START

Developing An Empirical Understanding of Improvised Explosive Devices: A Social and Behavioral Science Perspective

Final Report to Human Factors/Behavioral Sciences Division, Science and Technology Directorate, U.S. Department of Homeland Security

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National Consortium for the Study of Terrorism and Responses to Terrorism
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About This Report

This report is part of a series sponsored by the Human Factors/Behavioral Sciences Division in support of the Counter-IED Prevent/Deter program. The goal of this program is to sponsor research that will aid the intelligence and law enforcement communities in identifying potential terrorist threats and support policymakers in developing prevention efforts.

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About START

The National Consortium for the Study of Terrorism and Responses to Terrorism (START) is supported in part by the Science and Technology Directorate of the U.S. Department of Homeland Security through a Center of Excellence program based at the University of Maryland. START uses state-of-the-art theories, methods and data from the social and behavioral sciences to improve understanding of the origins, dynamics and social and psychological impacts of terrorism. For more information, contact START at infostart@start.umd.edu or visit www.start.umd.edu.

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Introduction

Unclassified, open-source data from the Global Terrorism Database (GTD) were used to create quantitative measures detailing the worldwide use of Improvised Explosive Devices (IEDs) by terrorists from 1970 to 2004. We define terrorism as: *The threatened or actual use of illegal force and violence by a non state actor to attain a political, economic, religious, or social goal through fear, coercion, or intimidation.* We define IEDs as: *Bombs that are constructed in part or wholly from military or commercial explosives or commercial components, and used in a manner other than intended by the manufacturer.* In this analysis we focus on describing and understanding some of the social and political characteristics associated with the terrorist use of IEDs. This report includes a brief review of past social science research on IEDs followed by a series of focused observations resulting from data collection and analysis efforts.

Past Social Science Research on IEDs

Improvised Explosive Devices have seldom been the subject of social science inquiry in the past. However, there have been a few recent efforts to examine the extent of IED use, the methods by which they are used, and their effects. Most of this work is not limited to terrorism, but the employment of IEDs by both terrorists and by insurgents in asymmetric warfare settings. Additionally, much of the existing literature is contained in unpublished workshop reports rather than refereed academic publications, and offers qualitative assessment rather than quantitative empirical analysis. Also, earlier reports focus mostly on deployment of IEDs and counter-IED technologies.

In a 2006 report on IEDs, based on a workshop sponsored by the National Science Foundation (NSF), the participants did attempt to put the threat of IEDs into a social science perspective by contemplating the process by which IEDs are used, from the early stages of planning through final detonation of a device (Burgoon and Varadan, 2006). A similar perspective was adopted in a subsequent National Academies of Science report (National Research Council, 2008). A major conclusion of both of these workshops was that future research on "lifecycles" or "threat chains" needs to address structural, cultural, and behavioral choices among groups that use IEDs. Both reports focus on technological results of IED countermeasures and decisions to use IEDs, but pay relatively little attention to the social and behavioral skills underlying their manufacture and use; especially the knowledge, training, and aptitude necessary to construct and use such devices (for a similar argument, see Kennedy, 2009). Finally, each of these workshop reports note that there is a dearth of usable, empirical social science data available to examine the problem from a scientific perspective.

The lack of available, high-quality data is also a common theme in reports from organizations charged with countering and defeating IEDs. For instance, a recent report by the U.S. House of Representatives Committee on Armed Services, Subcommittee on Oversight and Investigations (2008) found that the types of available data about IEDs and IED use were insufficient to test the efficacy of the Joint IED Defeat Organization's (JIEDDO) various counter-IED programs. The same report found that at present little was being done to improve available data.

Another source of information about IEDs are the reports of I the international Small Arms Survey (Wilkinson, Bevan, and Biddle, 2008). Most of the information in these reports offers details about the manufacture and use of IEDs. However, the reports' authors conclude that, "the majority of explosives for use in IEDs are manufactured using commercially available materials, such as compounds derived from nitrate-based agricultural fertilizers or hydrogen peroxides," but they provide no empirical evidence to support this conclusion.

Perhaps the most ambitious recent social science research to examine IEDs is a chapter by Johnson and Braithwaite (forthcoming) in which the authors analyzed 7,409 insurgent and terrorist IED attacks in Iraq using Geographic Information Systems (GIS) analytic methods. The authors find that IED attacks are focused on hardened targets and that attacks followed systematic temporal and spatial patterns. In their detailed analyses the authors find (p. 14) that new IED attacks are spatially linked to earlier attacks. Thus, when an IED attack occurs at a specific location there is an elevated risk of IED attack at locations within 2 kilometers of the initial attack for a period of 14-21 days. This pattern generally conforms to one of spatio-temporal decay; decreasing as a function of time and space. It also appears that previously targeted locations are at an elevated risk between 28-35 days after a previous attack. While this research applies to insurgents in a war zone as opposed to terrorist attacks only, it provides a useful model for future research.

This brief review leads us to three main conclusions. First, there is a general lack of data, and therefore knowledge, that describe IEDs, especially as used by terrorists. Second, IED manufacture and use are in principle similar to other terrorist activities in that they require planning, preparation, and organization to reach completion. Finally, although some research on IED use by insurgents in an asymmetric warfare setting is available, it may not be directly applicable to terrorists or terrorist organizational behavior.

Data and Methodology

We used data from the Global Terrorism Database (GTD) to determine which incidents involved the terrorist use of an IED. Coding of the IED-related variables for this project was conducted between August 2008 and May 2009. We reviewed and classified 66,509 terrorist attacks for IED involvement in 205 countries between 1970 and 2004.[1] Cases were assessed using a standardized coding scheme across all years and incidents. After the coding scheme was finalized, data collected, and validity assessed, a variety of empirical analyses of the data were conducted. These analyses are intended to provide an empirical baseline of IED terrorist attacks from around the world.

In order to create clear, replicable, empirical measurement of IEDs, we have constructed each of the variables in our analysis based on information available in incident-level databases such as the GTD. Definitions of the main variables used in the analysis are described in Table

[1] Approximately 12,000 cases that occurred from 1970-1997 were not coded because weapon details were unavailable. As this information becomes available in the future, we recommend that these cases be added to the current IED data base.

1. After a case was coded as an IED, coders then determined whether the case fit into the following subcategories: suicide, military, and vehicle born IED (VBIED).

Table 1. Coding and definitions of IED Variables

Variable Name	*Definition*	*Examples*	*Code*
IED Definitely	Weapon used in the incident was definitely an IED.	Pipe bombs, explosives using dynamite, and bombs using a person as part of the weapon.	1 = IED 0 = Not
Suicide IED	Incidents where the terrorist intentionally dies or attempts to die while detonating the IED.	Incidents where a "suicide vest" was used, or where a terrorist drove a vehicle into a building and then exploded a bomb This field does not include those incidents where terrorists die while making bombs or carrying bombs to targets. In those cases, we cannot be sure that the intention of bombers was to take their own life.	1 = SIED 0 = Not
Military IED	Materials that were designed for primarily military purposes or that are currently used by military forces in combat. Weapons constructed in part or in whole from military components.	Artillery shells that have been disassembled and reused in another manner, grenades that have been fastened to a vehicle's chassis (including "sticky" bombs), and C4 employed in package bombs. Because of their military nature, grenades and rockets used in an improvised manner are also included here.	1 = MIED 0 = Not
VBIED (car bombs)	IEDs that used vehicles as part of the weapon.	Car bombs, explosives hardwired to the ignition of a vehicle, and bombs attached to motorcycles are some of the weapons that are included in this category. Weapons that were brought onboard vehicles but were not actually part of vehicles were not included in this field. Also excluded are weapons placed on the ground underneath vehicles. We also excluded from this category weapons detonated on mass transit vehicles with no other information to determine whether they were improvised.	1 = VBIED 0 = Not

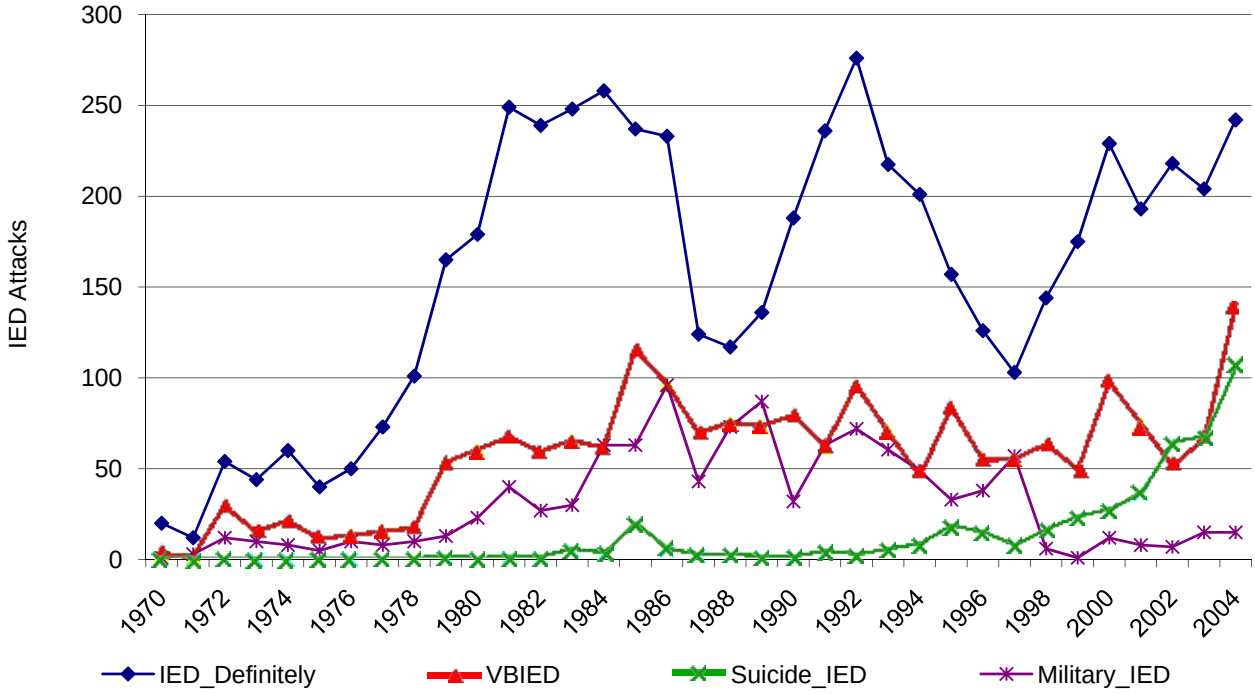
ANALYTIC FINDINGS

1. **The world wide terrorist use of IEDs has increased over time, but follows trends in other terrorist activity.**

General trends in terrorist use of IEDs from 1970 – 2004[2] are shown in Figure 1. While the IED definitely category shows a great deal of variation, it clearly follows general trends in terrorism over this time period (r = .59 for total IEDs and total terrorist attacks). Overall, the IED definitely variable shows a steady increase through the 1970s and early 1980s with an early peak of 258 attacks in 1984. After a decline in the late 1980s, IEDs reach a series peak of 276 in 1992. They then fall off again until reaching a low point of 103 in 1997. Thus, in 1997, total IED attacks were at about the same level as they had been in 1978. Following 1997, IED attacks again increase sharply to the end of the series in 2004 with 242 attacks.

VBIED trends are also clearly correlated with total IED trends (r = .79). In general, VBIEDs increase fairly consistently throughout the series so that the series low point is in 1971 and the series high point is the last year included: 2004. Of the IED variables tracked here, trends for suicide IEDs are perhaps the most dramatic: after hovering close to zero during most of the series, they increase rapidly in 1998 and reach their highest level in 2004.[3]

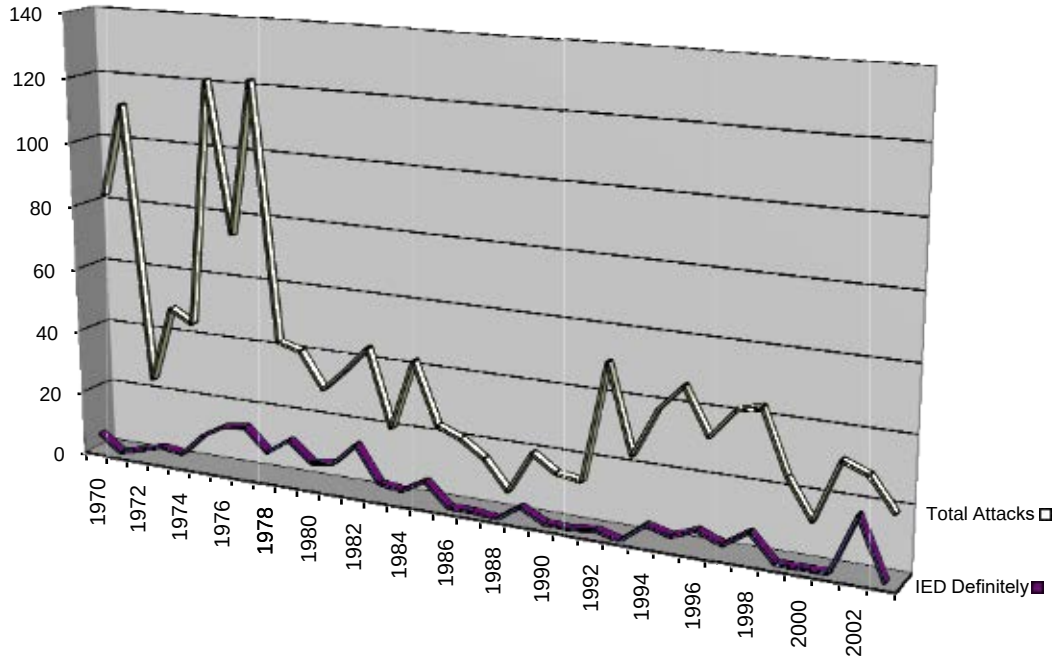
Figure 1. IED Category Counts (1970-2004)



[2] The GTD does not contain complete data for 1993 (see LaFree and Dugan, 2007). Where data for 1993 are included in this report, they were derived by mean imputation using values from 1992 and 1994.
[3] See Appendix C, Table C1.

In Figure 2 we show trends for total terrorist attacks and IED attacks that have taken place in the United States.[4] Terrorist IED attacks in the U.S. are relatively infrequent and stable throughout the series. It is also important to keep in mind that IED use by terrorists inside the borders of the United States is a relatively rare event when compared to all bombings. For example, the FBI's Uniform Crime Report (UCR) Bomb Summary Reports include a total of 26,366 actual or attempted explosions in the U.S. that violated Federal, state, or local laws between 1973 and 1999. These explosions resulted in over $800 million in damage, 6,779 injuries, and 840 deaths (Maguire and Pastore, 2003:337). We can compare these statistics with a total of 168 *terrorist* attacks with IEDs that resulted in 188 fatalities and 541 injuries in the United States for the same period. Beyond terrorism then, it appears that explosives and IEDs are a more general law enforcement problem if we assume that some of the attacks reported to the FBI are indeed IEDs.

Figure 2. Terrorism & Terrorist IED Attacks in the United States 1970 - 2004



Note also that IED attacks against the U.S. exhibit much different longitudinal trends than world-wide IED attacks. According to Figure 2, there has been a steady drop in terrorist attacks in the U.S. throughout the period spanned by the data. This is in contrast to the global use of IEDs, discussed in the last section, that have been increasing during this time period.

[4] Recall that the original data being analyzed here did not include information for 1993. Hence these data do not include the 1993 World Trade Center bombing which resulted in 1,042 injuries (Maguire & Pastore, 2003 p.337).

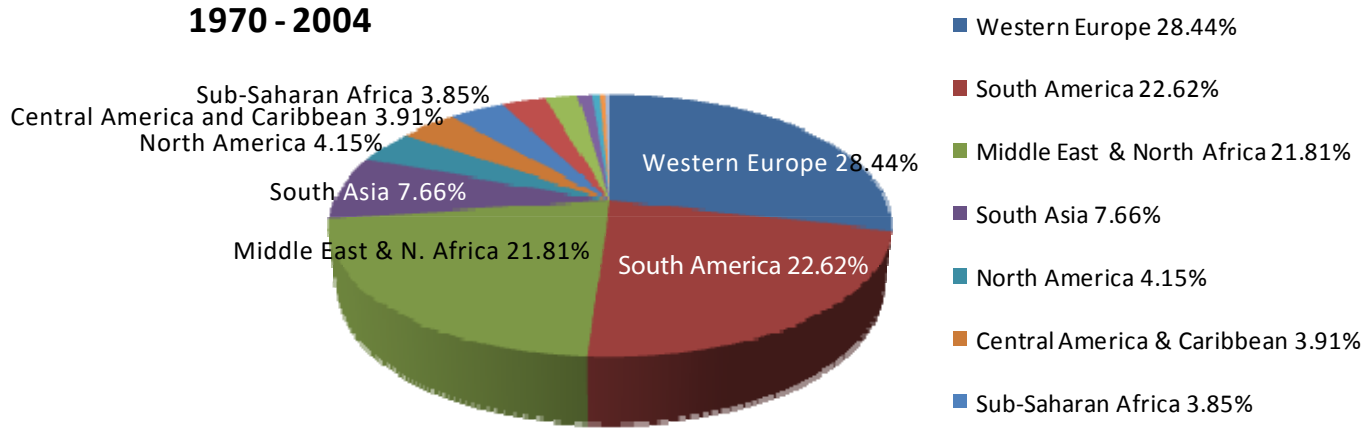
2. **The proportion of terrorist attacks that depend on IEDs has remained relatively steady from 1970 to 2004.**

Figure 3 presents the percentage of terrorist attacks that definitely involved an IED from 1970 to 2004. According to Figure 3, the reliance of terrorists on IEDs as an attack method usually remained below 10% from the start of the series in 1970 until the late 1990s and then increased dramatically, with the series high of 21.69% of terrorist attacks involving IEDs in 2002.

3. **Western Europe, South America, and the Middle East & North Africa have experienced the highest prevalence of Terrorist IED attacks over the time period spanned by the data.**

In Figure 4 we show the distribution of IED attacks in 13 major world regions. Western Europe, South America, and the Middle East and North Africa dominate the list and comprise 73% of all definite IED attacks from 1970 – 2004. Fifty-five percent of all terrorism during this time period occurred in these same three regions. Thus, while they are frequent targets of terrorism, they are an even more common target of terrorists using IEDs. A table listing exact numbers and proportion of attacks is presented in Appendix A, Table A3.

Figure 4. IED Terrorism by Region 1970 - 2004



4. **The use of IEDs as a terrorist weapon is unrelated to overall death rates caused by terrorist attacks, and the lethality of IED attacks by terrorists varied dramatically across countries.**

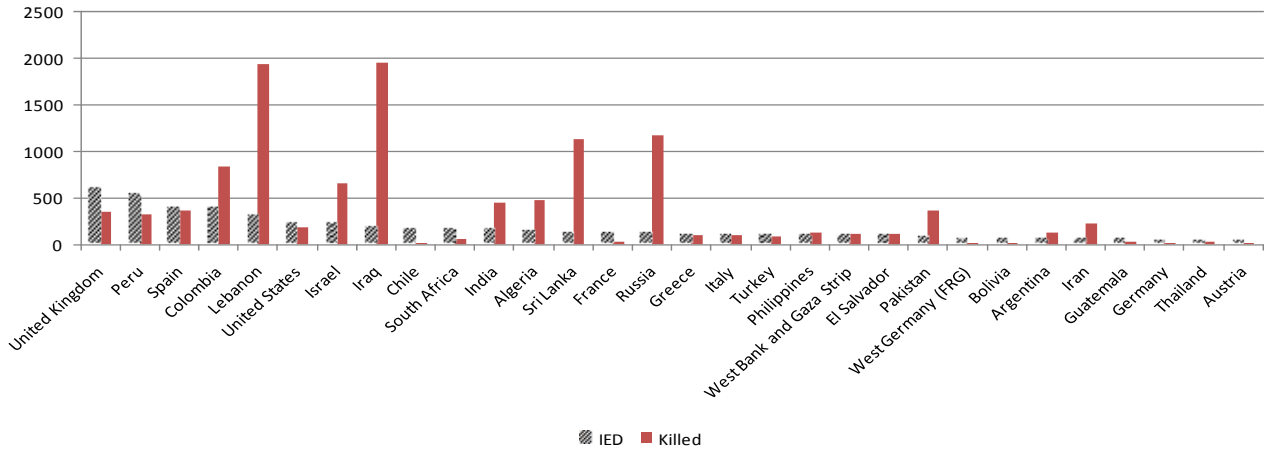
Figure 5 details the 30 countries (with the West Bank and Gaza Strip treated here as a country) that most frequently experienced IED terrorism from 1970 to 2004. The country that experienced the highest level of IED attacks (591) is the United Kingdom (including Northern Ireland). The United States ranks sixth among nations in terms of total attacks 15th among nations in terms of total IED-related fatalities.

There is not a strong relationship between the number of IED attacks and the number of fatalities connected to these attacks (the correlation between the number of IED attacks and the number of deaths due to these attacks is only .303, indicating a positive but weak

relationship). In a supplementary analysis, we found that IED attacks and deaths resulting from these attacks for the top 30 countries shared only 9% of their variation ($R^2 = .09$).[5] For example, the UK, Peru, and Spain lead the world in total IED attacks, but Lebanon, Iraq, Russia and Sri Lanka lead the world in IED-related fatalities.

The weak relationship between IED attacks and fatalities could be a result of varying uses of IEDs. For instance, if a group intends to kill a large number of victims we expect that the relationship would be stronger than a group that uses an IED to send a public message without intending to kill or injure large numbers of victims. Furthermore, the weak relationship could be a result of differing strategies of groups over time, in different geographic areas, or the culture and goals of the group itself. This would imply systematic differences in the intended result of attacks based on time or place. Groups in the past often designed attacks that actively avoided killing victims. Conversely, terrorists in more recent years have been more likely to execute attacks expressly designed to kill or wound large numbers of victims (LaFree and Dugan, in press).

Figure 5. Top 30 Countries: Terrorist IED Attacks & Fatalities due to Terrorist IED Attacks



The weakness of the relationship between IED attacks and fatalities may also be due to variations in each country's ability to prevent attacks of this kind or mitigate the effects of attacks through effective emergency response and access to high quality medical care. For example, compared to other countries, the security apparatus in highly industrialized countries like the US or UK may be better able to mitigate the effects of IEDs through a number of pathways such as target hardening, limiting access to bomb making materials, or simply preventing attacks through law enforcement or intelligence efforts. Countries that are experiencing something akin to open warfare would almost certainly fail in preventing fatal attacks more often than less conflict-ridden nations.

Table 3 reveals that fatalities and injuries in all terrorist attacks are unrelated or very weakly related to the IED cases. These analyses allow us to draw several preliminary conclusions. First, IEDs are not necessarily instrumental for terrorist attacks resulting in death and injury.

[5] R^2 represents the square of the correlation coefficient (r) and can be interpreted as the proportion of variation shared between two variables. For those familiar with regression models, this would be the same as the model R^2 calculated in a bivariate regression equation, however, unlike in regression, we do not imply causal order.

Therefore, IEDs are not always the weapon of choice when the aim of the group is to injure or kill large numbers of people. Second, the eventual use of an IED does not always yield high numbers of casualties as evidenced by the weak relationships shown in Table 3 as well as the variation in these relationships among the top 30 countries to be victimized by terrorist attacks. These results are consistent with the theory that situational differences may play a major role in determining the lethality of IEDs. These could include considerations such as the intention of the terrorist or terrorists who employ these devices, the ability of terrorists to construct powerful devices, the ability to respond quickly to attacks with high quality medical care, and the ability of law enforcement, counterterrorism organizations, and the intelligence community to detect or deter attacks. In short, while IEDs are clearly powerful and dangerous devices, death and injury as a result of an IED attack is not a foregone conclusion.

Table 3. Correlations Between Worldwide IED use and Death & Injury
(1970 – 2004)

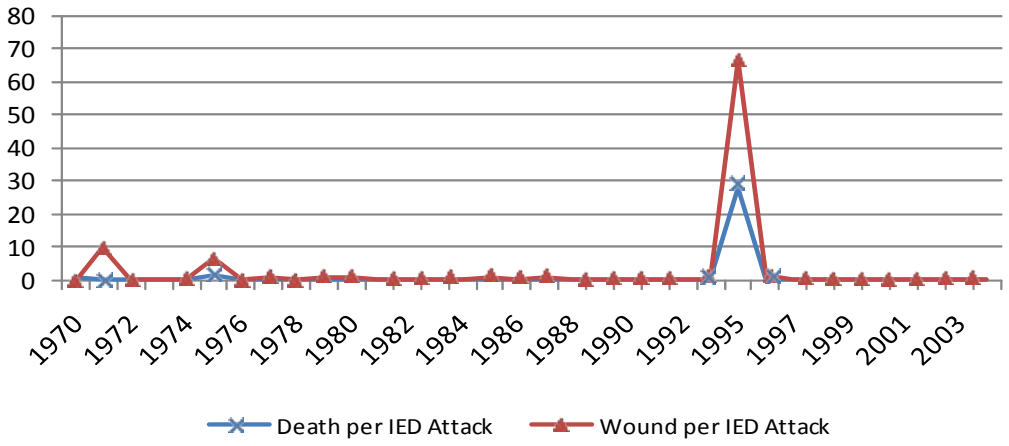
	IED Attack	IED Fatalities	IED Injuries	All Fatalities
IED Attack	-			
IED Fatality	**.221**	-		
IED Injury	**.136**	**.566**	-	
All Fatalities	.000	**.226**	**.125**	-
All Injuries	**.038**	**.208**	**.371**	**.109**

Statistically significant correlations in bold ($p < .05$, two-tailed tests)

5. **The use of IEDs by terrorists in the United States makes up a very small proportion of worldwide terrorist attacks, and this proportion has decreased over the period of this study. Because there are few IED attacks in the U.S. by terrorists, interpretations of the characteristics of these attacks can be strongly affected by a few large-scale incidents.**

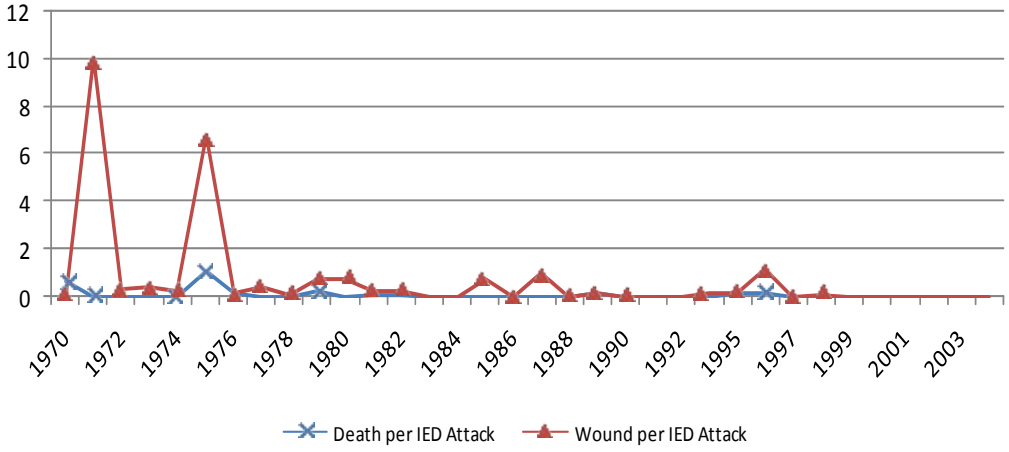
From 1970 through 2004 there have been 189 terrorist IED attacks in the United States. This represents 5.15% of all attacks worldwide over the same time period. Figure 6 presents the total fatalities and injuries per IED attack for the United States. Figure 7 shows large numbers of injuries and deaths concentrated in 1995, associated with the attack on the Alfred P. Murrah Federal Building in Oklahoma City, with much smaller peaks in 1971 and 1975. However, because there are relatively few IED attacks in the United States, the trends shown in Figure 6 are very sensitive to a small number of especially lethal attacks. To illustrate, in Figure 7 we present the same analysis, but exclude the Oklahoma City bombing which produced 160 fatalities and 400 injuries.

Figure 6. Fatalities and Injury Rates Caused by Terrorist IED Attacks in the United States (1970 - 2004)



Removing a prominent attack such as the Oklahoma City bombing in a relatively sparse series such as this has a major impact on the resulting distribution. Without the Oklahoma City case, the peaks in 1971 and 1975 become much more prominent and smaller peaks can now be observed in the late 1980s and mid-1990s. When considered as part of a data series, outliers such as this can strongly influence conclusions about the overall danger of IEDs. In this case, using a non-resistant statistic can lead to very different conclusions about fatalities and injuries from IEDs in the United States. The average rate of fatalities from terrorist IED attacks, including the Oklahoma City bombing, is 0.85 deaths per attack. When this one influential attack is excluded, the rate drops to only 0.13, a difference of 0.72 deaths per IED attack. This example underscores how important it is to to consider major outliers before drawing any conclusions from these types of analyses.

Figure 7. Fatality and Injury Rates Caused by Terrorist IED Attacks in the United States Excluding Oklahoma City (1970 - 2004)



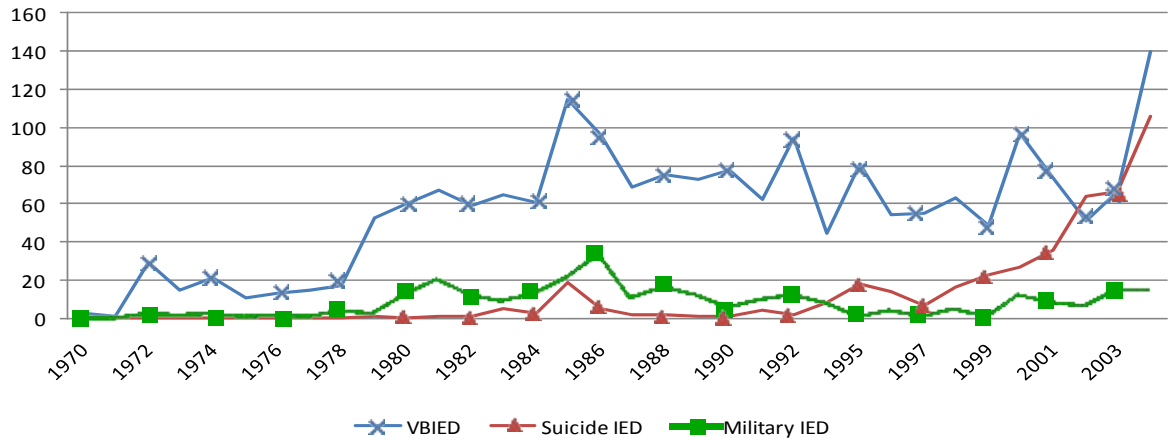
6. **The use of suicide IEDs globally has grown exponentially over the period studied, and the specialized use of VBIEDs and suicide IEDs results in a much higher rate of fatality per attack than the use of other types of IEDs.**

According to Figure 8, VBIEDs have been the most common of the three specific types of terrorist IEDs throughout the series with the exception of two years: in 2001 and 2002 suicide IEDs overtook VBIEDs in total frequency. VBIEDs steadily increased from 1970 until reaching a peak in 1985. In that year, the countries with the most VBIED attacks were the United Kingdom with 286 and Lebanon with 232. After 1985, VBIEDs declined somewhat and then increased sharply, reaching a series high of 140 in 2004.

Suicide IEDs show a much different trajectory. They remain close to zero until the late 1990s when they increase rapidly. From 1970 – 2004, 22 percent of suicide IEDs occurred in Israel and another 19 percent in Iraq. When examining specific countries we noted that there have been no recorded suicide IED attacks inside the borders of the United States during this series.

IEDs known to be fashioned from military ordinance were relatively uncommon throughout the series. They reached a series peak in 1986. Most of the military IEDs were recorded in Sri Lanka (187) and South Africa (146). We found relatively few military IEDs reported for Iraq and Afghanistan at the end of the series. This is a likely consequence of the fact that the Global Terrorism Database excludes most attacks on military targets in an active war situation and the fact that our series includes only the beginning year of the war in Iraq.

Figure 8. Frequency of Terrorist IED Types (1970 - 2004)

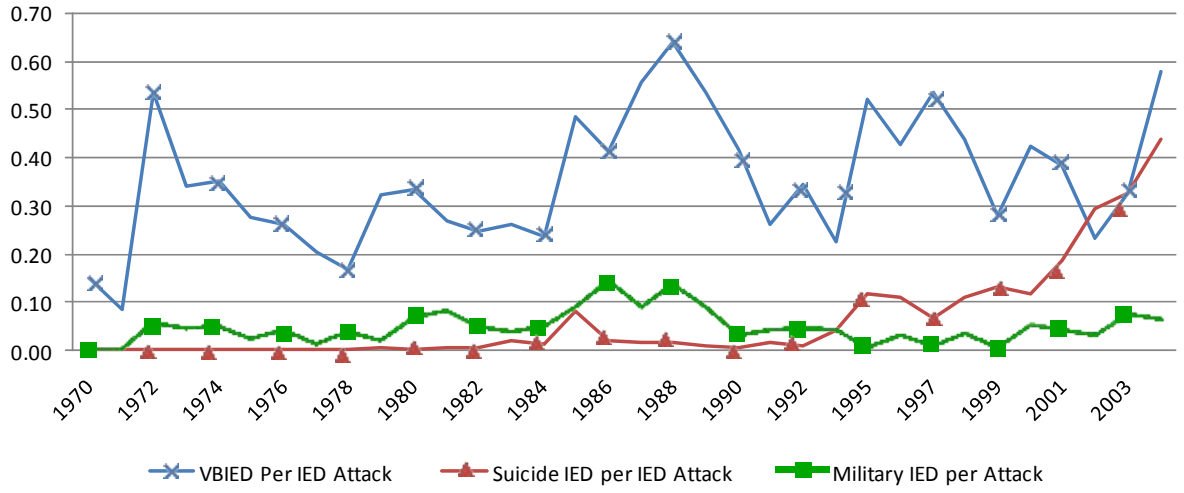


In Figure 9, we examine the rates of VBIEDs, suicide IEDs,[6] and military IEDs per IED attack.[7]

[6] These figures include the death of the suicide attacker in each case.
[7] It is important to note here that these categories are not mutually exclusive. In other words, one attack may be coded as both a VBIED and a suicide IED if the suicide bomber used a car bomb to attack a target. If the bomb was constructed in part from military components it would be included in all three categories. However, these overlapping categorizations were

When observing these special types of IEDs as a function of all IED attacks we note that VBIEDs have been a popular choice of weapon among terrorists for the last four decades with pronounced peaks in the early 1970s, late 1980s, and late 1990s. Military IEDs were used most frequently in the late 1980s, but represent a fairly stable proportion of all IEDs over the period spanned by the data. The trend for suicide IED rates is very similar to the trend for its frequency: suicide IED use increased much more rapidly than other types of IEDs near the end of the series.

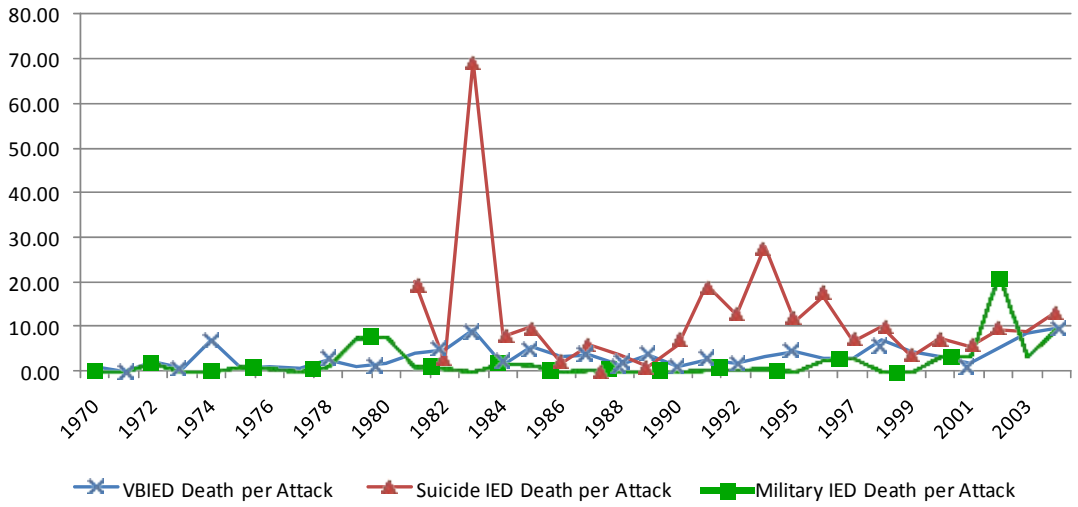
Figure 9. Rate of Terrorist IED Attack Types (1970 - 2004)



In Figure 10, we investigate fatality rates for each of these three specific types of IEDs. With the exception of only a few years, suicide IEDs caused the most fatalities per attack. Of course these comparisons could only be drawn after 1981, when we recorded the first examples of suicide IED attacks in the database. While VBIEDs and military IEDs had higher rates of fatalities per attack than IEDs in general, they had lower fatality rates than suicide IEDs. These findings provide some support for Pape's (2005) conclusion that terrorists use suicide IEDs for the simple reason that they are effective.

relatively rare. Thus, we had only 3 cases that were coded in all three categories. Of the cases that were coded in 2 categories, 12 cases were coded as both suicide and military IEDs, 173 were coded as suicide and VBIED, and 30 were coded as military and VBIED.

Figure 10. Rate of Deaths per Attack by Type (1970 - 2004)



To summarize, it appears that more specialized uses of IEDs (i.e., VBIEDs and suicide IEDs) have been successful at increasing fatalities and injuries. More powerful, refined IEDs that depend on an individual human as their guided delivery system are much more likely to kill than other types of IEDs. Increased specialization among terrorist groups to create these types of IEDs may also indicate intentions to do greater harm.

CONCLUSIONS AND RECOMMENDATIONS

This project built on existing quantitative social science data to develop a database of IED use by terrorists. These data have been utilized to develop baseline analyses of the characteristics of IED use, the locations where IEDs have been employed, and human consequences of IED attacks. Our research has not directly addressed any of the technical variables regarding the physical construction or detection of IEDs. Instead, in this analysis we have focused only on describing and understanding the social and political characteristics associated with the use of IEDs. By applying descriptive analytical methods to address basic research questions regarding IEDs a number of conclusions can be drawn.

- The use of IEDs by terrorists has increased over time, but generally follows trends in terrorist activity.

- As in all terrorism, Western Europe, South America, and the Middle East & North Africa have experienced the highest prevalence of IED attacks over this time period.

- IEDs do not appear to be instrumental. That is, the use of IEDs may not necessarily cause or result in increased fatalities or injuries. At a country level, the ratio of deaths to IEDs is highly variable. In some countries IEDs kill many people, and in some countries they do not. This is likely due to a combination of group intent, states' response capacity, and counterterrorism efforts.

- Globally, the use of IEDs is not a good predictor of death or injury from a terrorist attack; that is, the use of IEDs is unrelated to overall death rates caused by terrorist attacks.

- The use of IEDs by terrorists in the United States makes up a very small proportion of all terrorist attacks and appears to drop over the period of this study. Because there are few IED attacks in the United States by terrorists, interpretations of the characteristics of these attacks can be strongly affected by a few large-scale incidents.

- The use of suicide IEDs has grown exponentially over the period studied and the specialized use of VBIEDs and suicide IEDs results in a much higher rate of deaths per attack than the use of IEDs in general.

FUTURE RESEARCH DIRECTIONS

In this report we have used the GTD to develop a global time series database of attacks that allow us develop quantitative estimates of longitudinal trends and spatial diffusion of IEDs. We have also begun to disaggregate the data to better understand IED use by region, country, group, ideology, and resource availability. Future research should examine connections between IED use by terrorists and the role of social networks, learning, and a groups' intent or goals. Now that the initial data have been developed and weaknesses identified (such as the very large undetermined category of "IED maybe") efforts to improve the data should naturally follow. As we argue above, we feel that any useful analysis in this area must start with a consistent definition of IEDs. We argue that IEDs are not just explosive attacks perpetrated by terrorists. They may follow similar trends to explosive attacks, but they differ in a number of important substantive ways. Understanding these differences should be a major focus of future IED study.

Theoretical Evaluation

Future analyses should focus on explaining potential causes of IED terrorism by assessing theoretical explanations of IED use such as diffusion theory and social learning theory. Such analyses could be facilitated by employing social science quantitative methods, including network analysis, time series analysis, hazard modeling and exploratory spatial data analysis. By using statistical methods such as these and focusing on how and why IEDs are used by terrorists, researchers could provide important information on the necessary antecedents to IED construction and use. These efforts should move beyond relatively simple concepts such as obtaining materials and focus heavily on motivation and the development of knowledge and skills necessary to construct IEDs.

Understanding the effect of group or individual intent on the outcomes of terrorist IED attacks is extremely important. Based on these data it appears that compared to other types of terrorist attack, IED-based attacks do not necessarily result in more injuries or fatalities. However, specialized use of IEDs, including VBIEDs and suicide IEDs are clearly more effective in terms of producing death and injury. Understanding the differences between the device, the group, and the intent to do harm will be of vital importance in understanding the

dynamic of IED use. The concept of a weapons' instrumentality is very important in the development of weapon violence prevention among criminologists, and these types of theories and techniques should be used to develop a clearer understanding of the relationship between IEDs and physical harm.

Examining and evaluating the spatial-temporal relationships of terrorist IED campaigns may yield important information in the development of counter-IED policy. If these distributions are observable and supported by sufficiently detailed geo-spatial data, research should work toward specifying patterns and relationships to support, supplement, and inform intelligence and law enforcement efforts.

Data Improvement

It is important to reiterate that the proportion of these cases that are definitely not IEDs is unknown. It will be useful to do further analysis to try and determine how many of these cases can be unambiguously added to either the "not IED" or the "definitely IED" categories. However, based on our analysis for this report, greatly reducing the number of ambiguous cases will be labor intensive, requiring at least three steps:

1) Manually examining each case that is currently labeled IED maybe;
2) Identifying and reviewing original source documentation for each case;
3) And in cases where GTD information is not detailed enough to make a determination, seeking additional open source information to allow a final determination to be made.

In general, our past work with the GTD suggests that it is much more difficult to retrieve information the farther back in time the analysis goes. Both print and electronic media information decay over time. Nevertheless, because over 21,000 cases in these data are currently undetermined, but possibly IEDs, the threat of systematic bias exerting undesirable effects on the conclusions drawn from these data is a very real danger. In short, collecting additional data to reduce the indeterminate category would be a time consuming, but perhaps worthwhile exercise to increase our ability to draw valid inferences from these data. We believe that efforts to improve these data should not be abandoned now that some baseline data are available. If resources are limited, it would be most cost effective to concentrate on improving data collection for the most recent years. Subsequent data collection efforts should address three goals:

1) *Improve the current data*
    a. Use existing source documentation to:
        i. Eliminate or reduce the IED maybe category
        ii. Code IED specialty categories
    b. When necessary, obtain additional open source data
        i. Eliminate or reduce the IED maybe category

ii. Code IED specialty categories

2) *Complete coding the GTD2*
   a. Since we began this report, the GTD2 (2005 – 2007) data have become available. These data should be coded to the same standards as earlier data to extend the series closer to real time and to allow us to determine whether our earlier conclusions still hold.
3) *Continue collecting IED data in the future: as indicated we have revised the GTD to include IED data in future data collection.*

Additional data collection efforts will obviously improve our ability to provide strong conclusions. It is also extremely important that data be collected using the same coding instructions and definitions so that they may be compared to data that are already available.

ARE IEDs DIFFERENT FROM OTHER TERRORIST ATTACKS?

Much of the recent concern about IEDs is based on the assumption that IEDs are somehow different than other types of terrorist attacks in general and other types of explosive attacks in particular.[8] Determining whether there is empirical support for this assumption will be of key importance in future IED studies because it will be these differences that inform policy and predict behavior. An essential question then is "How are IEDs different from other bombings?" We can already provide a partial answer to this question: IEDs require different skill sets to construct and use. These skill sets will vary based on the complexity of the device and its components. Whether individual, didactic training coupled with practical training is necessary is an important question. In any case, constructing a bomb certainly requires more knowledge and training than simply pulling a pin on a grenade and throwing it into a crowded café.

Future research should provide a better understanding of the level of training needed for the construction and implementation of IEDs of varying levels of complexity. We assume that the distinction between self training by reading a book or visiting a webpage is considerably different than attending formal training at a terrorist training camp or compound. And because the latter often requires international travel and additional exposure, it is also more easily tracked by law enforcement or intelligence agencies. Determining whether the use of IEDs spreads through simple diffusion, technological expediency in weapon choices, or social learning through formal or informal networks, is one of the most important issues in interrupting the successful employment of IEDs.

In sum, we can say that IEDs have the potential to do much greater harm than other types of terrorist attacks. IEDs make up a very large proportion of terrorist attacks, and some types of IED attacks are far more deadly than others. The use of IEDs is a major tactic among terrorists with varying goals and strategies.

[8] For concise appraisal of the hazards of not carefully defining the concept of IED *see* Bale, 2007.

REFERENCES

Ackerman, Gary (2003). Beyond Arson? A threat assessment of the Earth Liberation Front. *Terrorism and Political Violence* 15(4):143-170.

Bale, Jeffrey M. (2007). Some Preliminary Observations on Jihadist Operations in Europe. In *Workshop on Determining a Research Agenda for Disrupting IED Terror Campaigns: Finding the Weak Links*. Irvine, CA.

Bureau of Alcohol, Tobacco, Firearms and Explosives (2009). United States Bomb Data Center: 2007 USBDC Explosives Statistics. Retrieved online 15 January, 2009 from http://www.atf.gov/aexis2/bombingrpts/bombings2004-2006-rev.pdf

Burgoon, Judee and Vasundara V. Varadan (2006). *Workshop Report on Detecting and Countering IEDs and Related Threats*. National Science Foundation Workshop Report.

Johnson, Neil F., Juan Camilo Bohórquez, Zhenyuan Zhao, and Mike Spagat (2007). *Common Complexity Underlying Insurgent Wars and Terrorism: A Contribution to the Workshop on Disrupting IED Terror Campaigns*.

Johnson, Shane and Alex Braithwaite (Unpublished Manuscript). *Spatio-Temporal Modeling of Insurgency in Iraq*, University College, London.

Kennedy, Michael (2008) Mētis, Techne and IEDs. In *Human and Social Forces in the Spread of the IED Threat: Innovation, Diffusion and Adaptation*. A workshop report of the National Consortium for the Study of Terrorism and Responses to Terrorism.

LaFree, Gary and Laura Dugan (2007). "Introducing the Global Terrorism Database," *Political Violence and Terrorism* 19:181-204.

LaFree, Gary, Sue-Ming Yang, and Martha Crenshaw (In Press) Trajectories of terrorism: Attack patterns of foreign groups that have targeted the United States, 1970 to 2004. *Criminology & Public Policy*.

Maguire, Kathleen and Ann L. Pastore, eds. (2003). *Sourcebook of Criminal Justice Statistics*. U.S. Department of Justice, Bureau of Justice Statistics. Washington DC:USGPO.

National Research Council of the National Academies (2008). *Disrupting Improvised Explosive Device Terror Campaigns: Basic Research Opportunities*. National Academies Press: Washington DC.

Pape, Robert A. (2005). *Dying to Win: The Strategic Logic of Suicide Terrorism*. New York: Random House.

Rapoport, David C. (2001). The four waves of modern terrorism. In Audrey Kurth Cronin and James M. Ludes (eds.), *Attacking Terrorism*. Washington, DC: Georgetown University Press.

U.S. House of Representatives • Committee on Armed Services Subcommittee on Oversight & Investigations (2008). *The Joint Improvised Explosive Device Defeat Organization: DOD'S Fight against IEDs Today and Tomorrow*. Committee Print 110-11.

Wells, W. & Horney, J. (2002). Weapon Effects and Individual Intent to Do Harm: Influences on the Escalation of Violence. *Criminology*, 40, 265-95.

Wilkinson, Adrian, James Bevan and Ian Biddle (2008). Improvised Explosive Devices (IEDs): An Introduction. In James Bevan (ed.) *Conventional Ammunition in Surplus: A Reference Guide*. (pp. 136-144) Small Arms Survey: Geneva.

Zimring, F. (1968). Is gun control likely to reduce violent killings? *The University of Chicago Law Review*, 35, 721-735.

APPENDIX C: Additional Tables Mentioned in the Text

Table C1. IED Category Counts [a]
(1970 – 2004)

	IED			
Year	Total	VBIED	Suicide IED	Military IED
1970	20	3	0	1
1971	12	1	0	3
1972	54	29	0	12
1973	44	15	0	10
1974	60	21	0	8
1975	40	11	0	5
1976	50	13	0	10
1977	73	15	0	8
1978	101	17	0	10
1979	165	53	1	13
1980	179	60	0	23
1981	249	67	1	40
1982	239	59	1	27
1983	248	65	5	30
1984	258	61	3	63
1985	237	115	19	63
1986	233	96	5	96
1987	124	69	2	43
1988	117	75	2	73
1989	136	73	1	87
1990	188	79	1	32
1991	236	62	4	63
1992	276	95	2	72
1993	218	70	5	61
1994	201	45	8	49
1995	157	83	18	33
1996	126	54	14	38
1997	103	55	7	57
1998	144	63	16	6
1999	175	49	23	1
2000	229	97	27	12
2001	193	74	36	8
2002	218	51	64	7
2003	204	66	67	15
2004	242	140	106	15

[a] Includes all IEDs for all years in all countries in the GTD.

Table C2. Percent of Terrorist attacks using IEDs
(1970 – 2004)

Year	IED	IED
1970	6.99 %	15.75 %
1971	3.41	6.86
1972	11.46	29.51
1973	8.92	27.33
1974	11.05	22.73
1975	5.49	11.17
1976	5.55	12.72
1977	5.49	12.15
1978	6.55	15.86
1979	5.97	16.50
1980	6.43	18.96
1981	9.19	24.06
1982	9.43	22.68
1983	8.58	21.45
1984	7.33	18.00
1985	8.03	21.18
1986	8.00	21.11
1987	3.86	12.05
1988	3.13	8.20
1989	3.13	8.49
1990	4.79	13.06
1991	4.96	14.64
1992	5.24	17.44
1993	4.92	17.37
1994	5.45	18.84
1995	3.95	21.02
1996	3.64	12.41
1997	2.92	10.52
1998	15.75	29.39
1999	12.45	27.52
2000	16.50	31.98
2001	13.61	31.13
2002	21.69	37.65
2003	16.44	30.13
2004	21.53	36.39

Table C3. IED Attacks by World Region and Percent Distribution [a]

Region	IED	%
Western Europe	1,514	28.44
South America	1,204	22.62
Middle East & North Africa	1,161	21.81
South Asia	408	7.66
North America	221	4.15
Central America & Caribbean	208	3.91
Sub-Saharan Africa	205	3.85
Southeast Asia	162	3.04
USSR & the Newly Independent States (NIS)	122	2.29
East Asia	51	0.96
Eastern Europe	30	0.56
Central Asia	20	0.38
Australasia & Oceania	17	0.32

[a] Regions are rank ordered by number of attacks

Table C4. Terrorist and IED Attacks with Resulting Fatalities, Injuries, and Rates

	Total Terrorist			IED		
Country	Incidents[a]	Fatalities per Attack	Injuries per Attack	Attack	Fatalities per Attack	Injuries per Attack
United Kingdom	494	0.72	591	591	0.60	2.36
Peru	624	0.52	518	518	0.63	1.50
Spain	296	1.21	385	385	0.93	6.82
Colombia	280	3.01	383	383	2.20	5.62
Lebanon	299	6.48	311	311	6.23	16.70
United States	189	0.99	220	220	0.85	2.46
Israel	111	5.97	216	216	3.07	16.56
Iraq	17	114.56	168	168	11.59	29.17
Chile	174	0.10	156	156	0.11	1.29
South Africa	148	0.42	156	156	0.40	4.72
India	59	7.68	153	153	2.96	10.69
Algeria	85	5.60	142	142	3.35	17.79
Sri Lanka	60	18.73	113	113	9.95	30.98
France	87	0.36	111	111	0.28	3.26
Russia	11	106.73	109	109	10.77	26.19
Greece	76	1.30	104	104	0.95	1.57
Italy	82	1.18	104	104	0.93	2.98
Turkey	54	1.57	97	97	0.88	3.31
Philippines	54	2.24	91	91	1.33	6.34
West Bank & Gaza Strip[c]	33	3.58	91	91	1.30	2.92
El Salvador	91	1.19	87	87	1.24	1.43
Pakistan	35	10.57	77	77	4.81	15.34
West Germany (FRG)	50	0.26	50	50	0.26	3.36
Bolivia	47	0.13	47	47	0.13	1.04
Argentina	44	2.73	45	45	2.67	11.04
Iran	43	5.33	45	45	5.09	31.96
Guatemala	46	0.57	43	43	0.60	2.51
Germany	36	0.08	36	36	0.08	2.39
Thailand	16	1.44	31	31	0.74	7.39
Austria	29	0.21	30	30	0.20	0.63

[a] Includes the number of terrorist incidents. Incidents may contain multiple attacks as in the Madrid Train Bombings or September 11 Attacks. Multiple IEDs may be used in a set of related attacks that represent one incident, or an IED may be used in only 1 attack as part of a series of closely related attacks or incidents.
[c] Although not governed separately throughout the entire series, these areas are considered a country throughout the series for purposes of comparison.

Table C5. Fatality and Injury Rates resulting from IEDs and all Terrorist Attacks [a]
(1970 – 2004)

	Per IED Attack		Per Terrorist Attack	
Year	Fatalities	Injuries	Fatalities	Injuries
1970	2.650	0.000	0.579	0.243
1971	0.083	1.083	0.509	0.137
1972	2.944	0.574	1.289	0.449
1973	0.727	1.295	0.745	1.119
1974	2.667	1.417	1.034	1.462
1975	0.800	2.275	0.845	0.868
1976	0.760	6.180	0.776	0.872
1977	0.164	0.548	0.350	0.388
1978	0.584	3.188	0.958	1.102
1979	0.703	2.588	0.797	1.118
1980	1.676	5.196	1.969	1.460
1981	1.201	4.948	2.168	1.307
1982	1.858	7.548	2.199	1.414
1983	2.867	4.766	3.829	5.304
1984	0.841	2.578	3.207	1.690
1985	3.097	8.629	3.019	2.292
1986	1.627	7.575	1.947	2.602
1987	2.282	5.073	2.498	2.219
1988	1.000	3.393	2.097	1.990
1989	2.199	5.625	2.059	1.430
1990	0.749	3.492	2.049	1.768
1991	1.301	4.470	2.103	1.844
1992	1.047	4.313	2.026	2.100
1994	1.615	6.045	2.500	2.489
1995	2.916	13.006	2.221	5.444
1996	3.524	23.460	2.244	4.141
1997	1.883	10.961	3.498	3.107
1998	4.750	38.372	5.196	8.803
1999	2.386	8.186	2.397	3.589
2000	2.170	6.454	2.385	3.460
2001	1.762	8.482	4.468	3.512
2002	4.092	12.670	3.131	5.803
2003	4.803	16.305	2.577	5.031
2004	9.820	29.269	5.049	11.174

[a] All rates calculated per 100 attacks for all countries in GTD.

Table C6. Frequency and Percent Distribution of Suicide IEDs [a]
(1970 – 2004)

Country	IED Definitely	Suicide IED	Percent of all Suicide IEDs [b]
Israel	216	94	21.76 %
Iraq	168	82	18.98
Sri Lanka	113	57	13.19
West Bank & Gaza Strip	91	49	11.34
Lebanon	311	37	8.56
Russia	109	24	5.56
Turkey	97	19	4.40
Pakistan	77	13	3.01
India	153	8	1.85
Saudi Arabia	15	6	1.39
Uzbekistan	11	6	1.39
Morocco	7	5	1.16
Philippines	91	4	0.93
Indonesia	26	4	0.93
Algeria	142	3	0.69
Afghanistan	25	3	0.69
China	13	3	0.69
Great Britain	591	2	0.46
Peru	518	2	0.46
Argentina	45	2	0.46
Iran	45	1	0.23
Italy	104	1	0.23
Kuwait	9	1	0.23
Yemen	6	1	0.23
Kenya	5	1	0.23
Namibia	6	1	0.23
Bangladesh	26	1	0.23
Croatia	1	1	0.23
Finland	2	1	0.23

[a] These data represent all countries that have been coded for suicide IEDs.
[b] Frequency may not sum to 100 due to rounding