to be utilized in a particular scenario. These consist of beanbag rounds, rubber bullets, and other less dangerous projectiles. In contrast, tasers are electroshock weapons that temporarily paralyze a person by interfering with their ability to move their muscles. Although both technologies have been broadly embraced by militaries and law enforcement organizations worldwide, there has been much disagreement about how best to use them.

The public has expressed concern and the need for discussion about law enforcement personnel's use of force, especially when it involves the use of lethal force. The use of LLWs, such as rubber bullets, pepper spray, and shock guns, has become more popular in recent years as an alternative to conventionally lethal weapons. However, not enough research has been done on the effectiveness and benefits of LLWs in reducing fatalities and injuries in law enforcement engagements and military applications.

A. RESEARCH FOCUS

The aim of this study is to examine the utility of a less-lethal, single-shot, bullet-catching handgun accessory in law enforcement and military settings. It seeks to assess its effectiveness in reducing fatalities and injuries during law enforcement encounters and to gauge its perceived value among military personnel in various scenarios. The focus is on evaluating the potential benefits and drawbacks of deploying less-lethal weaponry in policing roles, both within civilian agencies and military units engaged in law enforcement duties, and its impact on public perception and trust in law enforcement. By providing valuable insights into the integration of LLWs into use-of-force protocols, the research aims to inform policy and practice recommendations for their safe and effective implementation, while also examining the cost-effectiveness of such technologies in law enforcement and military contexts.

B. RESEARCH SCOPE

This research offers a comprehensive examination of the pros and cons associated with a less-lethal, single-shot, bullet-catching handgun accessory, focusing specifically on its suitability as a less-lethal option for law enforcement and military police. It will assess the accessory's potential to reduce collateral damage, mitigate reputational risks, and prevent unnecessary fatalities caused by lethal gunfire. Additionally, the accessory's ability to minimize wrongful death lawsuits and legal liabilities for officers or agents, while also considering the perceived benefits it could offer to military operations, will be explored. However, due to the limitations and scope of this study, it will not review the development, engineering, or physics of these LLWs. For instance, for the purposes of this study, we assume that the LLW has been thoroughly tested and vetted by qualified law enforcement and military officials and that it works as advertised. Any discussion on efficacy, ease of use, robustness, reliability, and other associated properties will be based on the literature survey of prior research.

C. PROBLEM STATEMENT

The problem is that the available options of less-lethal weapons technology to government agencies, including the DOD, are insufficient to accomplish a given mission in the complexity and variety of situations that personnel may encounter in future operations. This is a problem because as government agencies engage in forceful actions, concerns with collateral damage, reputational risk, and legal exposure while preventing wrongful and unnecessary deaths caused by conventional bullet wounds are brought to the forefront as the loss of life and fiscal burdens increase. Specifically for the DOD, the operating forces are missing the necessary capabilities to successfully accomplish the possible mission sets they will be tasked with. Furthermore, the current armaments available to government personnel are inadequate to handle challenges at every level of the continuum of force (see Figure 1).

The study seeks to explore the following questions:

1. As the operating environment becomes increasingly complex, what role will LLW play in enabling operating forces to handle novel situations in novel environments?

2. Will a less-lethal, single-shot, bullet-capture attachment that allows rapid transition from less-lethal to lethal force allow the DOD to operate more effectively in anticipated future operating environments?

3. What value can a less-lethal, single-shot, bullet-capture handgun attachment add to civilian policing and military operations?

D. PURPOSE STATEMENT

The purpose of this research is to analyze the return on investment that a single-shot, bullet-capture handgun attachment that allows for rapid transition from less-lethal to lethal weapons can provide the DOD and other government agencies. This study will model the value-add using the novel Alternative Ballistics Corporation's technology over conventional firearms and will find that although the probability of extreme events occurring is low, the impact of such events on society is significant.

E. DEFINITIONS

1. Less Lethal Weapons

Much of the academic literature uses the term "non-lethal weapons" (NLW) as opposed to "less-lethal weapons." Furthermore, the DOD uses the term "intermediate force capability" (IFC) in reference to LLWs. For this thesis, "less-lethal weapons" is used. In most instances, the terms are interchangeable with no discernable differences; if clarification is needed, it will be provided.

Specific characteristics for classifying an asset as an LLW is defined by DOD Directive 3000.03E, DOD Executive Agent for Non-Lethal Weapons (NLW), and NLW Policy, which defines NLW as "explicitly designed and primarily employed to incapacitate personnel or materiel immediately while minimizing fatalities, permanent injury to personnel, and undesired damage to property, facilities, materiel, and the environment"

(DOD, 2018). To be classified as a less-lethal counter-personnel weapon, an asset must meet the following DOD list of requirements (DOD, 2018):

- Counter-personnel tasks
- Deny access into/out of an area to individuals (open/confined) (single/few/many)
- Disable individuals (open/confined) (single/few/many)
- Move individuals through an area (open/confined) (single/few/many)
- Suppress individuals (open/confined) (single/few/many)

As it stands this definition can include some effects from cyber and electronic warfare; however, for this thesis, LLW will not include these areas due to the DOD Directive 3000.03E not being the governing document.

2. Police Violence

The phrase "police violence" has not been defined consistently in the literature on police use of force (Stinson, 2020). Nonetheless, studies have shown that most police departments gauge the use of force using a linear continuum of some kind (Terrill & Paoline, 2013). Likewise, the Continuum of Force concept is a linear continuum employed by the United States Marine Corps (USMC). Therefore, the Continuum of Force model found in Marine Corps (2011) Order 5500.6H will be used for this thesis.

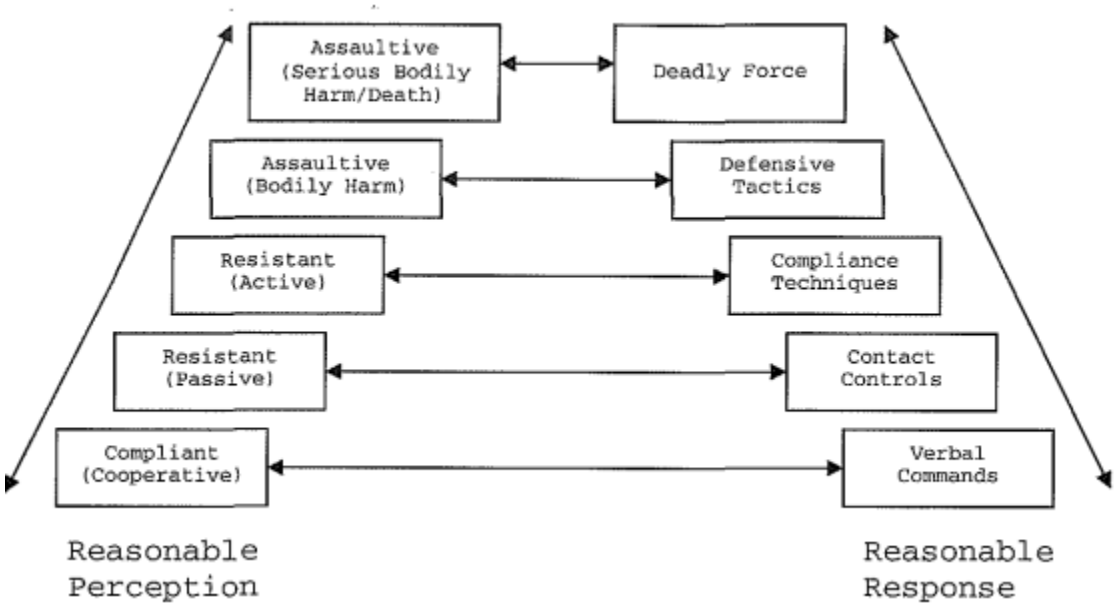


Figure 1. USMC Continuum of Force Model. Source: Marine Corps (2011).

Contact controls, compliance strategies, defense maneuvers, and the use of lethal force will all be regarded as violent under this model. This continuum will be utilized throughout this thesis to examine violence, whether it comes from members of the uniformed military serving in a police capacity or from domestic law enforcement officials. It is important to note that, regarding policing, brutality and violence are not the same thing. Violence is considered the legitimate use of physical force, while brutality is the use of excessive physical force and is illegal. When managing the societal impact of using force, this distinction becomes crucial.

F. THESIS OVERVIEW

Chapter II provides an academic literature review of the extant and most relevant research to date. Chapter III delves into the research methodology. Chapter IV provides a qualitative analysis of interviews from subject matter experts. In Chapter V, the study's quantitative analytics are examined, and value-adding and possible return on investment are simulated to support the use of LLWs. Chapter VI provides some key conclusions to the study.

II. LITERATURE REVIEW

LLWs are designed to disable or subjugate targets without killing them. Primarily used by law enforcement, military, and private security firms, they are employed in a variety of situations ranging from riots to individual arrests as well as many other scenarios. The usefulness of LLWs resides in their capacity to maintain effective control while lowering the risk of harm and death to the target and the user.

Because LLWs draw attention from almost every realm of influence within society, including political, civilian, and military, their use has been hotly debated. To ensure that each perspective is captured, this literature review includes the employment of LLWs by the military and law enforcement in addition to an overview of what they are and how they are used as well as their effectiveness, safety, limitations, and constraints.

A. LESS LETHAL WEAPONS

The North Atlantic Treaty Organization (NATO) defines non-lethal weapons as "weapons that are explicitly designed and developed to incapacitate or repel personnel, with a low probability of fatality or permanent injury, or to disable equipment, with minimal undesired damage or impact on the environment" (North Atlantic Treaty Organization [NATO], n.d.). It is important to acknowledge this definition when considering the application of LLWs across the globe because each country may define LLW capabilities slightly differently, and this may affect the attitude and perception that the local populace has of the organization employing LLWs.

1. Categorization and Employment

Grocholski et al. (2022) provided a list of currently used LLW classifications that can be used to distinguish the applicability of an asset. Notably, each specific LLW in each classification may achieve its intended goal in a vastly different way. The Grocholski et al. list is as follows:

- **Acoustic systems.** The acoustic hailing device (AHD) can be used to communicate orally at long distances—e.g., to tell someone to back away. The experimental concept Laser-Induced Plasma Effects

may use lasers to create a distant ball of plasma that can create sounds, including human speech, to persuade people to alter their movements or behavior.

- **Laser dazzlers.** These include the currently fielded Ocular Interrupter (OI) and developmental Long-Range Ocular Interrupter (LROI), both of which create intense glare that prevents people from being able to perceive their environment well but without any permanent effects (in keeping with the Protocol on Blinding Laser Weapons). They can also be used to gain someone's attention (hail) at long ranges.
- **Integrated-effects systems.** The still-in-development Escalation of Force (EoF) Common Remotely Operated Weapons Station (CROWS) includes acoustic, light, and laser dazzling capabilities.
- **Flash-bang grenades**. These create a burst of intense light and sound to distract and temporarily incapacitate individuals.
- **Blunt impact munitions.** These include rubber bullets, beanbag rounds, grenades that disperse rubber pellets, and other systems intended to strike individuals to temporarily incapacitate them while limiting the scope of permanent injuries.
- **Electro-muscular incapacitation systems.** These short-range devices use an electrical current to induce incapacitating muscle contractions. Tasers allow a modest degree of standoff distance.
- **Riot control agents.** These are non-lethal chemical irritants, such as pepper spray and tear gas, that are typically reserved for law enforcement and crowd-control situations. The Chemical Weapons Convention precludes their use in warfare; however, U.S. interpretation and ratification of the Chemical Weapons Convention allows for very limited use as delineated in Presidential Executive Order 11850. Pepper spray can be used at short ranges, while pepper balls can be used to disperse effects over wider areas.
- **Millimeter-wave systems.** The Active Denial System (ADS) emits a focused beam of millimeter-wave energy to safely and rapidly cause a temporary, immediately reversible heating sensation to deny personnel access to an area or encourage them to move. A developmental version, ADS Solid State, will reduce system weight and power requirements to improve mobility.
- **Microwave systems.** JIFCO is also completing prototype development and assessment for systems that temporarily interfere with vehicle electronics using high-power microwaves, including short- and long-range Radio Frequency Vehicle Stoppers (RFVSs) for stopping land-based vehicles and the Vessel Incapacitating Power Effect Radiation (VIPER) system for maritime use. Similar systems are envisioned to counter unmanned aerial vehicles (UAVs).

- **Mechanical vehicle/vessel-stopping technologies.** The Single Net Solution–Remote Deployment Device (SNS-RDD) consists of a spiked net deployed to stop land-based vehicles, and the Pre-Emplaced Vehicle Stopper (PEVS) injects electricity into a vehicle to damage its electronics. The Maritime Vessel Stopping Occlusion Technologies (MVSOT) include drogue lines (which tangle the propellers) and occlusion technologies (which coat propellers to reduce efficiency and effectiveness). (Grocholski et al., 2022, pp. 3–5)

The above definitions may also apply to some cyber and electronic warfare capabilities; however, such capabilities are not governed under the DOD Directive 3000.03E, which is the U.S. authority for LLWs (Grocholski et al., 2022, p. 6). Therefore, cyber and electronic warfare capabilities will not be included in the analysis for this thesis.

2. Effectiveness, Safety, Limitations, and Constraints[1]

When analyzing LLWs, safety is of utmost importance. Although these weapons are designed to decrease the chance of lethal harm, they are nonetheless capable of causing bodily harm or death in some circumstances. According to research, conducted energy devices (CEDs) carry a low risk of significant injury or death (Kunz et al., 2009). However, the non-lethality of LLW continues to be a topic of controversy (Sloane & Vilke, 2006). Similarly, Haar et al. (2017) indicated that the employment of chemical irritants like pepper spray or tear gas inappropriately has resulted in several cases of severe injury or death.

Even though LLWs can be successful in certain circumstances, their limits should be considered. The possibility of misuse or abuse by users is a limitation. According to a report by Amnesty International, the misuse of tasers by law enforcement officers has resulted in some deaths (Amnesty International, 2014). Another drawback is the probable ineffectiveness of LLWs against specific targets. Due to their stature, clothing, or medical issues, certain persons may be more resistant to the effects of CEDs than others (Dymond, 2021).

[1] Parts of this section have been reproduced with permission from Mun, J., McAnally, S., Mun, J., & Mun, E., *Journal of Economic Analysis;* published by Anser Press, 2024.

Many studies have assessed the efficacy of LLWs in a variety of contexts. According to a study undertaken by the National Institute of Justice (NIJ), CEDs such as tasers lower the risk of injury to arresting officers and suspects (Kunz et al., 2009). Similarly, a retrospective, cohort-designed study examining all CED uses by one police department revealed that CEDs are useful for subduing suspects without causing serious harm (Strote et al., 2010). Moreover, research done by the U.S. Department of Justice discovered that the use of pepper spray in police encounters led to a reduction in injuries to both officers and suspects (Ashcroft et al., 2001).

White and Ready (2007) showed that the employment of tasers was 85% effective in subduing the suspect without further incident. Furthermore, the article indicated that tasers were employed almost exclusively against violent suspects, showing an appropriate application of force on the use-of-force continuum. Additionally, the effectiveness of pepper spray was connected to the level with which a subject resisted the police (Brandl & Stroshine, 2017).

Existing research indicates that LLWs can effectively subdue targets while limiting the likelihood of harm or death. Yet, as previously noted, these weapons come with downsides that must be considered, such as the potential for misuse or abuse and the possibility of ineffectiveness against particular targets. Koplow (2006) explained that while LLWs have a multitude of uses, their application must be met with three caveats (ch. 9). First, an organization must consider the operational constraints of LLWs. These constraints range from cost to develop and implement, logistical requirements, poor performance, training availability, training costs, durability while maintaining functionality and minimizing size burdens, psychological effects, and legal implications (Koplow, 2006, pp. 130–135). Each of these constraints applies to both domestic law enforcement and the military. Notably, for the military the logistic requirements become increasingly more difficult when operating in a contested environment. Military logistic requirements are discussed more in depth in section B that follows.

Second, there is a danger of proliferation among malign users (Koplow, 2006, p. 135). As the U.S. military continues to develop LLW capabilities and prove their effectiveness, other nations and nonstate actors will begin to take notice. If LLWs truly

perform as advertised by being cost-effective, durable in austere environments, and able to enhance the operating force's ability to accomplish a mission, then imitators will arise. This becomes a concern when the imitators are enemies of the nation (Koplow, 2006, p. 136). LLWs may be reverse engineered, which will then introduce new threats on the battlefield. The misapplication of LLW technology can be catastrophic to troops. LLWs may have the capacity to inflict illness, pain, or disorientation on friendly troops (Koplow, 2006, p. 136). The weaponization of LLWs would also likely result in an LLWs arms race, which would have economic and technological repercussions. Additionally, law enforcement will need to become watchful of terrorist adaption of LLW technology, such as using eye-dazzling lasers to blind vehicles in traffic or blind pilots as they are landing. Furthermore, domestic criminals may use LLWs to commit crimes. Koplow (2006, p. 137) provided the example of a criminal using an acoustic wave system to temporarily paralyze everyone in a bank. The final concern about the proliferation of LLWs through adaptation among malign users would be in regard to human rights abusers. LLWs could be used to inflict pain on people being forced into slavery or trafficking. The U.S. Department of State claims that many traffickers rely on pacification through torture or other punishment of their victims to ensure obedience (Koplow, 2006, p. 138). LLWs would simply provide yet another means to apply these horrific practices.

Third, there is a danger of operating forces developing an overreliance on LLW capabilities and not exercising lethal force when necessary (Koplow, 2006, p. 139). This is a concern from the perspective of both leadership, who only see the data yielded from the application of LLWs, and from the employers of the LLW. If LLWs are effective or even if they are only perceived to be effective, leaders may be more willing to send people into dangerous situations under the guise that LLWs will reduce the lethality of the situation (Koplow, 2006, p. 139). Similarly, as the military explores new LLW technology, domestic law enforcement may desire to adapt the technology to their needs; however, this act may feed into the public perception about the militarization of the police and inhibit the building of trust in a community (Koplow, 2006, pp. 139–140). Finally, the adoption of more LLWs may result in a cultural shift to "shoot first (with the LLW) and ask questions later." Koplow (2006) claimed that law enforcement personnel are using their LLWs at a higher

frequency than necessary showing that the "shoot first mentality" already exists and might only be exacerbated by increased capabilities (p. 140).

The discussed effectiveness, safety, limitations, and constraints highlight the many concerns that surround the employment of LLWs. As LLWs become more prevalent in civilian law enforcement and military operations, leaders must be cognizant of the existence of such concerns, and must consider the alternatives. Nevertheless, LLWs could minimize the danger to law enforcement personnel, decrease the probability of fratricide, and decrease civilian casualties in both military operations and civilian policing efforts (Koplow, 2006, ch. 10).

B. MILITARY EMPLOYMENT OF LLWS

Militaries across the globe have been using LLWs to accomplish mission sets where lethal force would be unnecessary. The easiest way to navigate through the complexity of the military employment of LLWs is to first review the DOD current less-lethal weaponry efforts, then review military use cases, and, finally, review assessments of effectiveness.

1. DOD LLW Efforts

The DOD's Non-Lethal Weapons Program published guidance that emphasized the importance of LLWs as an intermediate force capability by claiming that these capabilities allow service members to have more and better options while determining whether an individual's actions show hostile intent (DOD, 2020). The operating environment is only becoming more complex. For example, the Marine Corps' Expeditionary Advance Base Operations (EABO) concept calls for the establishment of small units in contested, dispersed positions. This likely will place Marines in direct contact with the local populace, who may be hostile. However, the survivability of these positions will require local populace cooperation, which would be more easily achievable without the threat of lethal encounters.

Furthermore, future conflicts will likely be fought using the entire breadth of the competition continuum (DOD, 2020). Figure 2 shows that future operations will likely happen below the level of armed conflict and include cooperation. Intermediate force

provides a capability that gives service members more options as they navigate the competition continuum.

Figure 2. Relevance of Intermediate Force Capabilities to the Competition Continuum. Source: DOD (2020).

As Figure 2 illustrates, intermediate force capabilities do not apply solely to law enforcement engagements, security force operations, or crowd control. These capabilities allow for proportionality that can successfully address a myriad of mission sets while simultaneously minimizing civilian casualties (DOD, 2020).

The DOD aims to use intermediate force capabilities to provide capacity for its service members, allies, and partner nations. The DOD (2020) planning guidance specifically states that "intermediate force capabilities can enhance embassy reinforcement and security augmentation, support foreign humanitarian assistance and disaster relief, protect noncombatant evacuation operations, and are suitable to operations in support of weapons of mass destruction security, maritime interdiction, stability operations, detainee/ refugee control, and pandemic response" (DOD, 2020, p. 4).

2. Use Cases

Burks et al. (2022) and Scott (2007) suggested that intermediate force capabilities can provide special operations forces (SOF) with increased ability to maintain an advantage when operating within the gray zone, which Burks et al. (2022) defined as actions taken below armed conflict with respect to the competition continuum. Use of LLWs enables

SOF to accomplish their mission set by deescalating the competition continuum, which, in turn, decreases the likelihood of lethality.

Similarly, COIN is yet another mission set wherein the employment of LLWs may reduce the lethality of service members who must resort to the use of force (Scott, 2007). Scott (2007) defines the goal of COIN as ensuring that the legitimate political power of an established government is maintained (p. 26). Scott (2007) laid out the following principles and imperatives of COIN from *Field Manual 3-24*:

Principles of COIN include:

- Legitimacy is the main objective.
- Unity of effort is essential.
- Political factors are primary.
- Counterinsurgents must understand the environment.
- Intelligence drives operations.
- Insurgents must be isolated from their cause and support.
- Security under the rule of law is essential.
- Counterinsurgents should prepare for a long-term commitment.

Imperatives include:

- Manage information and expectations.
- Use the appropriate level of force.
- Learn and adapt.
- Empower the lowest levels (Scott, 2007, p. 22).

Notably among these is the use of "appropriate level of force," which is enabled by providing operators with the capabilities necessary to engage at every level of the continuum of force.

From the early 2000s to the early 2020s, the U.S. military has increasingly operated in the urban environment. Wittwer (2006) claimed that as military members operated along the competition continuum, they navigated many complex challenges including the negation of longer-ranged weapons ranges and tactics that combine direct and indirect fires, but most notably, the identification of friend or foe. In this environment, decisions must be made quickly due to the decreased standoff. As a result, service members have only two decisions: to use deadly force or not. An unwillingness to approve lethal force on targets

without confirmation was observed, which creates a weakness that the enemy could exploit (Wittwer, 2006). Wittwer (2006) posited that LLWs could provide a viable alternative and alleviate this vulnerability. It is clear that as the United States continues to operate abroad and fight nonstate actors, the difficulty of distinguishing between civilian and combatant will not decrease. Importantly, Wittwer (2006) concluded that "the use of NLWs does not degrade U.S. survivability; NLWs are essential to neutralizing suicide attacks; and NLWs decrease civilian casualties" (p. v).

Kung (1999) provided evidence to support the need for LLWs in noncombatant evacuation operations (NEO). In such operations, crowd control is paramount; however, crowds can become dangerous and unpredictable. When navigating the innate complexities of crowd control, the personnel must be equipped to handle escalatory situations quickly and efficiently to ensure that the crowd does not become uncontrollable. LLWs are powerful tools that can be employed to this end. Kung's (1999) non-exhaustive recommendation list advises that smoke grenades, blocking obstacles such as concertina wire, or 40mm beanbag rounds be available for NEO. However, Kung (1999) added multiple warnings about the potential danger that utilizing LLWs inherently carries. First, not all LLWs are made equal; some will be more effective than others for different situations. Second, with the current availability of LLW capabilities, the employment of LLWs means that lethal force is not immediately available without transitioning to a new weapon system (Kung, 1999).

Maldonado (2017) provided a detailed analysis of a real-world situation, the attack on the Benghazi embassy in 2012 where having LLW on hand reduced the lethality of the scenario. Figure 3 shows the employment of LLWs, flash bangs in this case, quantitatively have positive effects on the situation.

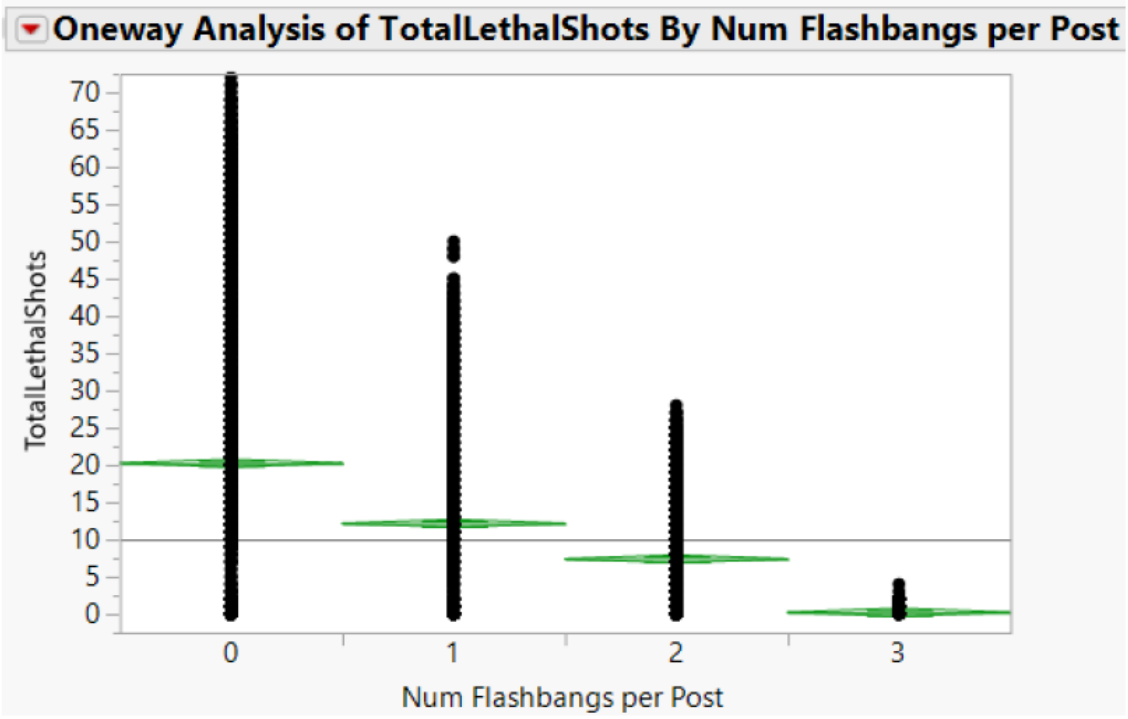


Figure 3. Total Lethal Shots Based on the Number of NLWs per Post. Source: Maldonado (2017).

Maldonado's analysis showed that if at least two LLWs would have been available per post, the lethality of the scenario would have been reduced further (Maldonado, 2017, p. 62).

Furthermore, in recent years, military policing operations have fallen to the wayside (Keller, 2010). Keller (2010) noted that a robust policing force is paramount when conducting counterinsurgency operations, but that the current disposition of the military is ill-equipped to accomplish that mission itself as well as ill-equipped to train or advise a partner nation to accomplish a mission. According to Keller, the military has focused much of its training on technical skills at the cost of training its personnel in other aspects of warfare such as responsiveness to the community, accountability to the rule of law, defense of human rights, and transparency to scrutiny from the outside (Keller, 2010, p. ix). This lack of preparation inhibits the operating force's ability to conduct cooperation operations (Keller, 2010, p. 4).

Additionally, Keenan and Long (2016) examined the potential employment of LLWs in operations in Afghanistan. The authors specifically presented opportunities in which LLWs would likely have reduced the number of civilian casualties. Additionally, the authors presented the importance that Congress has placed on the issue of protecting the civilian population and furthering the LLW capabilities that operating forces have access to and are trained in using. As many scholars have observed, the policies surrounding the employment of LLWs can either inhibit the use of the asset or significantly degrade its employment (Ba & Grogger, 2018; Dymond, 2021; Terrill & Paoline, 2017). Since the military is ruled by the U.S. government, it is paramount that government officials analyze each capability, the potential applications, and the possible repercussions. Dymond (2021) and Terrill and Paoline (2017) claimed that policies allow individuals to employ LLWs more appropriately and reduce the lethality of a situation. The point made by Dymond and by Terrill and Paoline is important to keep in mind, because as military members operate along the entire competition continuum, they must be able to apply the appropriate amount of force for their current situation.

Hoffberger (2017) discussed that as militaries are engaging in operations, lethal force may not always be the appropriate amount of force to use. She argued that LLWs can justifiably be employed under the concept of the principle of proportionality (Hoffberger, 2017). The principle of proportionality holds that in the myriad of potential operations, the military will need to be equipped with a variety of capabilities with varying degrees of lethality to handle all possible situations that may arise.

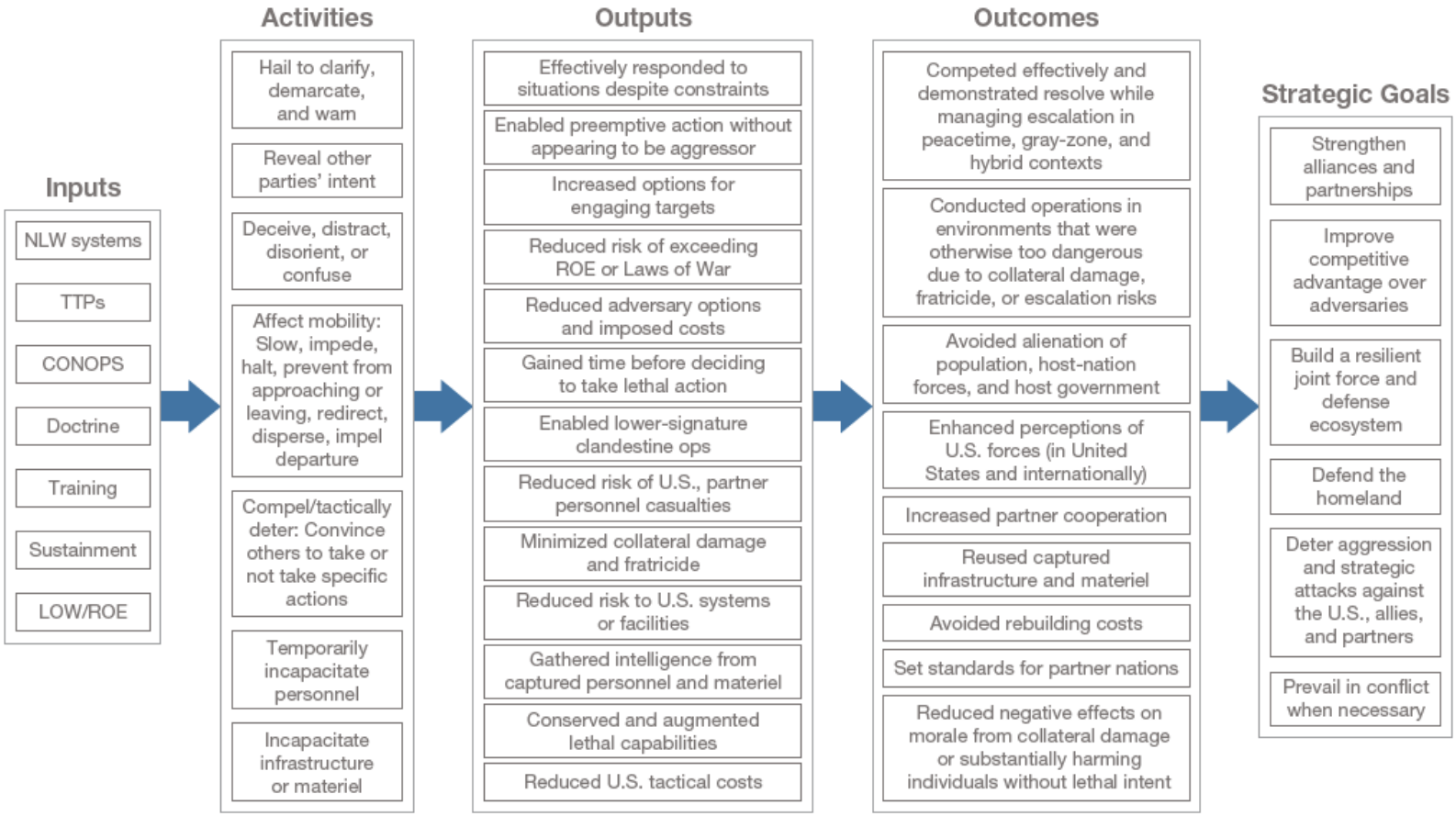
As Coalition forces were continuing to exit the Middle East in 2020, Gregory (2020) analyzed the impact that the war in Afghanistan and Iraq had had on the civilian populace by investigating the condolence payments made to civilians by the Coalition forces. An injured civilian received $3,000 and a killed civilian's family received $6,000. In 2020, the total for all payments was close to $50 million, which Gregory stated was comparatively low when compared to the totality of the cost of war. However, he claimed that the money used to pay for civilian deaths often does more harm than good by devaluing the lives of the civilians in the area of operations (Gregory, 2020). The strategy going into the Middle East was to win the hearts and minds of the local populace; but as the deaths of

civilians increased, the efforts of the operating forces, Gregory argued, were undermined. He proposed that militaries begin viewing money as a weapon to aid in winning the local populace's approval (Gregory, 2020). Taking Gregory's point and applying it to the DOD's approach as described in subsection 1 above (Militaries across the globe have been using LLWs to accomplish mission sets where lethal force would be unnecessary. The easiest way to navigate through the complexity of the military employment of LLWs is to first review the DOD current less-lethal weaponry efforts, then review military use cases, and, finally, review assessments of effectiveness.

DOD LLW Efforts), it can be seen that LLWs decrease the deaths of civilians and allow service members to navigate the continuum of force more easily, which can also increase the potential to win the approval of the local populace and reduce condolence payments.

3. Effectiveness Assessment

RAND Corporation provided two robust studies assessing the impact of intermediate force capabilities (IFCs). Grocholski et al. (2022) and Grocholski et al. (2023) created a DOD-centric logic model, as seen in Figure 4, and a NATO-centric logic model to measure the ability that LLWs have to accomplish the DOD's and NATO's strategic goals. By definition, the developed logic models "characterize how systems, processes, organizations, or other entities support goal achievement" (Grocholski et al., 2022, p. 9).



TTP = tactics, techniques, and procedures; CONOPS = concept of operations; ROE = Rules of Engagement; LOW = Laws of War.

Figure 4. Revised DOD-Centric Logic Model. Source: Grocholski et al. (2023).

The connection between each element of this model was then analyzed using a three-point scale. Elements were compared only to elements directly adjacent to them. Figure 5 highlights the elements of the logic model that have the most strategic importance when assessing the impact of LLWs. Note that, according to Grocholski et al. (2023), the unhighlighted elements were not deemed unimportant as they very well may have operational or tactical impacts, but they were not deemed to have strategic impact.

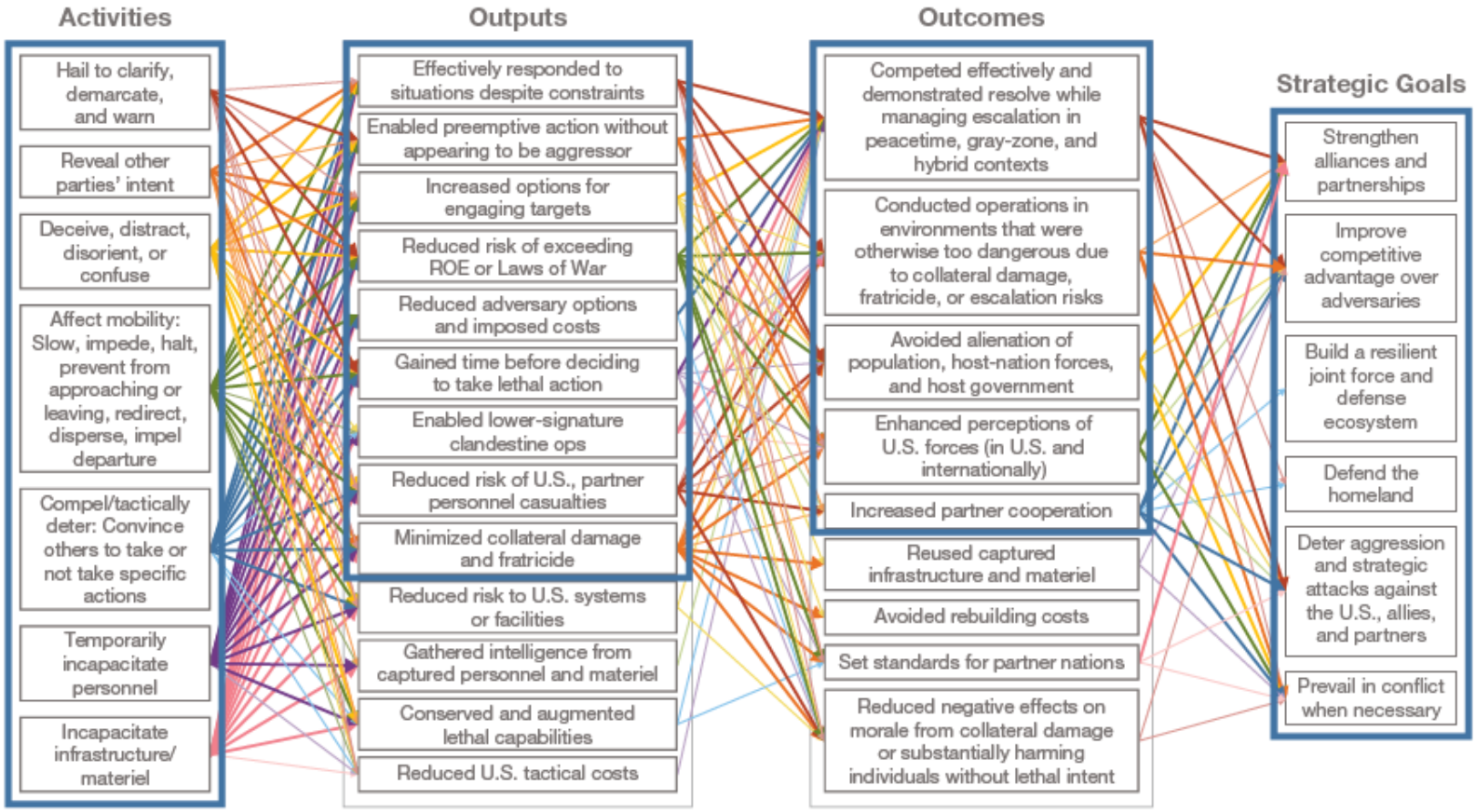


Figure 5. DOD-Centric Logic Model with Elements That Contribute Most to Strategic Goals Highlighted. Source: Grocholski et al. (2023).

The connections that were made allowed for the development of 115 metrics that were applied to 13 vignettes to assess the impact that LLWs had on specific scenarios. The results of this evaluation can be seen in Figure 6. For example, the activity of temporarily incapacitating personnel was evaluated using the following metrics: percentage of targeted population incapacitated by LLWs, percentage of encounters in which the non-targeted population is incapacitated by LLWs, timeline between LLW use and incapacitation, and duration of incapacitation (Grocholski et al., 2022). Similarly, the output of "effectively responded to situations despite constraints" was evaluated using the following: percentage of tactical encounters in which use of NLWs was permissible, but lethal force was not, whether LLWs are allowed by ROE, and degree to which targeted populations perceive LLWs as equivalent to lethal weapons (Grocholski et al., 2022). Outcomes were similarly associated with metrics. Ultimately, all seven of the activities, 9 out of 13 outputs, and 5 out of 9 outcomes can be connected to strategic goals. Figure 6 lists elements that have the strongest possibility of having an impact on strategic goals (Grocholski et al., 2022). Combining these elements together shows the potential strategic impact of LLWs at a DOD-wide level.

Activities	Outputs	Outcomes
• Hail to clarify, demarcate, and warn • Reveal other parties' intent • Deceive, distract, disorient, or confuse • Affect mobility (i.e., slow, impede, halt, prevent from approaching or leaving, redirect, disperse, impel departure) • Compel or tactically deter (i.e., persuade others to take or not take specific actions) • Temporarily incapacitate personnel • Incapacitate infrastructure or materiel	• Effectively responded to situations despite constraints • Enabled pre-emptive action without appearing to be aggressor • Increased options for engaging targets • Reduced risk of exceeding ROE or Laws of War • Reduced adversary options and imposed costs • Gained time before deciding to take lethal action • Enabled lower-signature clandestine operations • Reduced risk of U.S. and partner personnel casualties • Minimized collateral damage and fratricide	• Competed effectively and demonstrated resolve while managing escalation in peacetime, gray-zone, and hybrid contexts • Conducted operations in environments that were otherwise too dangerous due to collateral damage, fratricide, or escalation risks • Avoided alienation of population, host-nation forces, and host government • Enhanced perceptions of U.S. forces (in the United States and internationally) • Increased partner cooperation

Figure 6. Elements of Logic Model with Strong Connection to DOD Strategic Goals. Source: Grocholski et al. (2022)

Furthermore, Grocholski et al. (2022) conducted interviews with experts and stakeholders across 25 organizations. A thematic analysis approach was taken to analyze the qualitative data. The study stated that four key themes emerged from this analysis:

1. **Cultural and resource issues are the greatest challenges to NLW adoption.** Cultural issues primarily related to a reticence to embrace NLWs even when doctrine and policy allowed for their use. This reticence often related to potential users having little confidence in NLWs working as intended, not seeing them as useful compared with lethal capabilities, or not fully understanding the effects of NLWs. In terms of resource challenges, interviewees highlighted that a lack of NLW availability and competing training demands often forced them to de-emphasize NLWs even when they might have been useful.

2. **NLWs are often perceived as burdensome** to the point that they are not carried into operational engagements due to logistical concerns and constraints.
3. **Challenges interact and reinforce each other.** An example of this is that commands with little familiarity with NLWs tend to discount their utility, so they limit the extent of NLW training and usage, which reinforces that unfamiliarity.
4. **Opportunities for additional NLW usage are not widely recognized.** For example, interviewees generally had little to say about the potential applicability of NLWs in strategic or great-power competition, beyond limited perception of NLW usage in gray-zone situations (Grocholski et al., 2022, pp. xiii-xiv).

These observations reveal potential limitations to the employment of LLWs. Cultural resistance plays a significant factor in the successful use of an asset. If a civilian populace disapproves of the use of a specific LLW, it could lead to a decreased trust between the force using the LLW and the local populace. Furthermore, the themes highlight the disparity between the senior leaders of the DOD and the experts—specifically, the push for LLWs to be employed more broadly, but the reluctance for tactical-level actors to choose to use the available assets. This reluctance may be a result of the lack of training that tactical-level actors receive. This lack of training may be resulting in an ignorance of the capabilities and application of the available LLWs.

C. LAW ENFORCEMENT EMPLOYMENT OF LLWS[2]

The ability of police officers to use both lethal and nonlethal force is a distinguishing characteristic of the police profession (Bittner, 1970). This aspect of police work contributes to officers' exposure to high levels of risk, which may result in litigation, liability claims, or citizen complaints (Archbold, 2005). According to reports, improper use of lethal and nonlethal force by police officers during an arrest and improper service of due process are two instances in which damages are likely to be sought and settlements paid to citizens (Blalock, 1974; del Carmen & Walker, 1991; Newell et al., 1992). As police

[2] Parts of this section have been reproduced with permission from Mun, J., McAnally, S., Mun, J., & Mun, E., *Journal of Economic Analysis;* published by Anser Press, 2024.

engage in their profession, they must be able to navigate the complexities of applying the appropriate amount of force to any given situation. Serrato (2022) claimed that policing in modern society is a difficult, foggy practice that is confused by societal, cultural, and practical issues. Communities are asking police to do more while resisting their presence. Policing forces have historically adapted to the needs of the society they serve. Serrato (2022) explained that the reigning authorities urge policing forces to develop professional relationships and identify potential problems to prevent crime rather than respond to crime.

Economically, truly nonlethal devices would likely significantly alter the emphasis of economies and reallocate funds to solve many of the world's most pressing needs. For example, the United States could save billions of dollars in lawsuits, medical expenditures, and pension benefits related to police service alone (Bostic, 1994).

McLean et al. (2023) discussed the decision loop that police must go through as they choose whether to apply force and what level of force is necessary. While there exists a well-established model, the continuum of force, that policing forces are trained to follow, there also exists a discrepancy in the continuum and the force actually used. This discrepancy comes from the perception of the individual in the situation emphasizing the human factors in the application of force (McLean et al., 2023). However, by definition, perfectly nonlethal technology would eliminate the concerns raised by lethal weaponry. Importantly, through LLWs, law enforcement could finally eliminate the enormous chasm that physical force has created between police and the communities they serve (Bostic, 1994).

Current public policy mandates that officers on the street use the least amount of force necessary to make an arrest or suppress a disturbance. Even when uses of force are deemed justifiable, police officers are nevertheless susceptible to lawsuits, especially in a litigious society (Houghland et al., 2005). A recurring element in the existing literature on litigation against the police force is that citizens are filing such claims at an unprecedented rate. Since 1961, litigations against the police have continued to increase due to several court rulings, the litigious nature of modern society, and a trend toward holding public authorities more accountable for their acts (Houghland et al., 2005).

When police in a democracy use force and cause injuries, concerns about police abuse develop, lawsuits frequently follow, and the police's reputation is put at risk. Injuries may also lead to medical bills for destitute suspects, workers' compensation claims for injured officers, and damages paid in settlements or court judgments (Bulman, 2010). Alpert et al. (2011), Bulman (2010), and MacDonald et al. (2009) claimed that when law enforcement utilized LLWs, the risk of injury to both the officer and the suspect decreased, which would naturally decrease the likelihood of civilians seeking settlements as well as the expenses related to officer injuries or deaths.

The primary duty of the police is to preserve order and execute the law while protecting individual rights. Yet, they ultimately achieve these goals by exercising their coercive authority (Bittner, 1985). According to the Department of Homeland Security's Federal Law Enforcement Training Center, we expect police officers to rely on their training and good judgment when using physical force to defend citizens and themselves or to capture criminal suspects (Department of Homeland Security, 2011). Because police officers must occasionally participate in physical acts of coercion, which may involve deadly weapons, it is somewhat unavoidable that some of these interactions may result in bodily injuries to individuals and the officers themselves (Hickman et al., 2021). These injuries have real costs (such as medical treatment, lost wages, and municipal liability) as well as less-tangible collateral costs, such as the erosion of police legitimacy and public trust, which are more difficult to quantify but arguably more influential in shaping long-term public perceptions than personal injuries alone (Hickman et al., 2021).

According to the National Institute of Justice (NIJ) the use of less-lethal weaponry is a good strategy for minimizing civilian and officer harm (Bulman, 2010). There is a need for greater quality evaluations of police use of LLWs to inform policy and practice for reducing harm during violent police–citizen interactions. Police departments contemplating adopting, continuing, or expanding the use of these weapons should proceed cautiously, considering the best available scientific evidence and the necessity to maintain rigorous academy and in-service training (Sheppard & Welsh, 2022). Furthermore, Terrill and Paoline (2017) discussed that police departments with more restrictive policies have officers who use force less readily. Therefore, policy must be considered heavily when an

organization is considering the adoption of a new technology or procedure. Similarly, Dymond (2021) also emphasized the impact that training, policies, and accountability mechanisms can have on the decision cycle of a policing force. Organizations must consider each part of the system separately and consider the interactions that each element has with one another to ensure that the adoption of new technology is beneficial.

For example, Ba and Grogger (2018) analyzed the Chicago Police Department's revised policy of taser deployment among personnel. Historically, that force had limited taser use primarily to sergeants and above. However, after providing tasers to more officers, the study showed that this policy reduced injury to officers, though it did not change the rate of injury to civilians. This discrepancy from the findings of Alpert et al. (2011), Bulman (2010), and MacDonald et al. (2009) can be attributed to the uniqueness of every police department. Notably, the policy change did not affect the rate of use of firearms. This lack of change in the rate of firearm usage shows that the need for lethal force for a police force does not change with the increased availability of LLWs.

Salt and Smith (2008) connected policing activities to military objectives and the delicate balance that must be struck to establish an effective policing force. Clausewitzian theories were used to reconcile the principle of using minimal force to subdue suspects in light of the escalatory nature of violence. Notably, the authors indicated that when force is used, there must exist trust between the civilian populace and the police force. To establish that trust, the police must defend their actions to the public to uphold their trust (Salt & Smith, 2008). Furthermore, police must operate as professionals and execute sound judgment since they are perceived as those who use violence, and therefore must manage the natural escalation of policing (Salt & Smith, 2008).

Jackson (2015) further explained the importance of establishing trust between a police force and the public being policed. However, building this trust is increasingly difficult. Specifically, he points out that police have come under increased scrutiny due to the prevalence of videos and social media. While video, both by bystanders and by body-worn cameras, increases transparency, which can increase trust, it also hinders the ability that departments have to control what is released to the public. According to Jackson (2015), this is especially troublesome when investigations are ongoing and police

departments are unable to provide clear answers to why specific actions were taken. Such environments create rumors that spread rapidly and are often untrue. Coupling Jackson's ideas with those of Salt and Smith (2008), the conclusion can be drawn that employing the appropriate amount of force at the appropriate time will help build the trust of the public. LLWs bridge a gap in the continuum of force that allows a policing force to use the appropriate amount of force at the appropriate time.

At the same time, even if the force applied is lawful and proportional, Mourtgos and Adams (2020) showed that the public may still disapprove of police use of force. To successfully change the public's opinion, some departments have hosted civilian police academies to educate the attendees about the complexities of police use of force. However, Mourtgos and Adams (2020) state that such events likely do not target the appropriate demographic because those who attend likely already support the police. Another avenue that has been taken to increase transparency is body-worn cameras. Body-worn cameras can be used to present the narrative of a situation and explain why a level of force was chosen. Finally, there must be a concerted public affairs effort to reach the groups of civilians who hold negative opinions. Multiple researchers have concluded that educating a civilian populace will improve their opinion of a policing force and allow the police to operate with their support rather than their animosity (McLean et al., 2023; Mourtgos & Adams, 2020). Jackson (2015) further emphasized that since information is so readily available with current technology, police must take a proactive stance to ensure community trust. In general, policing organizations need a way to navigate the social situations of the population being policed so that trust can be established.

D. CONCLUSION

From the review of the literature, then, the following three points become clear:

1. LLW technology has been empirically proven to reduce lethality and provide personnel with an effective measure of navigating the continuum of force.
2. The DOD has placed significant emphasis on enhancing its LLW capabilities due to the uncertainty of future operations. The military will

need to engage in operations throughout the entirety of the competition continuum. To operate along the competition continuum, LLWs will need to be used. To operate in an EABO concept, service members will need to build relationships with the local populace, and likely police them as necessary in a contested environment. However, service members view LLWs as burdensome to use, and the military's traditional approach to collateral damage has hindered the development of trust relationships.

3. Successful policing operations rely heavily on the trust between a community and the operating force executing the policing. Employing LLWs decreases the likelihood of injury to operators and civilians, which increases trust. Civilians generally view applications of force negatively even if applied lawfully and reasonably, so any mitigation of force applied will result in less negative attitudes.

These distilled salient points exemplify the need for increased training as well as increased capabilities available to the operating forces. Increased capabilities will allow service members and law enforcement personnel to navigate their continuum of force more seamlessly, transitioning from less lethal to lethal force faster, and ultimately accomplish the mission more easily. Service members and law enforcement must not only be equipped with the appropriate tools, but they must be trained in their use to such a degree that they may teach others the effective use of any specific LLW. Military members will need to be trained specifically in policing operations to ensure that the trust that is necessary to conduct such operations is fostered.

Additionally, it can be seen that specific LLWs are designed for specific situations. There is no current technology that allows for rapid transition from less lethal to lethal without switching to an entirely different weapons system. This is the gap this research aims to explore. Will a less-lethal, single-shot, bullet-capture attachment fill this gap in technology?

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III. RESEARCH METHODOLOGY

A. INTERVIEWS

1. Recruitment and Preparation

Interviewees were selected to ensure a diverse set of perspectives and were identified by their field of expertise. All interviewees were members of the armed services. One foreign military member was interviewed. Recruited interviewees can be categorized as users, however they can also be split into two perspectives:

- Planners—Commanders or leaders responsible for planning the tactical employment of LLWs. These individuals are also equipped and trained to use LLWs, however, the likelihood of use is significantly less than for the LLW employers.
- Employers—Individuals who are trained and will likely use LLWs in operations. These individuals are often senior enlisted leaders or staff noncommissioned officers.

Twenty-six interviews were conducted among these categories across the U.S. Army, Marine Corps, Navy, and Air Force, as well as one foreign officer. IRB approval was provided by Naval Postgraduate School as well as the USMC.

2. Data-Gathering

The interviews were conducted by using a semistructured approach that allowed interviewees to lead the conversation to areas where their expertise resided. Interviews were conducted through three different mediums: in person, via telephone, and via web call with cameras. Regardless of medium, interviewees were asked the same questions.

3. Survey

Each interviewee completed a survey to provide quantitative data for statistical use. Additional personnel from similar specialty fields also completed the survey to provide data.

B. MONTE CARLO STOCHASTIC SIMULATION

Monte Carlo stochastic simulations are used to predict an outcome by running multiple probability simulations while accounting for the potential for random variables (Mun, 2015). Mun (2015) described Monte Carlo stochastic simulations as a tool for estimations and risk analysis by using random numbers to create probabilities. Typically, a scenario's variables are manipulated and assigned a random number from the spectrum of potential outcomes chosen by the cost analysis then processed through the Monte Carlo stochastic simulation (Mun, 2015). The model will produce outcomes in a probability distribution, which offers specific insights into the risk and can be used to forecast future events (Mun, 2015).

For this thesis, Monte Carlo stochastic simulations will be used for estimating the potential return on investment (ROI) of a single-shot bullet-capture handgun attachment intended for domestic law enforcement. Due to the newness and availability of this technology, a stochastic approach is appropriate due to the uncertainty in the employment of LLWs. By definition, the weapon system is less lethal, not non-lethal, meaning there exists a possibility that the weapon will result in a lethal outcome. For a detailed breakdown for the ROI calculations see Chapter V.

As an example of this specific LLW technology, The Alternative created by Alternative Ballistic will be used. The Alternative is an attachment for the front of a handgun that captures the bullet in a ball bearing and reduces the kinetic energy enough to make the round less lethal when employed appropriately. Once fired, the handgun becomes lethal immediately following the less-lethal round with no action required from the user. This product was chosen due to its newness and availability; the selection of this product does not equate to an endorsement.

IV. QUALITATIVE ANALYSIS

A. INTERVIEW ANALYSIS

Throughout the interviews, the interviewees expressed overwhelming support for the use of LLWs. Much of the discussion centered around two topics: 1) the current challenges to the employment of LLWs and 2) the challenges that introducing new capabilities would bring. Each interviewee was asked to provide changes that would enable more widespread use of LLWs in future operating environments. Through the lens of these two main topics of discussion, multiple shared challenges and solutions were presented. Figure 7 provides a breakdown of the most mentioned challenges.

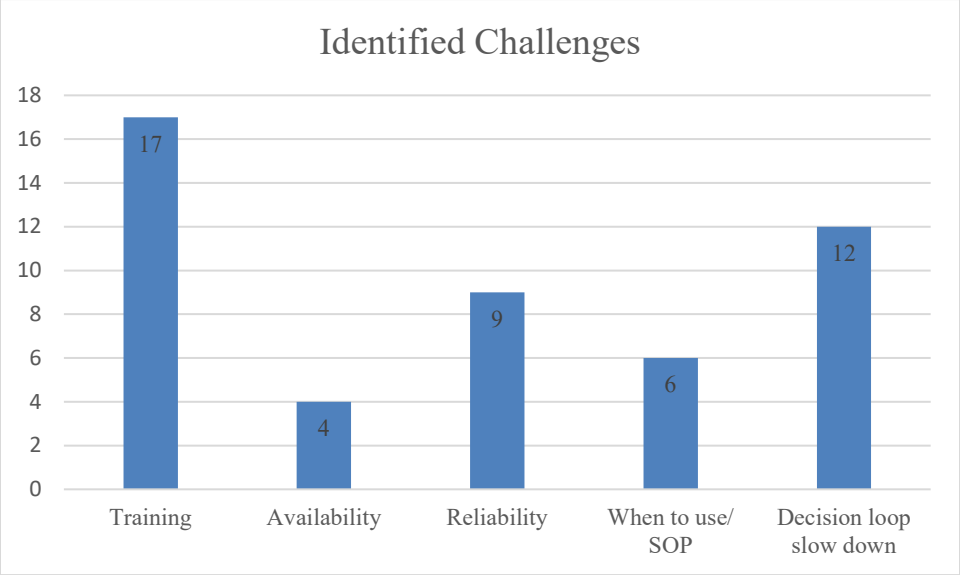

Figure 7. Interviewee-Identified Challenges

Each of the identified challenges is defined as follows:

1. Training: The necessary technical and tactical training required to ensure effective use of LLWs in operating environments.

2. Availability: Logistically and financially ensuring LLWs are supported and ready to use.

3. Reliability: Ensuring the LLW can be effectively employed in the operating environment as well as perform as described.

4. When to use/SOP (standard operating procedure): Establishing an SOP for employment of LLWs to reduce ambiguity for the individuals employing the capability.

5. Decision loop slowdown: The individual's decision loop slows due to increased factors they must consider.

These identified challenges created themes through which the interviews can be analyzed. The challenges are discussed in depth in the following subsections. It is important to note that the connection between each identified challenge makes discussion of a single idea difficult without mentioning other challenges. Furthermore, interviewees offered multiple recommendations that could potentially serve as solutions for each problem. These recommended solutions are presented in the discussion of the corresponding challenge.

1. Training

The concerns manifested about LLW training can be categorized into three separate issues. First, the level of current training is lacking to such a degree that most service members could not effectively use LLWs. Many of the described training regimens were a once-and-done approach wherein LLW users did not have to maintain certifications or qualifications. For example, one interviewee expressed his concern about this approach, stating that sailors are trained with the baton when they first enter the fleet, but there is no follow-on training. Few sailors ever actually employ the baton, but there was doubt that any could employ the baton as designed—that is, targeting specific parts of the body to quickly subdue the assailant. This sentiment was expressed by every service branch.

Second, training takes time. Multiple interviewees discussed the time factor as a cultural issue. The majority of interviewees expressed that the primary mission of the military is to maintain a certain level of lethality. Along this vein, to train service members

in nonlethal means would take time and money away from training service members in lethal means. An interviewee used the following example to illustrate this point.

> Imagine a [Marine Corps] infantry battalion being given LLWs. I don't know a single commander who would use field time [which is training time outside of the garrison] to train with LLWs unless they were specifically told to do so. Even then I don't think it would be the primary focus. It would likely be jammed in during white space [which is free time where no training is being conducted] … Even if LLW training was a T&R [training and readiness] task, I'm pretty sure it wouldn't be taken seriously. Marines are trained to kill, and LLWs inherently don't kill.

Nine of the 26 interviewees expressed direct concern about the feasibility of convincing unit commanders to use training time on LLWs. Additionally, Grocholski et al. (2022) expressed a similar finding; while the specifics differ, the idea of cultural impediments is widespread.

Third, discussion about changes necessary to make the use of LLWs more widespread in future operating environments brought concerns about necessary technical and tactical changes. When considering the unknowns surrounding future operating environments, attempting to develop new LLWs becomes more of a concern. When considering introducing a single-shot bullet-capture device, consideration must be given to the current tactics, techniques, and procedures (TTPs), but TTPs are often driven from experience, which is absent for LLWs due to the lack of operational use of LLWs. For example, the Marine Corps pistol qualification table teaches qualifying Marines to double tap when firing. The other services expressed similar concerns based on their own TTPs. Bringing this factor to the application of a single-shot device, there is significant concern that the less-lethal round would be immediately followed by an unintended lethal round.

Interviewees speculated that approaching the training challenge from a top-down perspective would be an effective solution to this problem. Senior leaders must prioritize LLW training for more junior leaders to accept the risks of training in LLWs—those risks being that by training in LLWs, the unit would inherently be less lethal than if it solely trained to lethal solutions.

2. Logistics

Every capability requires a degree of logistical and finance support. LLWs are no different. The interviewees expressed concerns about bringing LLWs into future operating environments, especially EABO, which is designed to operate in a contested environment. At a tactical level, the very real concern about how to resupply or maintain these capabilities was brought to the forefront in the discussion. While each LLW capability has its own unique set of logistical requirements, the general acceptance was that the tradeoff was not worth the risk. The logistical footprint of bringing LLW capabilities into future fights was not worth the benefit they would provide.

At an operational and strategic level, concerns about funding became apparent. Again, this concern is amplified in a contested environment where capabilities may be lost before reaching the users. Additionally, as commanders get more capabilities, they must know that the capability exists, the capability must actually be fielded, and, most importantly, there must be someone trained to use the capability in the area of operation. One interviewee anecdotally expressed a situation in which commanders are given a list of task-organized capabilities; however, when a capability is chosen to accomplish a specific mission, the commander learns that the capability has not actually been fielded to the unit.

There is ongoing research to alleviate the burden of providing logistics in a contested environment. As that research aims to solve the logistical side of the availability problem, interviewees emphasized that an organizational effort to ensure that all LLW capabilities are fielded with trained personnel to using units must become a commander's priority. There is an unspoken understanding that LLWs are to be deemphasized in the face of lethal capabilities. Again, this challenge must be approached from a top-down perspective to truly solve it.

3. Reliability

Reliability was one of the most mentioned characteristics when discussing attributes that make LLWs attractive to use. However, there is a general mistrust of LLWs. Interviewees spoke of this mistrust from two perspectives. First, when they were asked about times LLWs have failed to fulfill their potential, all of the interviewees could recall

a situation where this was the case. Second, there was concern about the needed ruggedness of LLWs in contested operating environments. As a result of these concerns, many of the employers said they would rather not carry the weight of the equipment. The physical burden of carrying a capability that operated on only a probability of success deterred many from wanting to bring the capability.

Interviewees claimed that to build trust in LLWs, they would want thorough training before using them operationally—specifically, to see the LLW used effectively multiple times in multiple situations.

4. When to Use/SOP

The interviewees communicated concerns about proper employment of LLWs during stressful environments where the time to make a decision is compressed. These concerns arose primarily when discussing SOPs and doctrinal issues. Notably, the Army, Marine Corps, and Air Force interviewees said that while doctrine exists, it is not well known throughout the organization. Furthermore, the specialized units who understand the doctrine often did not have SOPs. Of those who did have SOPs, the SOP was not well known.

Overall, the interviewees expressed that common soldiers, marines, sailors, or airmen are uneducated on the currently available LLW capabilities due to lack of knowledge dissemination. That is, those trained in LLWs are few and often they are not given the time to share their knowledge.

Conversely, the sailors who were interviewed shared that the Navy has a robust SOP that is known by all. The Navy offers clear engagement criteria for each weapon system. However, the emphasis was solely placed on ship mounted weapons. The sailors still expressed similar concerns as the other services when discussing individuals engaging in situations where they must employ personal weapons like pepper spray or a baton.

Solutions offered by the interviewees to this challenge manifested in similar ways as the other challenges, primarily in the form of increased training. The nuance here lies in

that the training must be scenario driven in order to expose the trainees to many situations so that they have a robust database to draw on when encountering real-world situations.

5. Decision Loop Slowdown

When discussing decision cycles, time must be given to Boyd's OODA Loop. Figure 8 illustrates the process used by the U.S. military when discussing how decisions are made.

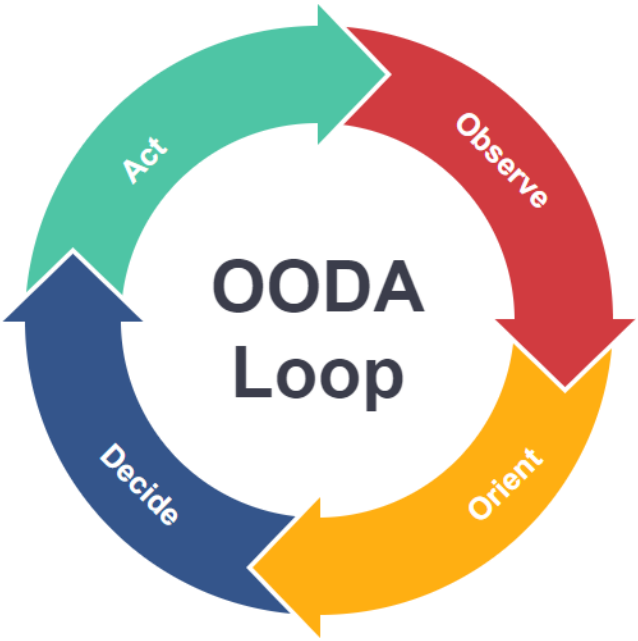

Figure 8. Boyd's OODA Loop. Source: VisualParadigm Online (n.d.).

The introduction of additional capabilities increases the time it takes to work through the OODA Loop. Specifically, increased capabilities increased the time in the Decide step, as the decisionmaker must consider the available options. There is a method of thinking that says: as soon as a good enough solution is found, commit to it and move to the next decision. However, as commanders are making life-or-death decisions, this decision-making philosophy increases the risk significantly. Therefore, it is safe to say that introducing more capabilities slows down the decision loops of commanders because capabilities add factors that must be considered when making life-or-death decisions.

This argument becomes increasingly important for tactical users due to the reduced time to decide and act. The presence of an LLW also adds factors to the decision loop of the person employing the weapon. An interviewee described the following situation when discussing the decision loop of employing LLWs:

> In situations where someone has to use force to subdue a target, they usually only have three to five seconds to react. That is not a lot of time. A person has to choose which weapon they're going to use, pull the weapon from where it is stored, and use it before the assailant closes the distance between them. Right now we only have a pistol, a baton, and OC spray. If we were to introduce an additional capability, that would just confuse the person using it. (Lieutenant, United States Navy, November 7, 2023)

The salient point is that adding capabilities provides multiple ways to handle a situation, but with that capability comes the tradeoff of the time it takes to choose which capability to use.

Every interviewee who addressed this challenge claimed that overcoming it ties in closely with the need for training. For users and planners to employ the capability effectively, they must be well-trained in the capability. As the number of capabilities increases, commanders will be forced to familiarize themselves with more capabilities.

Finally, one proposed solution was to task organize designated LLW sections at the company or battalion level. A specialized section would ensure expert users and would ease the burden on commanders by providing an LLW choice and entrusting the specifics to the subordinate unit leader.

6. Conclusion

In conclusion, when interviewees were asked if they could see the value in LLWs the answer was unanimously yes. However, the largest challenge that the interviews identified was that by introducing these capabilities, the decision cycle for commanders and those employing them at a tactical level would be significantly inhibited. Excluding the Navy, most interviewees had little understanding of doctrinal employment; rather, they approached the employment of LLWs from a case-by-case perspective.

Additionally, when discussing a single-shot bullet-capture device, the interviewees expressed strongly divided opinions. Interviewees either enthusiastically saw the potential value of the device or decidedly did not want the capability. The naysayers spoke largely of the need for different training to ensure effective use.

Notably, the previously listed challenges reinforce the different themes that were identified by the Grocholski et al. (2022) RAND article, which can be found in the literature review (see Chapter II, B.3). The specific reemphasized themes were the cultural and resource issues that must be overcome for widespread LLW adoption, the burdensome nature of LLWs, and the lack of widely recognized opportunities for LLWs. While the themes remained similar to those identified by Grocholski et al. (2022), the specifics varied. This variation is likely due to the personnel interviewed. The interviewees for this thesis were mostly tactical planners and tactical LLW employers rather than the technologists and policymakers interviewed by RAND.

B. CASE STUDIES[3]

The following illustrates simple use cases where nonlethal weapons such as a single-shot bullet-capture device might be appropriate, as opposed to using conventional lethal sidearms.

1. Case Study I: Domestic Violence

A 911 call was placed for potential domestic violence in a normally quiet suburban neighborhood. Emergency dispatch requested two patrol cars to investigate the call. When officers arrived on the scene, they saw a man brandishing a baseball bat and a young woman with bruises on her hand and some blood on the side of her dress. The woman had a red mark on her right cheek, her lips were trembling, and her face was wet with smeared makeup. The man looked intoxicated, with red eyes, rosy cheeks, and slurred speech. Although motor function was impaired, the man was belligerent and seemed to have lowered inhibitions. When the officers approached, the man seemed to grow more agitated.

[3] This section has been reproduced with permission from Mun, J., McAnally, S., Mun, J., & Mun, E., *Journal of Economic Analysis;* published by Anser Press, 2024.

The officers had their hands on their service weapons with holsters unlatched. The officers ordered the man to drop the baseball bat. The man refused, and the woman came rushing to his side, trying to intervene. Because the woman might end up in the line of fire, LLWs can and should be employed if necessary.

2. Case Study II: Mental Health and a Homeless Person

A homeless person usually sleeps in parks or alleys, on sidewalks, or in other public locations and can sometimes erect temporary shelters by using boxes or clothing material. Many municipalities have attempted to outlaw such behavior and encourage the homeless to seek city-provided shelters.

Officers were dispatched to a new construction area where nearby residents reported that a homeless individual was roaming the neighborhood looking at front porches for delivered packages and was spending his nights on the porches of some model homes. The person of interest likely violated the city's ordinance on erecting obstructions in private spaces and possible misdemeanor petty theft. When officers approached to remove him from the premises and look through some unopened delivery boxes, the suspect pulled out a pen knife. The suspect probably suffers from chronic mental illness and is not completely aware of his actions.

This is another example of police officers needing to apprehend a suspect to keep the neighborhood safe while needing to be cautious and protect themselves. The less lethal alternative might be appropriate in such a situation.

3. Case Study III: Navy and Marine Personnel on Liberty

Military police officers (MPs) are charged with enforcing military laws and regulations, responding to emergencies, conducting force protection and anti-terrorism, and performing investigations and security at bases around the world. Sometimes, MPs patrol the local restaurants and bars where military personnel visit. On this occasion, a Navy ship was at a local port, and some of its sailors were on shore leave for the day. As is customary for the first day, the sailors were in uniform and easily identified. Several of the sailors were intoxicated and acting in a disorderly manner. A fight soon broke out. MPs

responding to the scene decided to break up the fight and issue warnings to the sailors when a few of them became belligerent and challenged the officers to a fight with broken bottles. The less lethal alternative might again be appropriate.

C. RAND LOGIC MODEL

Applying the RAND logic model seen in Figure 4 shows the potential strategic impact that a single-shot bullet-capture attachment may have for the U.S. military. Table 1 breaks down the criteria that are met in this logic model.

Table 1. RAND Logic Model Applied to Single-Shot Bullet-Capture Attachment. Source: RAND (n.d.)

Activities	Outputs	Outcomes	Strategic Goals
A4: Compel / tactically deter: Convince others to take or not take specific actions	OP1: Effectively responded to situations despite constraints	OC1: Competed effectively and demonstrated resolve while managing escalation in peacetime, gray-zone and hybrid contexts	SG1: Strengthen alliances and partnerships
A5: Temporarily incapacitate personnel	OP2: Enabled pre-emptive action without appearing to be aggressor	OC2: Conducted operations in environments that were otherwise too dangerous due to collateral damage, fratricide, or escalation risks	SG2: Improve competitive advantage over adversaries
	OP3: Increased options for engaging targets	OC3: Avoided alienation of population, host-nation forces, and host government	SG5: Deter aggression and strategic attacks against the U.S., allies, and partners
	OP4: Reduced risk of exceeding ROE or Laws of War	OC4: Enhanced perceptions of U.S. forces (in U.S. and internationally)	SG6: Prevail in Conflict when necessary
	OP5: Reduced adversary options and imposed costs	OC5: Increased partner cooperation	
	OP6: Gained time/ distance before deciding to take lethal action	OC6: Set standards for partner nations	
	OP8: Reduced risk of U.S., partner personnel casualties	OC7: Reused captured infrastructure and materiel	
	OP9: Minimized collateral damage and fratricide	OC8: Avoided rebuilding costs	

Activities	Outputs	Outcomes	Strategic Goals
	OP10: Reduced risk to U.S. systems or facilities	OC9: Reduced negative effects on morale from collateral damage or substantially harming individuals without lethal intent	
	OP12: Conserved and augmented lethal capabilities		

V. QUANTITATIVE ANALYSIS[4]

A. PROS AND CONS

In police law enforcement and military policing operations, less-lethal alternative technology has various benefits over traditional weaponry. For example, the ability of less-lethal ammunition to incapacitate a target without causing major harm or death is one of its primary advantages. This is especially beneficial in cases where the use of fatal force is not warranted or when police officers must restrain a subject without causing harm. In addition, the use of such technology decreases the risk of collateral damage and reputational harm, as well as the number of unnecessary deaths and lawsuits connected to wrongful death, thereby reducing police officers' or federal agents' criminal exposure.

The extent of gun violence is staggering in this country, and whatever little can be done should at least be under consideration. Table 2 shows a 7-year review of gun-related deaths in the United States from 2016–2022. These are not limited to law enforcement actions but attributable to other bad actors.

[4] Parts of this chapter have been reproduced with permission from Mun, J., McAnally, S., Mun, J., & Mun, E., *Journal of Economic Analysis;* published by Anser Press, 2024.

Table 2. U.S. Gun Violence from 2016–2022. Adapted from the Gun Violence Archive (2023).

Gun Violence	2016	2017	2018	2019	2020	2021	2022
Deaths (Willful, Malicious, Accidental)	15,139	15,742	14,943	15,509	19,558	21,009	20,200
Suicides by Gun	22,938	23,854	24,432	23,941	24,292	26,328	pending
Injuries (Willful, Malicious, Accidental)	30,586	31,358	28,285	30,199	39,542	40,603	38,550
Children (Aged 0–11) Killed or Injured	665	734	665	696	1,001	1,065	995
Teens (Aged 12–17) Killed or Injured	3,154	3,296	2,883	3,129	4,159	4,645	5,157
Mass Shooting	383	348	336	417	610	690	647
Murder-Suicide	549	608	623	632	570	594	670
Defensive Use	1,993	2,118	1,889	1,619	1,513	1,295	1,178
Unintentional Shooting	2,235	2,065	1,696	1,912	2,336	2,027	1,626

1. Reduction in Collateral Damage

Conventional weapons are designed to kill or injure a target. Employment of less-lethal weaponry can reduce collateral damage, the unintentional injury inflicted on individuals, bystanders, and property during law-enforcement operations. The use of tear gas, pepper spray, shock guns, or velocity-reduction alternative ballistics technology, for instance, can incapacitate a criminal without causing physical harm or environmental damage. Less-lethal ammunition, in particular, is meant to limit the potential of collateral damage by employing bullets less likely to penetrate walls or other objects while still being able to subdue a suspect or criminal. In contrast, the use of lethal weapons can result in fatal injuries that could have been avoided if less-lethal alternatives were available. Figure 9 shows that there were 10,743 police-related shooting deaths in the United States between 2013 and 2022, segregated by age groups (Mapping Police Violence, 2023). What is heartbreaking in this chart is that there were multiple needless deaths of children under 10 years of age and even more deaths for those under 20 years old. There is no justification for children being killed in this country in needless shooting deaths.

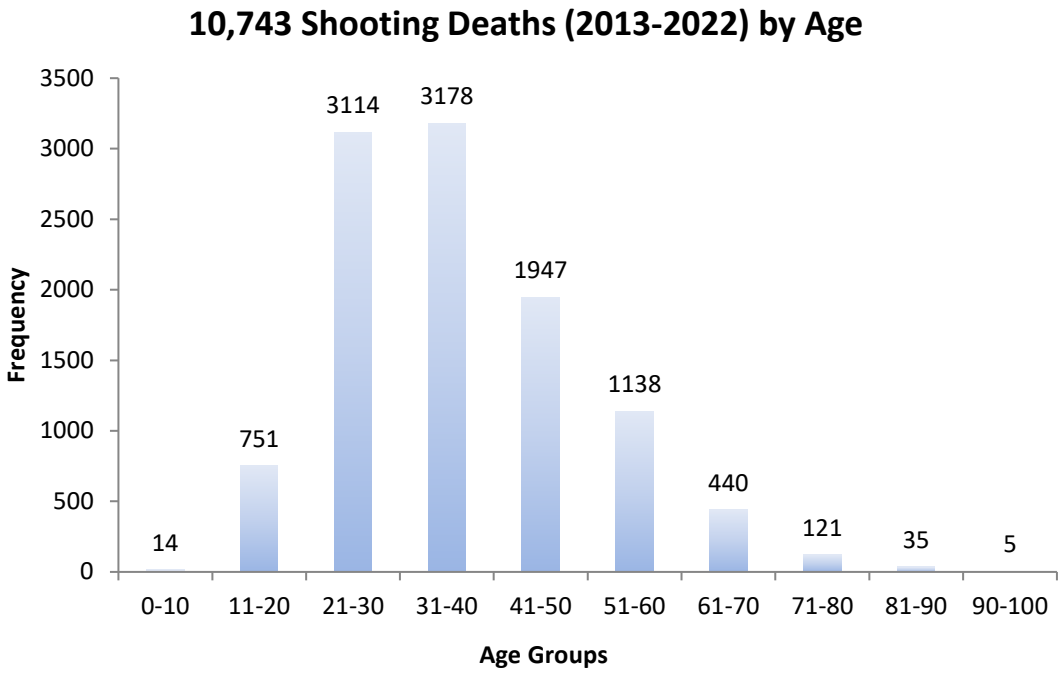

Figure 9. Police-Related Shooting Deaths in the United States between 2013 and 2022. Adapted from Mapping Police Violence (2023).

2. Reduction in Reputational Risk for Law Enforcement Agencies

In addition to limiting collateral damage, alternative less-lethal technologies can lessen law enforcement organizations' reputational risk. Incidents of police brutality or excessive use of force can harm a law enforcement agency's reputation and weaken public confidence. Law enforcement officers can reduce the danger of causing injury or death by using less-lethal weapons and help foster community trust. The excessive use of fatal force can harm the public's view of law enforcement and lead to unfavorable media coverage, demonstrations, and even protests and riots. In addition, using less-lethal weaponry may be regarded as a more humanitarian and less confrontational approach to police enforcement, which can further build community trust and support.

3. Reduction in Cases of Wrongful Death

The use of fatal force by law enforcement officials has been questioned, especially in circumstances when the subject killed was unarmed or posed no immediate threat to the

officer or others. The wrongful use of firearms and stun guns has become a big concern. The use of tasers, which has been related to a number of deaths, is another concern. Despite the fact that tasers are intended to be a nonlethal alternative to weapons, they can nevertheless inflict serious harm or death, especially in those with pre-existing medical issues. As a result, there has been controversy regarding the police use of tasers and whether they should be viewed as a safe alternative to weapons.

As a result of these problems, the number of wrongful death claims filed against police departments and individual officers has increased. These lawsuits are filed by the families of victims slain by police in an effort to receive recompense for their loss, justice for the family, and to prevent future incidents. In these circumstances, evaluating whether the use of lethal force was justifiable is one of the central issues. In specific circumstances, police officers are permitted to use deadly force, such as when they or others are in imminent danger. The use of lethal force may be deemed unjustified if, however, the officer used excessive force or did not adhere to the necessary protocols.

Often, wrongful death claims involve numerous parties, such as the police agency, the officer involved, and the city or county where the incident occurred. To prevail in a wrongful death lawsuit, the plaintiff must demonstrate that the death was caused by the defendant's negligence or willful actions. Table 3 shows the number of police shooting deaths in the last decade based on threat levels and weapons status.

Table 3. Police-Related Shooting Deaths by Category in the U.S. between 2013 and 2022. Adapted from Mapping Police Violence (2023).

Weapons Status		
Unarmed/Did Not Have Actual Weapon	1,521	13.60%
Allegedly Armed	8,022	71.70%
Unclear	986	8.80%
Vehicle	667	6.00%
Total Cases	11,196	
Threat Level		
Attack	5,101	45.60%
Brandished Weapon	363	3.20%
None	128	1.10%
Other	2,256	20.20%
Sudden Threatening Movement	160	1.40%
Unclear	163	1.50%
Undetermined	2,881	25.70%
Used Weapon	144	1.30%
Total Cases	11,196	

4. Reduction in Legal Liability and Criminal Exposure of Officers

When officers use excessive force, they may face criminal or civil penalties for breaching the suspect's civil rights. Claims filed against law enforcement agencies and federal agents for wrongful killing can be expensive and damaging to the reputation of law enforcement agencies, as well as corrosive to public confidence. By providing a less aggressive means of apprehending suspects, the use of less-lethal weapons can reduce the likelihood of such lawsuits and avoid their negative consequences. Although rare, Figure 10 shows the number of police officers convicted of serious criminal offenses related to their firearm discharge.

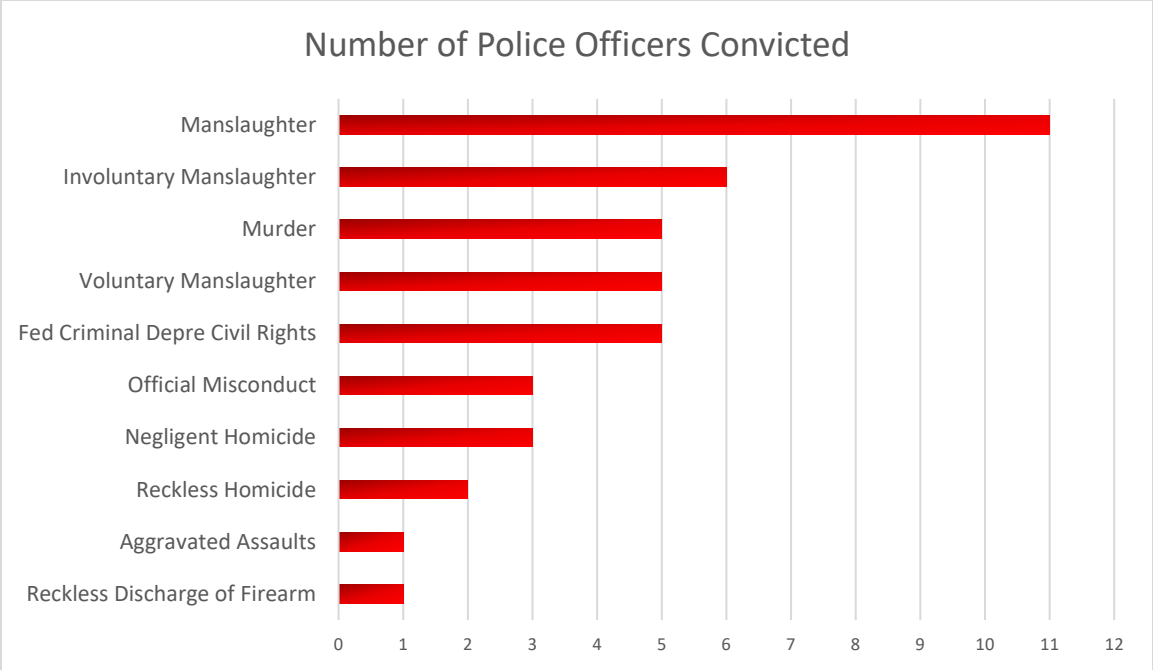

Figure 10. Number of Police Officers Convicted 2005–2020. Adapted from Statista (2020).

5. Disadvantages

Deploying alternative weapons technologies in police and military police operations does have some drawbacks. Less-lethal ammunition can still cause serious harm, including lasting injury or impairment, or death if handled improperly. Rubber bullets and beanbag rounds, for instance, can cause severe injuries if shot at close range or if they strike a vulnerable body region such as the head or neck. In addition, they may not be as effective as conventional firearms in stopping an individual, and their employment may not be appropriate in all circumstances. Each LLW is designed to handle a specific scenario with little room to be employed outside its designed environment. This narrow application of LLW could be seen as one of the biggest drawbacks, especially when considering the uncertainty that is inherent to both law enforcement and military operations. Personnel may be required to carry many different types of LLW to be prepared to navigate the entirety of the continuum of force. As personnel have increased capability they will be not only physically weighed down, but also mentally weighed down. Having

more options does not always help when many of the decisions need to be made in less than one second and have life and death consequences.

B. MONTE CARLO STOCHASTIC SIMULATION ON POLICE VIOLENCE

From 2009–2023, the Thurgood Marshall Institute identified 217 publicly announced settlements that led to policy changes and over $2,340,780,094 in compensation for victims. Their National Police Funding Database contains detailed settlements by individuals and settlements linked to internal police department misbehavior (The National Police Funding Database, 2023).

Although there is no assurance that the deployment of less-lethal weapons will always prevent death or serious injury, both occurrences are dramatically decreased with their use. It is considered that neither the officer nor the agency will be held accountable for civil or criminal action if it can be demonstrated that the officer behaved within the limits of his or her official duties and prescribed protocols. Through adequate training and the use of less-lethal weapons, the amount of money paid out to victims and their families due to the reckless actions of police officers in lethal force situations will be greatly decreased (Cox, 2005).

When one considers the numerous negative social consequences of police shootings in addition to the personal ones, such as riots, widespread antipathy toward the police in minority communities, and substantial awards as a result of civil lawsuits, the price for ignoring the use of LLWs appears excessively high (Geis & Binder, 1990).

Recent examples involving the use of less-deadly force, such as tasers, chemical sprays, and projectiles, highlight both the prevalence of such force and the potential for its abuse. These cases also demonstrate the substantial financial risk municipalities face when their police personnel employ excessive force and bring attention to the significance of developing an effective policy for the use of less-lethal force. The American Civil Liberties Union believes that implementing the policy recommendations for limiting the use of less-lethal force by police officers will benefit both the police and the broader population. The people will be protected against the excessive use of less-lethal force. The police will be provided with much-needed direction concerning its use. Lastly, governments can reduce

the risk of compensating those against whom less-lethal force was unlawfully employed (ACLU, 2015).

For police enforcement, less-lethal weapons have become an absolute necessity. One needs only consider the number of people involved in altercations when less-lethal weapons were utilized to comprehend how drastically things would change if only fatal force was available in those instances. In fact, it may be said that departments that do not equip their police with less-lethal weapons are negligent in safeguarding the public (Kjellman, 2016).

To compute the quantitative return on investment or ROI (Π) on the value of acquiring, training, and implementing The Alternative, we make the following assumptions. The total monetary benefits from potential costs saved $f(\pi_i)$ comes from the probability distribution of the frequency Φ_p^f and severity Φ_l^x. There were 11,195 police-related shootings over the last 10 years, averaging 1,120 cases annually, with an average population of 331 million in the United States during that period (Macrotrends, 2024). Further, we assume 0.311 cases per 100K population with an average lawsuit of $25 million (with a minimum of $5 million). We run a Monte Carlo stochastic simulation of 100,000 to 1,000,000 trials using a Poisson distribution ϕ_p for the frequency and lognormal ϕ_l as well as triangular distributions for the severity of an outcome if it does occur. That is, we have

$$\Pi = \frac{f(\pi_i) - \sum \omega(\chi_1 + \chi_2 + \chi_3)}{\sum \omega(\chi_1 + \chi_2 + \chi_3)}$$

where

$$f(\pi_i) = \Phi_p^f \times \Phi_l^x,$$

$$\phi_p(x) = \frac{e^{-\lambda}\lambda^x}{x!} \text{for } x \text{ and } \lambda > 0$$

and

$$\phi_l(x) = \frac{1}{x\sqrt{2\pi}\, ln(\sigma)} e^{\frac{-[ln(x) - ln(\mu)]^2}{2[ln(\sigma)]^2}} \quad \text{for } x > 0;\ \mu > 0 \text{ and } \sigma > 0.$$

The total cost is the sum of the individual costs χ_i for The Alternative, holster, and certification, multiplied by the number of units required per police officer, ω. According to the FBI's Uniform Crime Report (2019), the national average statistics show approximately 2.4 police officers per 10,000 population in the United States, where annually, an average of three units per officer would suffice. Supposing that The Alternative prorated cost averages $100 per unit ($\chi_1 + \chi_2 + \chi_3$), we estimate that based on our stochastic analysis, the ROI is between **1,343%** and **1,841%** with a 95% statistical confidence (Figure 11). In other words, for every $1 spent on acquiring, equipping, and training an officer to use The Alternative, the shadow return or value is between $14 and $19.

That is, for a small city or suburb with a population of 10,000, the total expenses would be approximately $10,000 per year for the equipment and certification. For a slightly larger town with a 100,000 populace, the expected value impact is $7.7 million in legal exposure with a 3% probability of occurrence. Although the probability of any incident of this magnitude happening is remote, when it does occur, the impact is significant in the community. The legal and financial exposures are equally significant. The $10,000 can be seen as an insurance policy against any collateral damage. A similar analogy would be that of home insurance against fire hazards. The typical home has between 0.03% and 0.05% probability of a fire with an average insurance cost of $1,000 to $1,500 depending on location, size, and year it was built, among other things. One hopes that the insurance is never claimed, but it is there in the event of a worst-case scenario. The same can be said about The Alternative. One hopes that unnecessary loss of life will not occur, but, at the very least, The Alternative less-lethal device can help mitigate the risks.

These computations are based only on quantitative measures, which do not include qualitative benefits such as the reduction of reputation risk, decrease in risks of riots and civil unrest, and the decrease in the erosion of trust and goodwill of the police department. The value of these risk mitigations is incalculable. And the most valuable impact of all is the possibility of preventing unnecessary loss of life. Even if the $10,000 implementation cost can prevent the collateral death of a young child, one would surmise that the benefit is infinitely greater and incalculable.

Table 4 provides a scenario analysis based on the simulated ROI results for various cities with different population sizes (1,000 to 10 million) and the corresponding average pro-rated annual cost per officer (equipment acquisition, spares, training, and certification). For example, with The Alternative priced at $100 per officer, a 10,000-person city with an average of 3.4 officers per 1,000 population, equipping and arming these 34 officers will return on average of 1,564% in ROI. The larger the city, the lower the average number of officers per 1,000 population because the total number of officers will increase substantially and there is a decrease in marginal ratio, meaning that the ROI increases (i.e., 1,564% increases to 2,728% from a 10,000 town to a large metropolis of 10 million). In addition, the more expensive the less lethal equipment, the lower the ROI. For example, a high energy discharge weapon that costs $1,500 per officer may only yield an 11% ROI in a 10,000-person town.

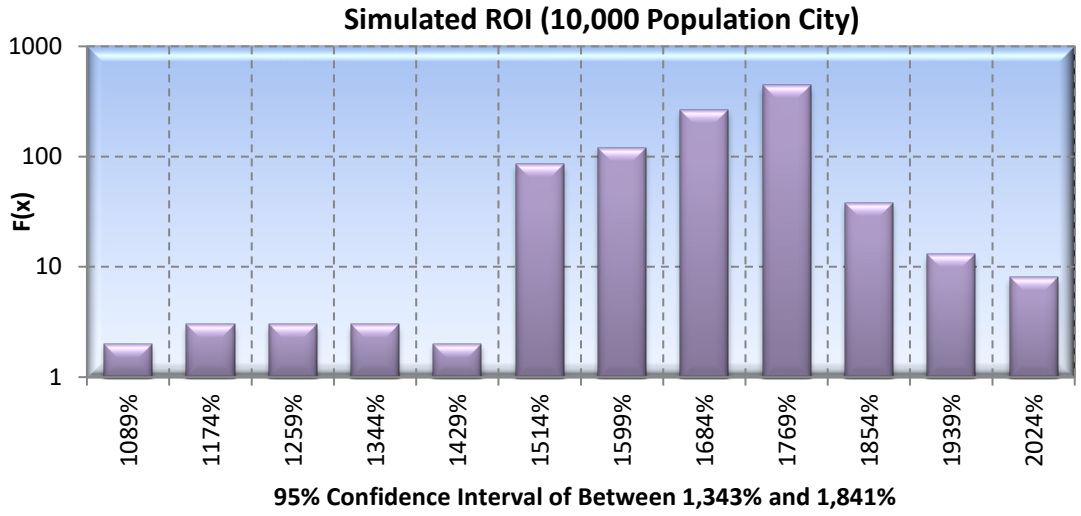

Figure 11. Return on Investment

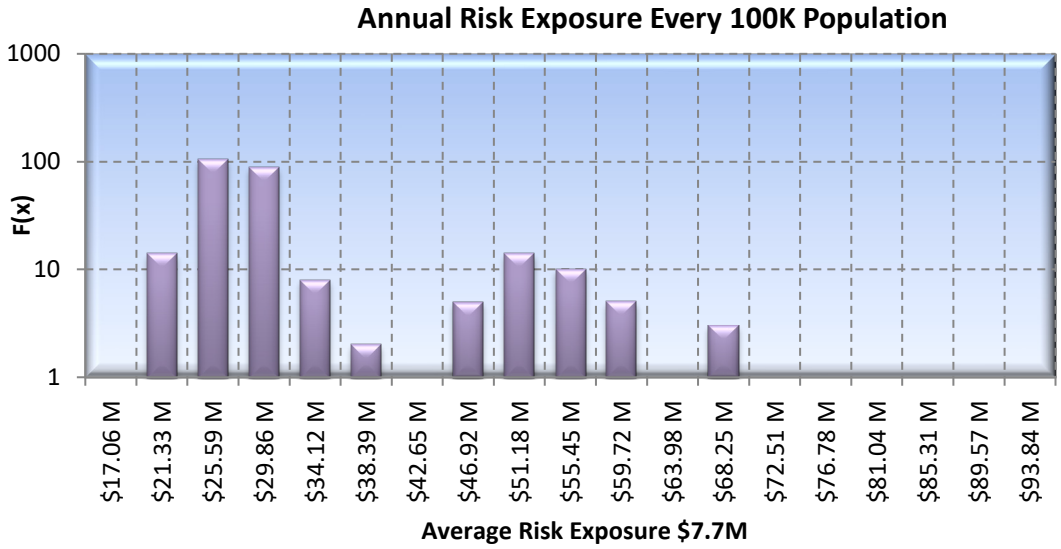

Figure 12. Average Annual Risk Exposure for Every 100K Population

Table 4. ROI Scenario Analysis

Officers/ 1K Pop	Unit Cost / Population	$50	$75	$100	$150	$200	$300	$500	$1,000	$1,200	$1,500
3.4	1,000	3227%	2118%	1564%	1009%	732%	455%	233%	66%	39%	11%
3.4	10,000	3227%	2118%	1564%	1009%	732%	455%	233%	66%	39%	11%
2.8	30,000	3940%	2594%	1920%	1247%	910%	573%	304%	102%	68%	35%
2.8	50,000	3940%	2594%	1920%	1247%	910%	573%	304%	102%	68%	35%
2.8	100,000	3940%	2594%	1920%	1247%	910%	573%	304%	102%	68%	35%
2.3	300,000	4819%	3179%	2359%	1540%	1130%	720%	392%	146%	105%	64%
2.3	500,000	4819%	3179%	2359%	1540%	1130%	720%	392%	146%	105%	64%
2.3	1,000,000	4819%	3179%	2359%	1540%	1130%	720%	392%	146%	105%	64%
2.3	3,000,000	4819%	3179%	2359%	1540%	1130%	720%	392%	146%	105%	64%
2.0	5,000,000	5557%	3671%	2728%	1786%	1314%	843%	466%	183%	136%	89%
2.0	10,000,000	5557%	3671%	2728%	1786%	1314%	843%	466%	183%	136%	89%

C. SURVEY STATISTICAL ANALYSIS

The survey of planners and users of LLWs provided rich data that gives qualitative insights into the perception of LLWs by service members. The qualitative analysis supported the data collected from the interviews, while providing insights into specific applications and reservations.

1. Demographic Analysis

Figure 13. Survey Responses: LLWs Are Important to Military Operations

A total of 73.17% of participants expressed agreement or strong agreement with the statement: LLWs are important to military operations. This percentage clearly expresses the importance that service members place on LLWs. Furthermore, a cross tabulation with those involved in law enforcement shows that these subgroups think LLWs are more important for military operations than those not involved in law enforcement. A similar result can be seen by the cross tabulation of those trained in the use of LLWs. This generalized support of LLWs in military operations is consistent with the sentiment expressed by the interviewees.

When asked about the necessity of LLWs in military policing operations 60.98% of participants either agreed or strongly agreed with the need for LLWs in this application. Only 14.64% of participants disagreed or strongly disagreed with the sentiment. Additionally, a cross tabulation between Figure 14 and survey responses that are involved in law enforcement shows that LLWs are viewed as necessary for successful policing operations.

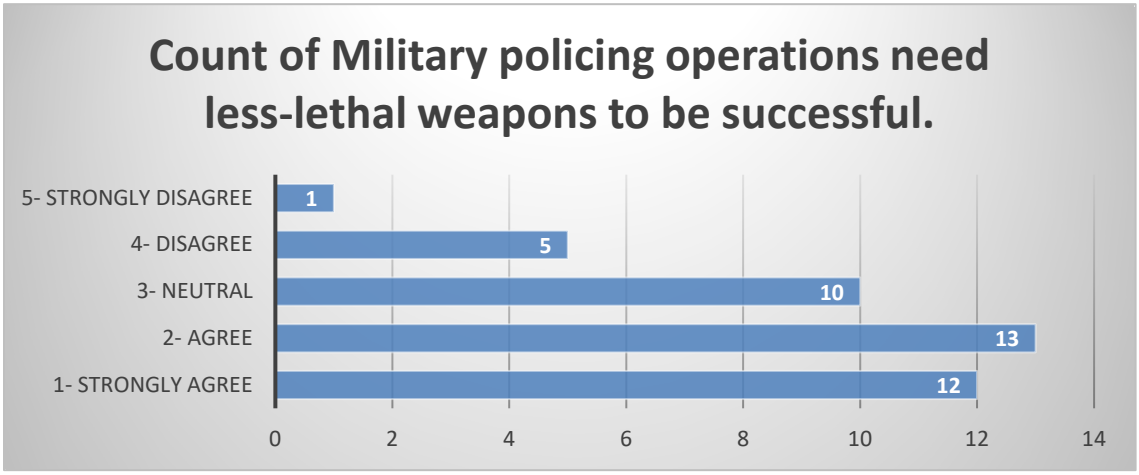

Figure 14. Survey Responses: Military Policing Operations Need LLWs

When combining Figure 13 and Figure 14, it can be seen that there exists a small degree of uncertainty when it comes to the mission sets in which LLWs should be employed. Most service members support LLWs in general, but when asked about a specific mission, support slightly decreased. Furthermore, a cross tabulation between Figure 14 and survey responses that are involved in law enforcement shows that LLWs are viewed as necessary for successful policing operations, which indicates that the experts view LLWs as a critical capability to accomplish their mission. However, experts may not always be the ones executing the mission.

Figure 15 and Figure 16 illustrate that service members generally believe that it is important to teach partner nations and allies the TTPs and SOPs of LLWs. Of the participants, 68.29% agreed or strongly agreed with the need to be able to train partner forces in LLW capabilities. However, only 41.47% of participants believed that with the

current knowledge level U.S. forces would be able to effectively teach partner nations about LLWs. This disparity reflects the concerns voiced by the interviewees.

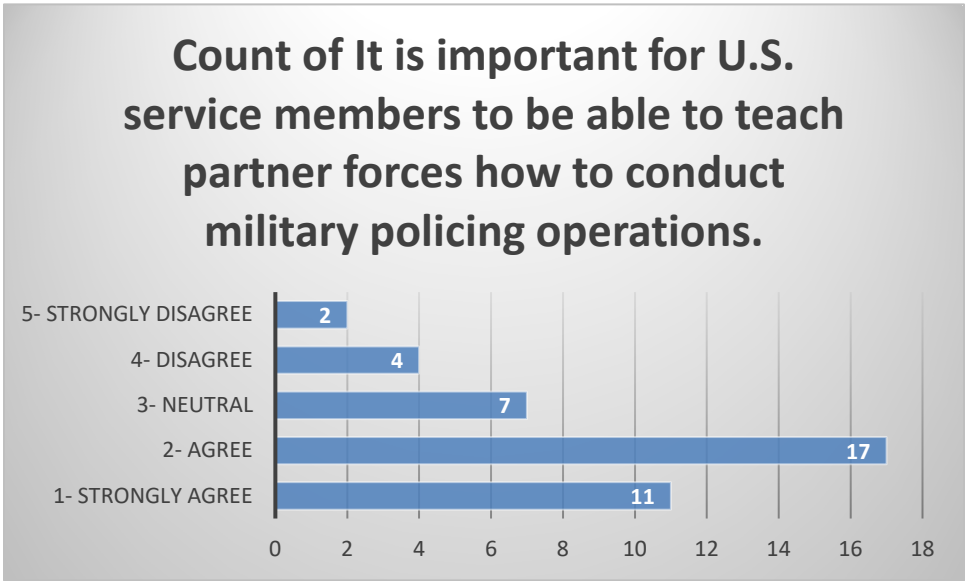

Figure 15. Survey Responses: Importance of Service Members Teaching Partner Nations

Figure 16. Survey Responses: Ability of Service Members to Teach Partner Nations

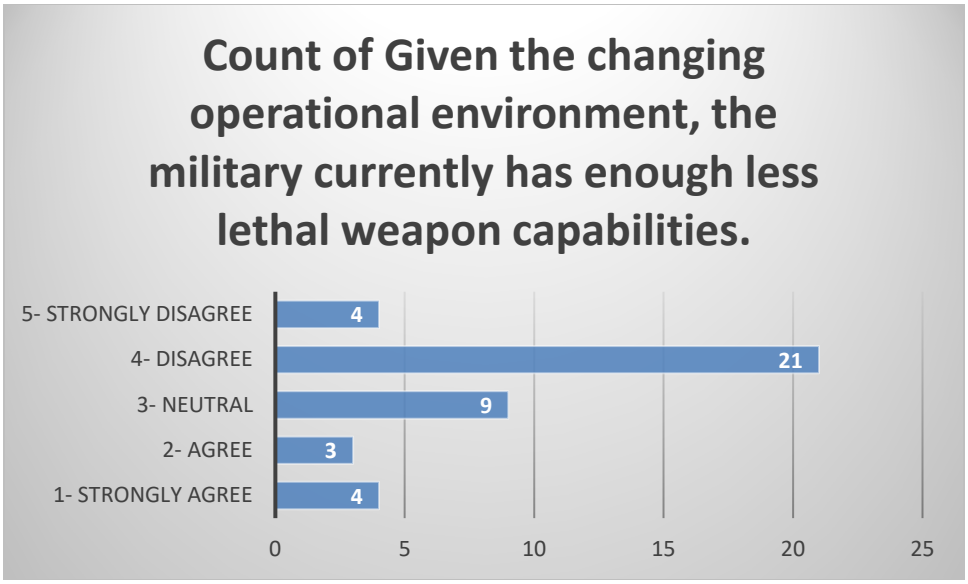

Figure 17. Survey Responses: Military Has Enough LLW Capabilities

A total of 60.98% of surveyed service members expressed that they do not think the military has enough LLW capabilities. A cross tabulation of those trained in LLWs showed that the training results in the belief that the military does have enough capabilities. This shows that there may be a disconnect between the perceived LLW capabilities from the lay-service member and amplifies the concern expressed by the interviewees who believed that commanders did not know what capabilities were available to them.

Of the survey responses, 92.68% indicated the significant importance of the ability to transition rapidly from lethal force to less-lethal force.

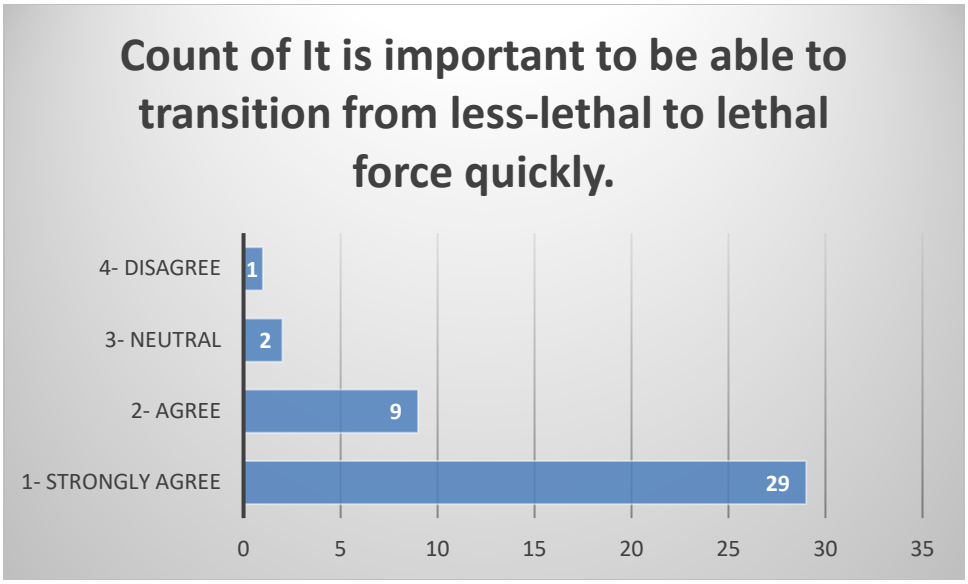

Figure 18. Survey Responses: Importance of Transitioning from Lethal to Less Lethal Quickly

Most service members expressed that they do not think the military has enough LLW capabilities. A cross tabulation of those trained in LLWs showed that the training results in the belief that the military does have enough capabilities.

Taking a wholistic view of the above information, it becomes clear that U.S. service members have a desire to be equipped with LLWs. However, there is a disparity between the available training and understanding and the knowledge of the general populace among service members. The usefulness of LLW capabilities is seen in specific situations where LLWs would traditionally be employed, but also in unique uncertain situations. Similarly, the importance of quick transitioning between lethal and less-lethal forces cannot be overstated.

2. Scenario Analysis

Each participant was presented with six different scenarios and asked if they believed that LLW capabilities such as a taser and pepper spray would be useful in that situation. Participants were then asked if they believed a single-shot bullet-capture LLW capability would be useful in the same situation. A picture of The Alternative was displayed to reduce confusion and provide a visualization of this novel technology.

In a domestic violence situation, there was a statistically significant preference to use LLW such as taser and pepper spray (Figure 19). A two-tailed *t*-test was conducted and with a confidence interval of .05, the null hypothesis can be rejected. Notably, tasers and pepper spray had a mean of 1.78, and The Alternative had a mean of 2.659, which further emphasizes the preference towards traditional LLWs in a domestic violence scenario. The statistical power (1-β) is .887, providing confidence in this analysis.

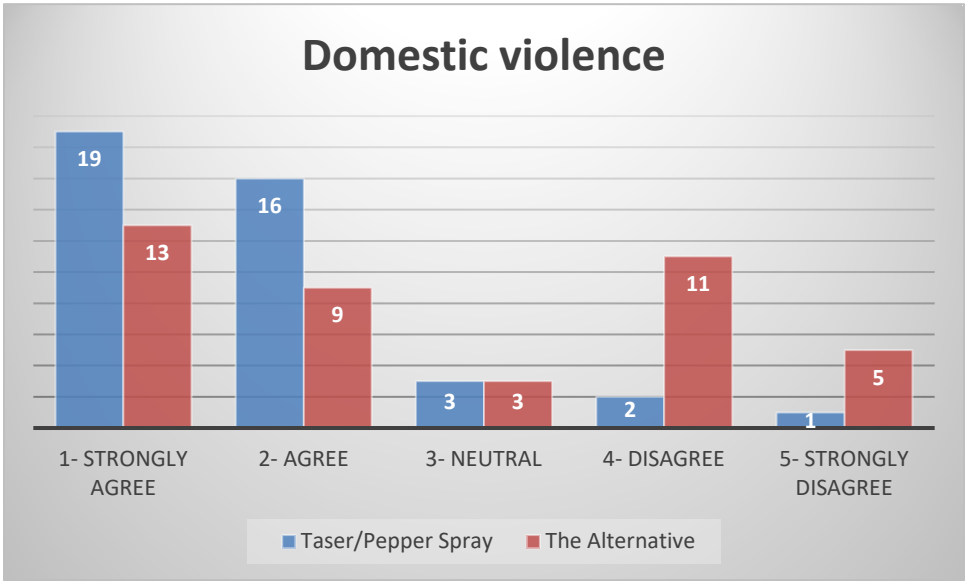

Figure 19. Domestic Violence Scenario Survey Data

When given a scenario of base police responding to barracks unrest, survey responses indicated a preference for traditional LLW capabilities (Figure 20). A two-tailed *t*-test was conducted and with a confidence interval of .05, the null hypothesis can be rejected. The Alternative had a mean of 2.8, displaying substantial opposition to its perceived usefulness in a scenario of barracks unrest. The statistical power for this scenario is .9924, amplifying the desire to use traditional LLWs in this scenario.

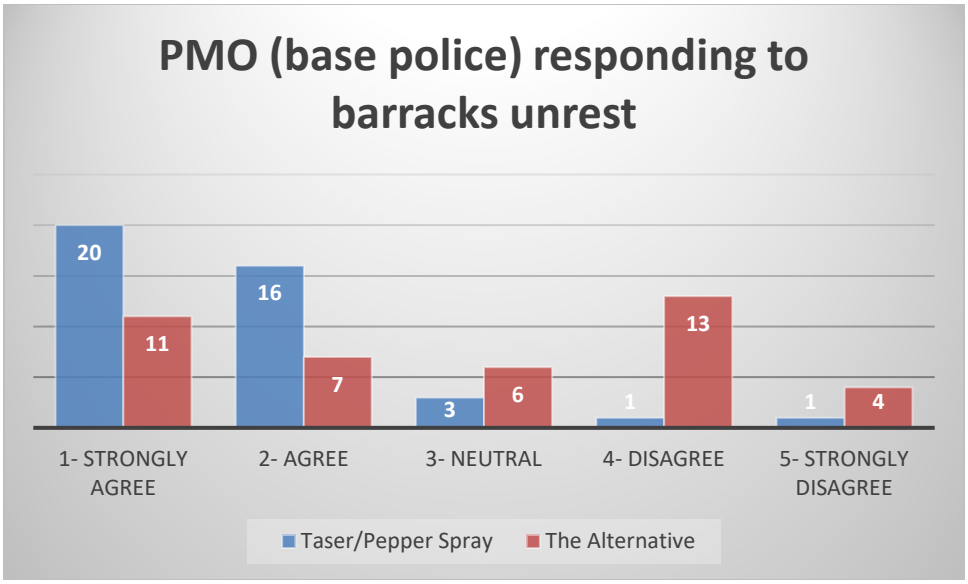

Figure 20. PMO Response to Barracks Unrest Scenario Survey Data

When presented with the scenario of embassy defense from a civilian riot, there was no statistically significant difference between the preference for traditional LLWs or The Alternative. A two-tailed *t*-test was conducted and, with a confidence interval of .05, the null hypothesis cannot be rejected, verifying the lack of preference. With means at 2.56 and 2.29 for the taser/pepper spray and The Alternative, respectively, it can be seen that there is still a small preference for traditional LLWs, but it is not large enough for statistical significance.

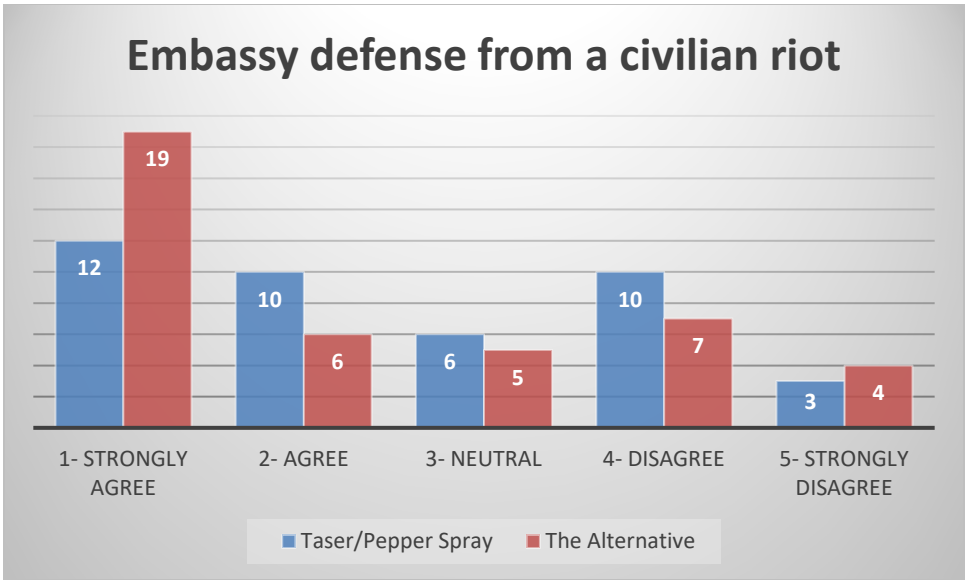

Figure 21. Embassy Defense Scenario Survey Data

NEO crowd control is the first scenario where a preference for The Alternative was present with a mean of 2.707, while tasers and pepper spray had a mean of 2.49 (Figure 22). However, a two-tailed *t*-test was conducted and with a confidence interval of .05, it proved the null hypothesis cannot be rejected.

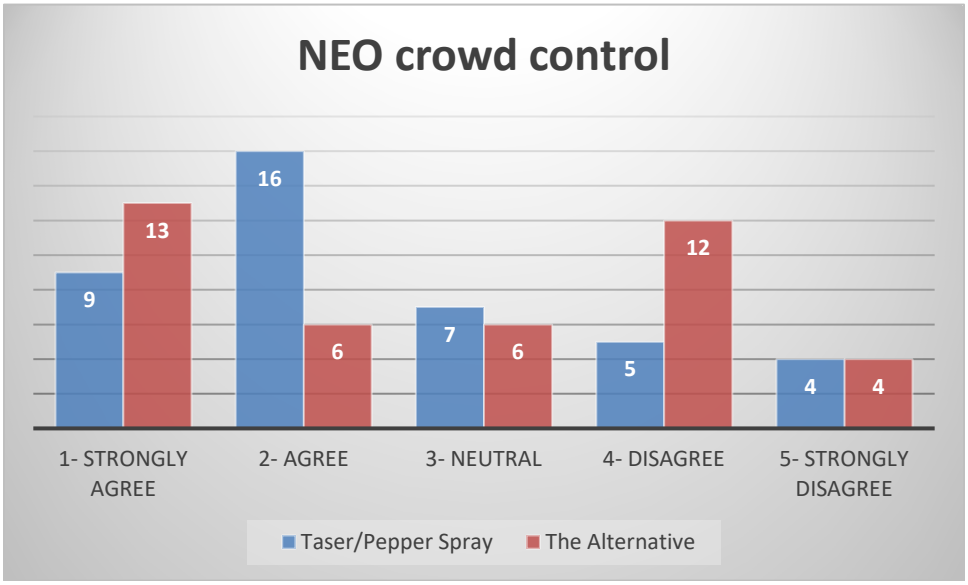

Figure 22. NEO Crowd Control Scenario Survey Data

In an EABO environment, tasers and pepper spray had a mean of 3.02 with a standard deviation of 1.33, and The Alternative had a mean of 2.88 with a standard deviation of 1.44 (Figure 23). Both traditional LLWs and The Alternative received a wide array of perceived usefulness, which can be seen by the means proximity to the neutral option holding a value of 3. This displays that there is no consensus on the usefulness of LLWs in the EABO environment. Additionally, a two-tailed *t*-test was conducted, and, with a confidence interval of .05, the null hypothesis cannot be rejected.

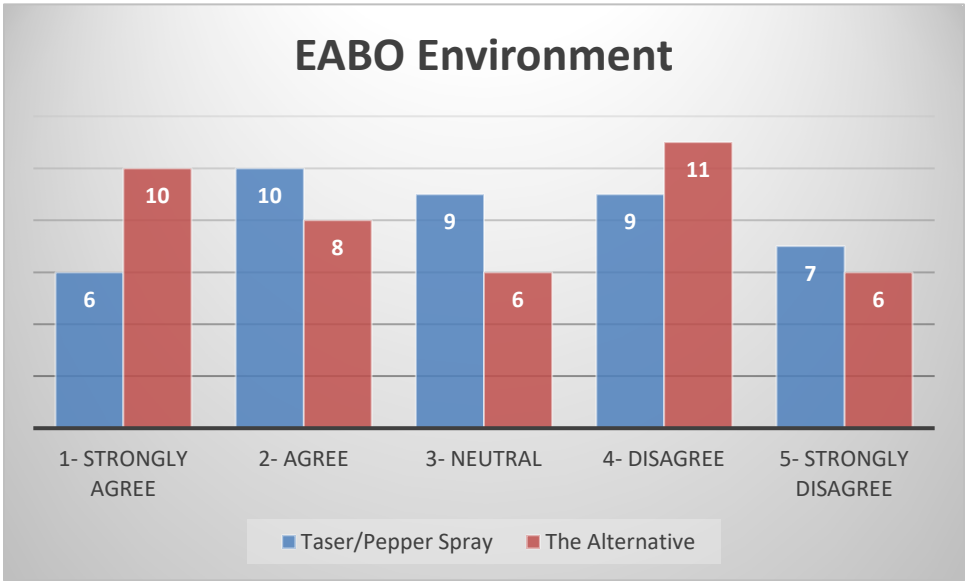

Figure 23. EABO Environment Scenario Survey Data

Finally, when engaging in a key leader engagement (KLE), survey participants displayed a small preference for The Alternative, which had a mean of 2.61 (Figure 24). Tasers and pepper spray had a mean of 2.53. However, when a two-tailed *t*-test was conducted with a confidence interval of .05, the null hypothesis could not be rejected.

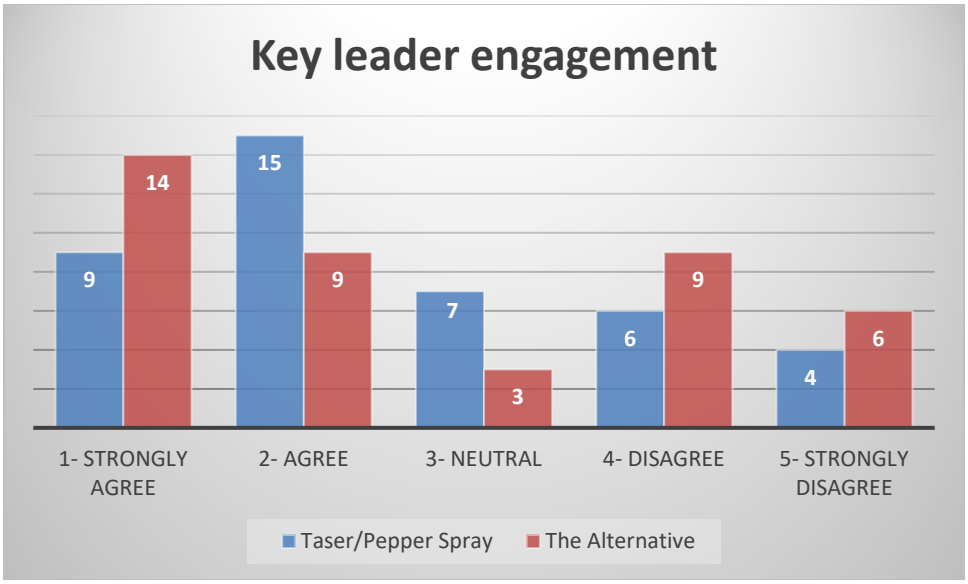

Figure 24. Key Leader Engagement Scenario Survey Data

3. Conclusion

Viewing the two-variable *t*-tests between tasers and a single-shot bullet-capture attachment shows that in scenarios where traditional law enforcement methods may be employed, such as domestic violence and barracks unrest, there is a statistically significant difference between the perceived usefulness of tasers and pepper spray when compared to a single-shot bullet-capture attachment in applying the appropriate level of force. However, in situations where traditional policing methods are less established, there was not a statistically significant difference between the two LLW capabilities. Furthermore, preference for The Alternative increased when engaging with foreign forces or civilians. This point warrants further research to test the validity of this disposition.

Additionally, a Guttman's Lambda test was conducted for consistency.

```
Guttman's Lambda
Internal Consistency and Reliability Test

Covariance                          32.06402
Variance of Total                  140.82805
Guttman's Lambda                     0.91073

Odd-Even Split Approach

Correlation Coefficient              0.83646
Spearman-Brown Correction            0.91095

Low correlations and lambda scores mean
low reliability and low consistency
```

With a correlation coefficient of 0.836 and a Spearman-Brown correction of 0.911, it can be seen that the survey responses possess a very high level of reliability and consistency.

Finally, a principal component analysis and factor analysis was conducted. Table 5 shows the top ten factors and the cumulative value of the variance.

Table 5. Factor Analysis

Rank	Factor	Cumulative Value
1	Situations where there is a large crowd control problem	20.58%
2	Situations where a small number of people are involved	31.33%
3	Situations where the primary party being engaged is foreign civilians	40.79%
4	Situations where there is significant uncertainty	48.37%
5	Available options of LLWs	54.13%
6	Ability to teach partner nations and allies	59.69%
7	Quick transition from less lethal to lethal	65.22%
8	Familiarity with DOD LLW capabilities	70.73%
9	Military policing operations	75.95%
10	Current training level of U.S. military members	81.05%

These factors illuminate some interesting ideas, each of which will need further research from which to draw clear conclusions. Appendix E provides the detailed breakdown for the factor analysis. The above-listed factors attribute for over 80% of the variation in the data. These factors could be the defining difference in perceived usefulness for a specific LLW capability in a given scenario. Due to the limitations of this thesis such granularity is beyond the scope of this research.

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VI. CONCLUSION

This thesis aimed to explore the possibilities of employing a novel LLW capability in the form of a single-shot, bullet-capture device in both a civilian law enforcement environment as well as an operational and nonoperational military environment. The following three questions provided the foundation for the methodology for this research:

1. As the operating environment becomes increasingly complex, what role will LLWs play in enabling operating forces to handle novel situations in novel environments?
2. Will a less-lethal, single-shot, bullet-capture attachment that allows rapid transition from less-lethal to lethal force allow the DOD to operate more effectively in anticipated future operating environments?
3. What value can a less-lethal, single-shot, bullet-capture handgun attachment add to civilian policing and military operations?

Through interviewing service members as well as a quantitative analysis of potential ROI, it can be said that service members believe LLWs will play a role in future conflicts and are indispensable in current policing operations. Service members also emphasized the importance of having the ability to transition from less-lethal to lethal force rapidly. Finally, by using stochastic Monte Carlos simulations, the value of such a capability ranged from 1,343% to 1,841%.

However, while the value of LLWs was clearly seen by service members, there were also concerns expressed. In the next section, these shortcomings are reviewed and coupled with recommendations.

A. RECOMMENDATIONS

The value of LLWs is apparent; however, they are not without their drawbacks. Throughout this research, many of the shortcomings of LLW have become clear. First, interviewees expressed concern about being able to logistically support LLWs in austere environments where any movements may be contested by adversarial forces. Second,

service members expressed concerns about slowing the OODA loop for both users and commanders. Presenting people with too many options could hamper decision makers' ability to choose. In a tactical environment these moments could be the difference between life and death. Finally, there was significant concern expressed about how people are trained. Current SOPs generally dictate that when employing a lethal weapon, the weapon should be used in a way to ensure lethality. When attaching a single-shot LLW to the front of a lethal weapon practices such as double tapping would create a lethal scenario where non-lethal methods were attempted.

The following are recommendations for mitigating the three primary shortcomings that became clear through the interview process.

Logistical solution: The logistical footprint for maintaining and rearming LLWs must be proportionate to the value the weapon is providing to the mission. Currently, the weapons are cumbersome, standalone systems that require specific training to employ correctly. The level of expertise that is required makes LLWs undesirable. Moving forward, the development of LLWs should consider the ease of use and attritability of the LLW. Furthermore, the loss must not have operational impacts.

Decision loop slowdown solution: Training users effectively will reduce the amount of time it takes to decide which capability is appropriate for new situations. As commanders are trained, LLWs should be introduced as a possible solution to a situation. This can be specifically used in wargaming. Regardless of the approach, if LLWs are to be employed more, there must be increased training to reduce the effect that the increased number of capabilities available to commanders and users has on the decision cycle.

Training solution: Revised TTPs and SOPs will be necessary to successfully implement new LLWs. These concerns will need to be addressed in entry-level training to facilitate the formation of habits that allow for the use of new technologies.

When considering a single-shot bullet-capture LLW, there needs to be further proof of concept in operational environments before widespread fielding is done. The benefits are easy to understand, but the risk of improper use has potentially fatal consequences.

According to Mun et al.,

The use of less-lethal weapons, such as alternative projectile technologies and tasers, in law enforcement and military policing operations, is a feasible alternative to conventional firearms. The proper use of these weapons decreases collateral damage, reputational risk, and the number of unnecessary deaths caused by fatal gunshot wounds. In addition, their utilization can reduce wrongful death-related litigation and the police officer's or federal agent's criminal liability. The risk exposure of wrongful death lawsuits averages $7.7M for every 100K population. The acquisition, training, and implementation of The Alternative, a velocity-reducing projectile, ranges from 1,343% and 1,841% with a 95% statistical confidence in return on investment. The quantifiable benefits alone justify The Alternative's acquisition and implementation, while many other additional incalculable intangible benefits exist.

The American Civil Liberties Union believes that implementing policy recommendations for limiting the use of less-lethal force by police officers will benefit both the police and the broader population. The people will be protected against the excessive use of less lethal force. The police will be provided with much-needed direction concerning its use. Lastly, governments can reduce the risk of compensating those against whom less-lethal force was unlawfully employed (ACLU, 2015). For police enforcement, LLWs have become an absolute necessity. One need only consider the number of people involved in altercations when LLWs were utilized to comprehend how drastically things would change if only fatal force were available in those instances. In fact, it may be said that departments that do not equip their police with LLWs are negligent in safeguarding the public. (Mun et al., 2024)

B. LIMITATIONS

The limitations of this research are primarily a result of the novelty of the new technology. The Alternative has not been widely fielded and therefore does not have real world data to support analysis. Further research will be needed once this data becomes available.

Furthermore, due to the limited size and available population of the interviewed and surveyed service members, the qualitative analysis lacks a degree of certainty found in sampling a larger number. Also, due to the specific nature of the interviewees and the participants of the survey, those aspects of this study do not meet the federal definition of research as defined under 32 CFR 219.

C. FUTURE RESEARCH

Further research is needed to more clearly identify why service members prefer LLWs over lethal force in certain situations, and if civilian law enforcement personnel hold similar sentiments. Such research could provide the foundation for new SOP development in the employment of LLWs. Furthermore, if a single-shot, bullet-capture device is fielded, additional research will be needed in the most effective way to ensure that lethal force is not accidentally used. New training standards and SOPs will need to be tested and adopted. As LLWs like The Alternative are used more widely, research similar to what was conducted in this thesis could provide new insights into the sentiments of service members. Finally, and more broadly, additional research will need to be conducted about the efficacy of LLWs in an EABO environment with specific consideration given to the logistical requirements of employing LLWs.

APPENDIX A. NON-LETHAL WEAPON REQUIREMENTS

Below is the DOD Non-Lethal Weapon Requirements fact sheet (DOD, 2016).

Non-Lethal Weapon Requirements

Updated: May 11, 2016

The Joint Non-Lethal Weapons Directorate, on behalf of the Commandant of the Marine Corps, who serves as the Executive Agent for the Department of Defense (DOD) Non-Lethal Weapons Program, leads the DOD in the identification, evaluation, recommendation and development of non-lethal weapons to enable their employment across the range of military operations.

To address specific non-lethal capability requirements for U.S. forces operating in complex environments, the Joint Non-Lethal Weapons Program (JNLWP) proposed two Initial Capabilities Documents (ICDs) for non-lethal effects—one for counter-personnel effects and one for counter-materiel effects. The ICDs support the Services by identifying requirements for non-lethal effects based on force application needs for major combat operations and homeland defense. The DOD's Joint Requirements Oversight Council approved the ICDs in April 2009, authorizing the Services to use the documents as a basis for pursuing solutions to their identified non-lethal capability gaps.

The ICDs identify the below required military tasks for counter-materiel and counter-personnel non-lethal effects. The JNLWP is interested in new weapons and capabilities that can support these tasks, especially at extended ranges. Current capabilities are listed on the Current Non-Lethal Weapons webpage.

The Directorate also posts Broad Area Announcements for science and technology development and for demonstrations of next generation non-lethal weapons on the Business Opportunities webpage.

Initial Capabilities Documents

- Counter-Personnel Tasks
    - Deny access into/out of an area to individuals (open/confined) (single/few/many)
    - Disable individuals (open/confined) (single/few/many)
    - Move individuals through an area (open/confined) (single/few/many)
    - Suppress individuals (open/confined) (single/few/many)
- Counter-Material Tasks
    - Stop small vehicle
    - Stop medium vehicle
    - Stop large vehicle
    - Disable vehicle/many vehicles
    - Stop small vessel
    - Stop large vessel
    - Disable vessel/many vessels
    - Stop fixed-wing aircraft on the ground
    - Disable aircraft on the ground
    - Divert aircraft in the air
    - Deny access to facility (i.e., block points of entry)

Terms and Definitions

- Confined Space: An area of varying dimensions/size that has limited or restricted avenues to enter, egress or evade engagement
- Counter-materiel: Directed effects against materiel (vehicles, vessels, aircraft, buildings, facilities, structures, weapon systems, ammunition and weapons of mass destruction, etc.) Note: Non-lethal counter-materiel effects must remain non-lethal to personnel.
- Counter-personnel: Directed effects against individual(s) that will not result in permanent injury
- Deny: An action to hider or prevent the use of space, personnel or facilities
- Disable: To render ineffective or unable to perform
- Divert: To turn aside from a course or direction
- Facility: A real property entity consisting of one or more of the following: a building, a structure, a utility system, pavement and underlying land
- Few: Consists of two to seven targets
- Large Vehicles: Semi-trailers, both boxed and bulk cargo
- Large Vessels: Vessels more than 100 feet long
- Many: Consists of seven or more targets
- Medium vehicles: Small box vans up to and including water/fuel trucks
- Move: To go or pass to another place or in a certain direction with a continuous motion

- Non-lethal weapons: Weapons, devices and munitions that are explicitly designed and primarily employed to incapacitate targeted personnel or materiel immediately, while minimizing fatalities, permanent injury to personnel and undesired damage to property in the target area or environment. Non-lethal weapons are intended to have reversible effects on personnel or materiel
- Open Space: Any area large enough to allow a target, relative to its size, ultimate avenues to enter, egress or evade engagement (e.g., fields, rural roads, desert, etc.)
- Single: Consists of one target
- Small vehicles: Four-wheeled cargo vans and smaller
- Small vessels: Vessels equal to and less than 100 feet in length
- Stop: 1) To hinder or prevent the passage of; 2) To make impassable: choke, obstruct; 3) To cause to give up or change a course of action; to keep from carrying out a proposed action: restrain, prevent; 4) To cause to cease: check, suppress
- Suppress: To degrade the ability of an individual(s) to take specified action

APPENDIX B. STATISTICAL ANALYSIS

```
*T TEST A

Model Inputs:
VAR7; VAR13
0.00
Q7A, Q8A

Two-Variable (T) Independent Equal Variance


Column 1 Observations : 41
Column 1 Sample Mean : 1.780488
Column 1 Sample Standard Deviation : 0.962086
Column 2 Observations : 41
Column 2 Sample Mean : 2.658537
Column 2 Sample Standard Deviation : 1.476647
Sample Mean Difference : -0.878049
T-Statistic : -3.190091
Hypothesized Mean : 0.000000

P-Value Left-Tailed : 0.001016
Significant at 1%, 5%, and 10%.
Null hypothesis is rejected.
Significantly less than the hypothesized mean difference.

P-Value Right-Tailed : 0.998984
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly greater than the hypothesized mean difference.

P-Value Two-Tailed : 0.002032
Significant at 1%, 5%, and 10%.
Null hypothesis is rejected.
Significantly different than the hypothesized mean difference.

--------------------------------------------------------------------------------

*T TEST B

Model Inputs:
VAR8; VAR14
0.00
Q7B, Q8B

Two-Variable (T) Independent Equal Variance


Column 1 Observations : 41
Column 1 Sample Mean : 1.707317
Column 1 Sample Standard Deviation : 0.901219
Column 2 Observations : 41
Column 2 Sample Mean : 2.804878
Column 2 Sample Standard Deviation : 1.400348
Sample Mean Difference : -1.097561
T-Statistic : -4.220193
Hypothesized Mean : 0.000000
```

P-Value Left-Tailed : 0.000032
Significant at 1%, 5%, and 10%.
Null hypothesis is rejected.
Significantly less than the hypothesized mean difference.

P-Value Right-Tailed : 0.999968
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly greater than the hypothesized mean difference.

P-Value Two-Tailed : 0.000064
Significant at 1%, 5%, and 10%.
Null hypothesis is rejected.
Significantly different than the hypothesized mean difference.

---

*T TEST C

Model Inputs:
VAR9; VAR15
0.00
Q7C, Q8C

Two-Variable (T) Independent Equal Variance

Column 1 Observations : 41
Column 1 Sample Mean : 2.560976
Column 1 Sample Standard Deviation : 1.342549
Column 2 Observations : 41
Column 2 Sample Mean : 2.292683
Column 2 Sample Standard Deviation : 1.453339
Sample Mean Difference : 0.268293
T-Statistic : 0.868271
Hypothesized Mean : 0.000000

P-Value Left-Tailed : 0.806078
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly less than the hypothesized mean difference.

P-Value Right-Tailed : 0.193922
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly greater than the hypothesized mean difference.

P-Value Two-Tailed : 0.387843
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly different than the hypothesized mean difference.

---

*T TEST D

Model Inputs:
VAR10; VAR16
0.00
Q7D, Q8D

Two-Variable (T) Independent Equal Variance

```
Column 1 Observations : 41
Column 1 Sample Mean : 2.487805
Column 1 Sample Standard Deviation : 1.247436
Column 2 Observations : 41
Column 2 Sample Mean : 2.707317
Column 2 Sample Standard Deviation : 1.436035
Sample Mean Difference : -0.219512
T-Statistic : -0.738922
Hypothesized Mean : 0.000000

P-Value Left-Tailed : 0.231058
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly less than the hypothesized mean difference.

P-Value Right-Tailed : 0.768942
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly greater than the hypothesized mean difference.

P-Value Two-Tailed : 0.462117
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly different than the hypothesized mean difference.

--------------------------------------------------------------------------------

*T TEST E

Model Inputs:
VAR11; VAR17
0.00
Q7E, Q8E

Two-Variable (T) Independent Equal Variance


Column 1 Observations : 41
Column 1 Sample Mean : 3.024390
Column 1 Sample Standard Deviation : 1.332062
Column 2 Observations : 41
Column 2 Sample Mean : 2.878049
Column 2 Sample Standard Deviation : 1.435185
Sample Mean Difference : 0.146341
T-Statistic : 0.478547
Hypothesized Mean : 0.000000

P-Value Left-Tailed : 0.683217
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly less than the hypothesized mean difference.

P-Value Right-Tailed : 0.316783
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly greater than the hypothesized mean difference.

P-Value Two-Tailed : 0.633566
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
```

Not significantly different than the hypothesized mean difference.

---

*T TEST F

Model Inputs:
VAR12; VAR18
0.00
Q7F, Q8F

Two-Variable (T) Independent Equal Variance

Column 1 Observations : 41
Column 1 Sample Mean : 2.536585
Column 1 Sample Standard Deviation : 1.266838
Column 2 Observations : 41
Column 2 Sample Mean : 2.609756
Column 2 Sample Standard Deviation : 1.514563
Sample Mean Difference : -0.073171
T-Statistic : -0.237282
Hypothesized Mean : 0.000000

P-Value Left-Tailed : 0.406522
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly less than the hypothesized mean difference.

P-Value Right-Tailed : 0.593478
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly greater than the hypothesized mean difference.

P-Value Two-Tailed : 0.813045
Not significant at any of the following significance levels: 1%, 5%, and 10%.
Null hypothesis is not rejected.
Not significantly different than the hypothesized mean difference.

CROSS TAB Q1 AND TRAINING

Model Inputs:
VAR1
VAR22
Q1
Q12

Data Analysis: Cross Tabulation

First Variable is in the Row and Second Variable is in the Column

	No	Yes	TOTAL
1	8	3	11
	25.81%	30.00%	26.83%
2	13	6	19
	41.94%	60.00%	46.34%
3	5	0	5
	16.13%	0.00%	12.20%
4	4	1	5
	12.90%	10.00%	12.20%
5	1	0	1
	3.23%	0.00%	2.44%
TOTAL	31	10	41

First Variable is in the Column and Second Variable is in the Row

	1	2	3	4	5	TOTAL
No	8	13	5	4	1	31
	72.73%	68.42%	100.00%	80.00%	100.00%	75.61%
Yes	3	6	0	1	0	10
	27.27%	31.58%	0.00%	20.00%	0.00%	24.39%
TOTAL	11	19	5	5	1	41

CROSS TAB Q1 AND SERVICE

Model Inputs:
VAR1
VAR23
Q1
Q13

Data Analysis: Cross Tabulation

First Variable is in the Row and Second Variable is in the Column

	Air Force	Army	Navy	USMC	TOTAL
1	5	3	1	2	11
	41.67%	23.08%	12.50%	25.00%	26.83%
2	2	6	6	5	19
	16.67%	46.15%	75.00%	62.50%	46.34%
3	3	1	0	1	5
	25.00%	7.69%	0.00%	12.50%	12.20%
4	2	2	1	0	5
	16.67%	15.38%	12.50%	0.00%	12.20%
5	0	1	0	0	1
	0.00%	7.69%	0.00%	0.00%	2.44%
TOTAL	12	13	8	8	41

First Variable is in the Column and Second Variable is in the Row

	1	2	3	4	5	TOTAL
Air Force	5	2	3	2	0	12
	45.45%	10.53%	60.00%	40.00%	0.00%	29.27%
Army	3	6	1	2	1	13
	27.27%	31.58%	20.00%	40.00%	100.00%	31.71%
Navy	1	6	0	1	0	8
	9.09%	31.58%	0.00%	20.00%	0.00%	19.51%
USMC	2	5	1	0	0	8
	18.18%	26.32%	20.00%	0.00%	0.00%	19.51%
TOTAL	11	19	5	5	1	41

---

*CROSS TAB Q1 AND LAW ENFORCEMENT INVOLVEMENT

Model Inputs:
VAR1
VAR21
Q1
Q11

Data Analysis: Cross Tabulation

First Variable is in the Row and Second Variable is in the Column

	No	Yes	TOTAL
1	8	3	11
	23.53%	42.86%	26.83%
2	15	4	19
	44.12%	57.14%	46.34%
3	5	0	5
	14.71%	0.00%	12.20%
4	5	0	5
	14.71%	0.00%	12.20%
5	1	0	1
	2.94%	0.00%	2.44%
TOTAL	34	7	41

First Variable is in the Column and Second Variable is in the Row

	1	2	3	4	5	TOTAL
No	8	15	5	5	1	34
	72.73%	78.95%	100.00%	100.00%	100.00%	82.93%
Yes	3	4	0	0	0	7
	27.27%	21.05%	0.00%	0.00%	0.00%	17.07%
TOTAL	11	19	5	5	1	41

---

*CROSS TAB Q1 AND GENDER

Model Inputs:
VAR1
VAR25
Q1
Q15

Data Analysis: Cross Tabulation

First Variable is in the Row and Second Variable is in the Column

	Female	Male	TOTAL
1	3	8	11
	33.33%	25.00%	26.83%
2	6	13	19
	66.67%	40.63%	46.34%
3	0	5	5
	0.00%	15.63%	12.20%
4	0	5	5
	0.00%	15.63%	12.20%
5	0	1	1
	0.00%	3.13%	2.44%
TOTAL	9	32	41

First Variable is in the Column and Second Variable is in the Row

	1	2	3	4	5	TOTAL
Female	3	6	0	0	0	9
	27.27%	31.58%	0.00%	0.00%	0.00%	21.95%
Male	8	13	5	5	1	32
	72.73%	68.42%	100.00%	100.00%	100.00%	78.05%
TOTAL	11	19	5	5	1	41

---

*CROSS TAB Q1 AND FAMILIARITY (Q10)

Model Inputs:
VAR1
VAR20
Q1
Q10

Data Analysis: Cross Tabulation

First Variable is in the Row and Second Variable is in the Column

	1	2	3	4	5	TOTAL
1	2	1	2	5	1	11
	50.00%	14.29%	20.00%	38.46%	14.29%	26.83%
2	2	4	3	6	4	19
	50.00%	57.14%	30.00%	46.15%	57.14%	46.34%
3	0	1	3	1	0	5
	0.00%	14.29%	30.00%	7.69%	0.00%	12.20%
4	0	1	1	1	2	5
	0.00%	14.29%	10.00%	7.69%	28.57%	12.20%
5	0	0	1	0	0	1
	0.00%	0.00%	10.00%	0.00%	0.00%	2.44%
TOTAL	4	7	10	13	7	41

First Variable is in the Column and Second Variable is in the Row

	1	2	3	4	5	TOTAL
1	2	2	0	0	0	4
	18.18%	10.53%	0.00%	0.00%	0.00%	9.76%
2	1	4	1	1	0	7
	9.09%	21.05%	20.00%	20.00%	0.00%	17.07%
3	2	3	3	1	1	10
	18.18%	15.79%	60.00%	20.00%	100.00%	24.39%
4	5	6	1	1	0	13
	45.45%	31.58%	20.00%	20.00%	0.00%	31.71%
5	1	4	0	2	0	7
	9.09%	21.05%	0.00%	40.00%	0.00%	17.07%
TOTAL	11	19	5	5	1	41

---

*COEF OF VARIABILITY- THE ALTERNATIVE

Model Inputs:
VAR13; VAR14; VAR15; VAR16; VAR17; VAR18
Q8A, Q8B, Q8C, Q8D, Q8E, Q8F

Descriptive Statistics

Summary Statistics

	VAR13	VAR14	VAR15	VAR16	VAR17	VAR18
Observations	41.00000	41.00000	41.00000	41.00000	41.00000	41.00000
Arithmetic Mean	2.65854	2.80488	2.29268	2.70732	2.87805	2.60976
Geometric Mean	2.22720	2.40053	1.87595	2.28182	2.46818	2.16491
Trimmed Mean	2.62162	2.78378	2.21622	2.67568	2.86486	2.56757
SE Arithmetic Mean	0.23061	0.21870	0.22697	0.22427	0.22414	0.23654
Lower CI Mean	2.19731	2.36748	1.83874	2.25878	2.42977	2.13669
Upper CI Mean	3.11976	3.24227	2.74663	3.15586	3.32633	3.08283
Median	2.00000	3.00000	2.00000	3.00000	3.00000	2.00000
Minimum	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Maximum	5.00000	5.00000	5.00000	5.00000	5.00000	5.00000
Range	4.00000	4.00000	4.00000	4.00000	4.00000	4.00000
Stdev (Sample)	1.47665	1.40035	1.45334	1.43603	1.43519	1.51456
Stdev (Population)	1.45853	1.38317	1.43551	1.41841	1.41757	1.49598
Lower CI Stdev	1.25070	1.18607	1.23095	1.21630	1.21558	1.28281
Upper CI Stdev	1.81388	1.72015	1.78524	1.76399	1.76294	1.86045
Variance (Sample)	2.18049	1.96098	2.11220	2.06220	2.05976	2.29390
Variance (Population)	2.12731	1.91315	2.06068	2.01190	2.00952	2.23795
Coef of Variability	0.55544	0.49925	0.63390	0.53043	0.49867	0.58035
First Quartile (Q1)	1.00000	1.00000	1.00000	1.00000	2.00000	1.00000
Third Quartile (Q3)	4.00000	4.00000	4.00000	4.00000	4.00000	4.00000
Inter-Quartile Range	3.00000	3.00000	3.00000	3.00000	2.00000	3.00000
Skewness	0.23655	-0.03618	0.64031	0.06617	0.01082	0.34691
Kurtosis	-1.49146	-1.43290	-1.09854	-1.48999	-1.40231	-1.44587

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* COEF OF VARIABILITY- OTHER LLW

Model Inputs:

VAR7; VAR8; VAR9; VAR10; VAR11; VAR12
Q7A, Q7B, Q7C, Q7D, Q7E, Q7F

Descriptive Statistics

Summary Statistics

	VAR7	VAR8	VAR9	VAR10	VAR11	VAR12
Observations	41.00000	41.00000	41.00000	41.00000	41.00000	41.00000
Arithmetic Mean	1.78049	1.70732	2.56098	2.48780	3.02439	2.53659
Geometric Mean	1.58053	1.52798	2.19398	2.19053	2.68938	2.22788
Trimmed Mean	1.67568	1.59459	2.51351	2.43243	3.02703	2.48649
SE Arithmetic Mean	0.15025	0.14075	0.20967	0.19482	0.20803	0.19785
Lower CI Mean	1.47998	1.42582	2.14163	2.09817	2.60832	2.14089
Upper CI Mean	2.08099	1.98881	2.98032	2.87744	3.44046	2.93228
Median	2.00000	2.00000	2.00000	2.00000	3.00000	2.00000
Minimum	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Maximum	5.00000	5.00000	5.00000	5.00000	5.00000	5.00000
Range	4.00000	4.00000	4.00000	4.00000	4.00000	4.00000
Stdev (Sample)	0.96209	0.90122	1.34255	1.24744	1.33206	1.26684
Stdev (Population)	0.95028	0.89016	1.32608	1.23213	1.31572	1.25129
Lower CI Stdev	0.81487	0.76332	1.13712	1.05656	1.12823	1.07299
Upper CI Stdev	1.18180	1.10703	1.64915	1.53232	1.63627	1.55615
Variance (Sample)	0.92561	0.81220	1.80244	1.55610	1.77439	1.60488
Variance (Population)	0.90303	0.79239	1.75848	1.51814	1.73111	1.56573
Coef of Variability	0.54035	0.52786	0.52423	0.50142	0.44044	0.49943
First Quartile (Q1)	1.00000	1.00000	1.00000	2.00000	2.00000	2.00000
Third Quartile (Q3)	2.00000	2.00000	4.00000	3.00000	4.00000	3.00000
Inter-Quartile Range	1.00000	1.00000	3.00000	1.00000	2.00000	1.00000
Skewness	1.52925	1.70747	0.28702	0.67904	0.02008	0.57302
Kurtosis	2.51479	3.74844	-1.25828	-0.46825	-1.14846	-0.68367

Model Inputs:
VAR1; VAR2; VAR3; VAR4; VAR5; VAR6; VAR7; VAR8; VAR9; VAR10; VAR11; VAR12; VAR13; VAR14;
VAR15; VAR16; VAR17; VAR18; VAR19; VAR20Q1, Q2, Q3, Q4, Q5, Q6, Q7A, Q7B, Q7C, Q7D, Q7E, Q7F, Q8A, Q8B, Q8C, Q8D, Q8E,
Q8F, Q9, Q10

Guttman's Lambda
Internal Consistency and Reliability Test

Covariance 32.06402

Variance of Total	140.82805
Guttman's Lambda	0.91073

Split-Half Approach

Correlation Coefficient	0.34751
Spearman-Brown Correction	0.51578

Odd-Even Split Approach

Correlation Coefficient	0.83646
Spearman-Brown Correction	0.91095

Low correlations and lambda scores means
low reliability and low consistency

APPENDIX C. FACTOR ANALYSIS

	FACT 1	FACT 2	FACT 3	FACT 4	FACT 5	FACT 6	FACT 7	FACT 8	FACT 9	FACT 10
VAR1	0.2217	0.2777	-0.2003	0.2703	0.1966	-0.0912	-0.1179	0.0659	-0.1798	0.0014
VAR2	0.0249	0.2682	-0.1645	-0.025	0.2861	-0.1383	-0.1696	-0.0124	-0.8500*	0.0164
VAR3	0.0581	0.159	-0.0071	0.0926	-0.0143	-0.9313*	-0.0342	0.0879	-0.096	0.2076
VAR4	0.0958	0.0111	0.011	-0.0644	-0.1718	-0.2123	0.039	0.2025	-0.0127	0.9305*
VAR5	-0.1511	-0.0317	0.068	0.0058	-0.9385*	-0.0145	0.051	0.1464	0.1437	0.1781
VAR6	0.1047	0.0718	-0.193	0.0567	0.0681	-0.0307	-0.9557*	0.0535	-0.1071	-0.0341
VAR7	-0.0081	0.9129*	-0.2743	0.0017	-0.0261	-0.0827	-0.0229	0.0163	-0.0927	0.0151
VAR8	0.2638	0.8229*	-0.1291	0.1748	0.0968	-0.0987	-0.1028	-0.092	-0.238	0.03
VAR9	-0.1461	0.2066	-0.9314*	0.1392	0.025	0.0018	-0.0972	0.0628	-0.0192	0.0085
VAR10	-0.0854	0.2464	-0.7872*	0.201	0.0912	-0.0551	-0.2281	-0.0494	-0.2333	-0.0282
VAR11	-0.0607	0.033	-0.1619	0.9614*	-0.0549	-0.0551	-0.0525	0.0127	-0.0225	-0.0313
VAR12	0.0959	0.4583	-0.3661	0.5288	0.1813	-0.0787	0.0011	0.0025	0.1808	-0.1282
VAR13	0.6609	0.0358	0.0317	0.0329	0.0568	-0.1122	-0.1011	0.0926	-0.1499	0.0877
VAR14	0.5963	0.2333	0.0257	0.1136	-0.0621	0.1135	-0.1607	0.0268	-0.1467	-0.0351
VAR15	0.9239*	0.0793	0.0483	-0.121	0.0734	-0.1069	0.0045	-0.2145	-0.0418	-0.0015
VAR16	0.9260*	0.096	0.0653	-0.1539	0.0472	0.0412	-0.1591	0.0299	-0.0329	0.1233
VAR17	0.8306*	-0.0194	0.1387	0.1102	0.0784	0.0422	0.0184	-0.0042	0.1864	0.052
VAR18	0.7795	0.0545	0.0228	0.1226	0.0858	-0.0586	0.0574	0.0142	-0.0945	-0.0793
VAR19	0.3183	0.2612	-0.1252	0.2248	0.1331	-0.304	-0.0099	0.1441	-0.0631	0.0499
VAR20	-0.0827	-0.0401	-0.0214	0.0163	-0.1279	-0.0804	-0.0603	0.9657*	-0.002	0.1495
Sum	4.1163	2.15	1.8926	1.5143	1.1528	1.1126	1.1054	1.1026	1.044	1.0194
Rank	1	2	3	4	5	6	7	8	9	10
Proportion	20.58%	10.75%	9.46%	7.57%	5.76%	5.56%	5.53%	5.51%	5.22%	5.10%

	FACT 1	FACT 2	FACT 3	FACT 4	FACT 5	FACT 6	FACT 7	FACT 8	FACT 9	FACT 10
Cum	20.58%	31.33%	40.79%	48.37%	54.13%	59.69%	65.22%	70.73%	75.95%	81.05%
	FACT 11	FACT 12	FACT 13	FACT 14	FACT 15	FACT 16	FACT 17	FACT 18	FACT 19	FACT 20
VAR1	0.8007	-0.1251	0.046	-0.0502	0.0235	0.0252	-0.0168	0.0068	-0.0036	-0.0015
VAR2	0.1824	-0.0345	0.0872	-0.0554	0.0242	-0.0267	0.0181	0.0165	-0.0068	-0.0012
VAR3	0.0623	-0.1635	-0.0397	-0.0363	0.0097	0.0159	0.0073	0.0031	-0.004	0.0015
VAR4	0.0074	-0.014	0.0441	-0.0243	-0.0059	-0.0209	-0.0082	-0.003	0.0004	-0.0012
VAR5	-0.078	0.0681	0.0077	-0.0477	-0.0131	0.0067	0.0251	-0.0141	0.001	-0.0016
VAR6	0.0759	-0.0202	0.049	-0.0157	-0.0036	-0.0006	-0.0029	0.0083	-0.0037	-0.0008
VAR7	0.1422	-0.1156	0.0809	0.0021	0.0061	-0.0448	-0.0075	-0.0225	0.1774	-0.005
VAR8	0.094	-0.0747	0.0891	-0.0367	0.0136	0.0989	0.0156	0.0561	-0.2708	0.0063
VAR9	0.0866	0.0168	0.0023	-0.0076	-0.0422	0.0358	0.0061	-0.1526	0.02	-0.0006
VAR10	0.0987	-0.1709	-0.0212	0.0284	0.0613	0.0043	0.0157	0.3241	-0.0409	0.0009
VAR11	0.1498	-0.0913	0.0521	0.0087	0.0134	0.0012	-0.0178	0.013	-0.0015	0.0008
VAR12	0.0451	-0.2179	0.019	-0.0887	0.0922	0.4595	0.0205	-0.0089	-0.032	-0.0034
VAR13	0.1572	-0.1181	0.3017	-0.6035	0.0208	0.0139	0.023	0.0035	0.0025	-0.0031
VAR14	0.0366	0.0443	0.6858	-0.1705	0.0762	0.0335	0.004	-0.0249	-0.0061	-0.002
VAR15	-0.0207	-0.0181	-0.0283	-0.009	-0.1591	-0.0305	0.1038	0.0007	-0.0416	0.1346
VAR16	0.0115	-0.1094	-0.0481	-0.1175	-0.0478	0.0103	0.097	-0.0136	0.0169	-0.1359
VAR17	0.1744	-0.0761	0.1029	0.113	0.1052	-0.0017	-0.4025	0.0006	0.0052	0.0001
VAR18	0.1033	-0.1174	0.2579	-0.0192	0.4952	0.066	-0.053	0.0236	-0.007	0.0067
VAR19	0.1208	-0.776	0.0478	-0.0553	0.0483	0.0413	-0.0186	0.0158	-0.0022	-0.003
VAR20	0.0429	-0.0754	-0.02	-0.0329	-0.0135	0.0022	0.0104	-0.0063	0.0052	-0.0018
Sum	0.8451	0.8087	0.678	0.4447	0.3085	0.2347	0.1887	0.1345	0.1102	0.0367
Rank	11	12	13	14	15	16	17	18	19	20
Proportion	4.23%	4.04%	3.39%	2.22%	1.54%	1.17%	0.94%	0.67%	0.55%	0.18%

	FACT 1	FACT 2	FACT 3	FACT 4	FACT 5	FACT 6	FACT 7	FACT 8	FACT 9	FACT 10
Cum	85.28%	89.32%	92.71%	94.93%	96.48%	97.65%	98.59%	99.27%	99.82%	100.00%

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