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The Use of Explosive Devices in Attacks on Public Surface Transportation: Trends in Frequency, Lethality, and Prevention

Brian Michael Jenkins
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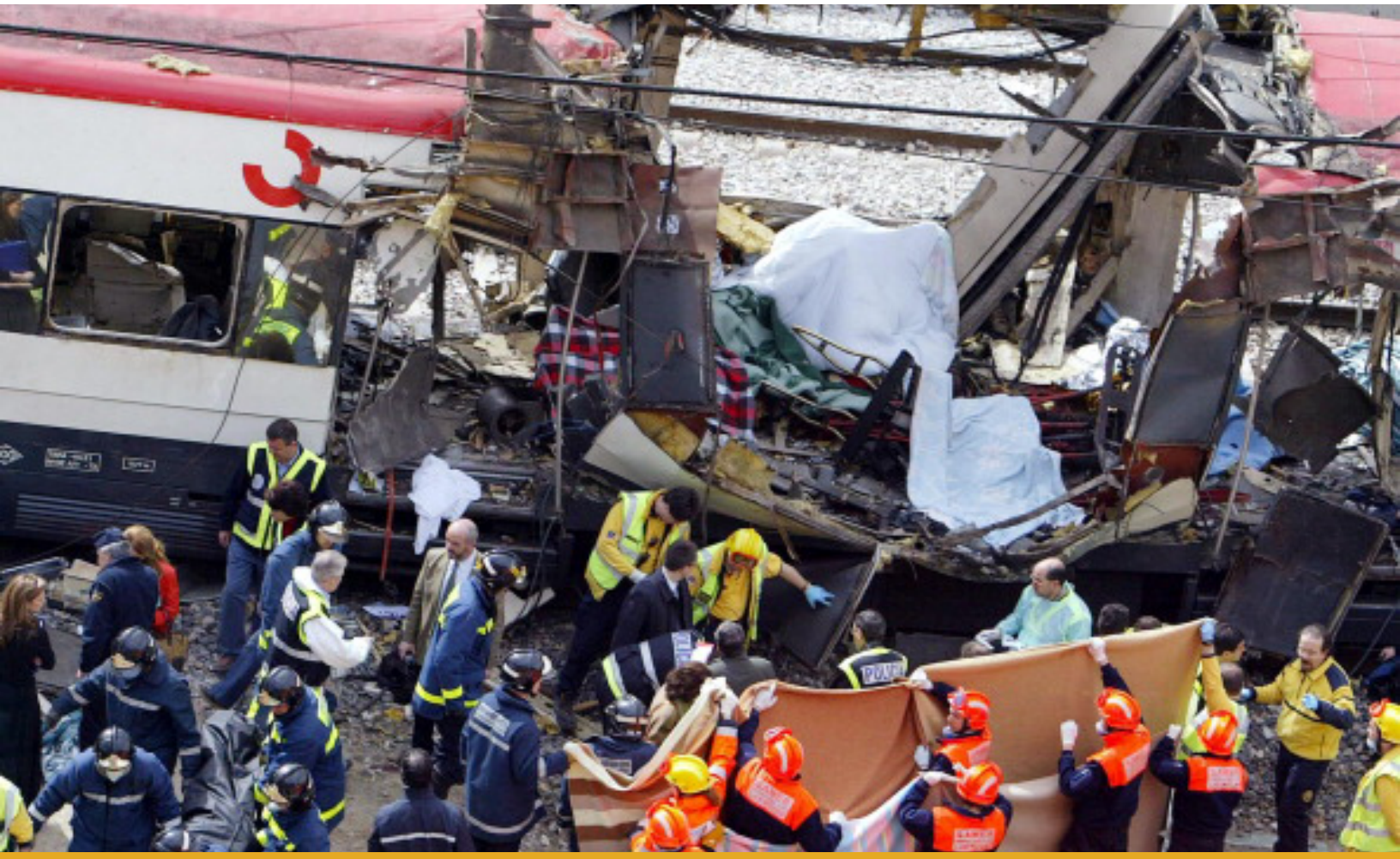

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REPORT 2369

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16. Abstract

This report is the third in a series of MTI studies of the frequency and lethality of attacks on public surface transportation between January 2004 and December 2021. The first study, released in August 2022, Changing Patterns of Violence Pose New Challenges to Public Surface Transportation in the United States, examined such attacks in economically advanced countries. The second study, released in August 2023, Evolving Patterns of Violence in Developing Countries, examined the attacks in less-developed countries. The present study focuses on attacks that used explosives, alone or in combination with other methods, against the same targets and countries during the same time period. (MTI will soon examine attacks in Israel and areas controlled by Palestinian territories, including attacks using explosives.)

The study finds that bombs—usually alone, but sometimes in combination with other methods—were used in 57% of the attacks, causing 63% of the fatalities and 76% of the injuries. Bombs are more frequently used in attacks in developing countries than in more economically advanced countries. While the percentage of bomb attacks has decreased, lethality has increased. Worldwide, bombs placed on railway tracks are not very lethal, as they are usually intended to create disruption, while bombs in passenger compartments or in train or bus stations are intended to result in mass casualties. Suicide bombings are the most lethal bomb attacks in economically developed countries, while vehicle-borne explosive devices (VBIEDs) are the most lethal in developing countries, followed by suicide attackers carrying bombs. Most of the bombing attacks in the economically developed countries were unsuccessful, but bombers had greater success in the other countries. This may be because explosives are easier to acquire in the latter countries or detection and prevention are weaker. Worldwide, successful bombings have declined. More bombs are being detected before detonation, particularly in the advanced countries, although the identity of most of the individuals who have found bombs and stopped attacks is unknown. Of those who foiled attacks in those countries and whose identities are known, 40% were passengers, citizens, or employees, while the percentage in the less-developed countries was only 21%. The proportions in the two country groups were reversed for security, police, and military officials.

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Cover image: “Bodies of victims are evacuated after a train exploded near the Atocha train station in Madrid,” March 11, 2004, CHRISTOPHE SIMON/AFP via Getty Images.

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I. INTRODUCTION

Bombs figure prominently in the history of political violence. Although assassins initially relied on daggers, swords, and, later, pistols, by the Middle Ages, explosive devices had become prominent instruments for murder. The husband of Mary Queen of Scots was killed by barrels of gunpowder hidden beneath his sleeping quarters in 1567. Guy Fawkes attempted to blow up the House of Lords in 1605 by packing its cellar with barrels of gunpowder.

Technological advances in explosives, such as the invention of dynamite in 1867, made bombings easier. Not only was dynamite powerful and reliable, it obliterated property, which had special appeal for anarchists and radical socialists. Russian revolutionaries carried out a campaign of assassinations in the late 19th century, killing the tsar with a bomb attack in 1881.

Miniaturized explosive devices facilitated the smuggling of bombs aboard airliners. Complex detonating systems guaranteed that the bombs would explode only after the plane had taken off.

Timing devices and remote detonation led to further advances in terrorist bombings. In 1946, members of the Zionist paramilitary organization Irgun employed a timing device to blow up the King David Hotel in Jerusalem. In 1985, Irish Republican Army (IRA) terrorists concealed a bomb with a long-term delay timer at the hotel where the British prime minister and members of her cabinet were scheduled to meet weeks later. The bomb killed five people but narrowly missed the prime minister.

In 1979, members of the IRA planted a bomb in Lord Mountbatten's fishing boat and detonated it remotely, killing him and a crew member and injuring members of his family. The Basque separatist group ETA killed Spain's prime minister in 1973 by detonating a huge bomb concealed in a tunnel it had dug under the street. In 1983, North Korean agents detonated a bomb at a Buddhist temple in Rangoon during the planned visit of South Korea's president and members of his cabinet. The president survived, but 11 people, including a number of senior officials, died in the blast.

One of the first vehicle-borne improvised explosive devices (VBIEDs) appeared in 1800 in Paris, where assassins tried to kill Napoleon by blowing up a cart filled with explosives as his carriage passed. In 1920, a horse-drawn cart loaded with explosives and metal parts exploded on Wall Street, killing 20 people. Huge truck bombs caused massive damage in London's financial district in the 1990s.

The 1980s saw the increasing use of a tactical innovation, suicide bombings. VBIEDs driven by suicide drivers delivered huge quantities of explosives to their targets. In 1983, a suicide bomber used a VBIED to kill 240 U.S. Marines and 55 French paratroopers in Beirut. In 1998, suicide drivers drove trucks loaded with explosives to the U.S. embassies in Nairobi and Dar es Salaam, killing 220 people and injuring more than 4,000. Suicide attackers wearing bomb-packed vests or concealing bombs in shoes or underwear also carried out terrorist attacks.

By the last decades of the 20th century, bombings had clearly become the terrorist weapon of choice. Of a total of 40,129 incidents between 1968 and 1970 included in the RAND Corporation's Database of Worldwide Terrorist Incidents, 20,524 (51%) involved bombings or the use of explosives. Of the 209,706 incidents in the Global Terrorism Database (GTD) maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland, between 1970 and 2020, 98,724 (47%) involved bombs or explosives.

This report examines the use of explosives in attacks on surface transportation targets. It continues MTI's examination of worldwide trends in the frequency, lethality, and rates of detecting and preventing the use of explosives in such attacks in a number of past reports.[1]

KEY FINDINGS

- Explosives were used in a majority (57%) of the attacks on public surface transportation. Bomb attacks were responsible for 63% of the fatalities and 76% of the injuries caused by the attacks.

- Bombs are used far more frequently in attacks in less-developed countries than in countries with advanced economies.

- In most of the bombing attacks in the MTI database, only one bomb was used.

- Over time, the number of explosives used in attacks in economically advanced countries has decreased slightly. There also has been a downward trend in the less-developed countries. However, the lethality of bombs in both groups of countries has increased.

- In economically advanced countries, bombers have most frequently placed their bombs inside a bus or train passenger compartment, on railway tracks, or inside train stations. No significant changes in the pattern of placement methods has occurred over time. Suicide bombing has been the most lethal form of attack, followed by non-suicide bombs placed in passenger compartments. Bombs placed on railway tracks have generated no fatalities, the objective being disruption, not body count.

- In less-developed countries, the most frequent placements were on railway tracks, in passenger compartments, or at stations or stops. Attacks with VBIEDs—both suicide and non-suicide—were the most lethal, followed by suicide attackers

1 The lethality of explosives and methods of placing them have been examined in many MTI reports, including Brian Michael Jenkins and Bruce R. Butterworth, *Changing Patterns of Violence Pose New Challenges to Public Surface Transportation in the United States*, Mineta Transportation Institute, August 2022; and Brian Michael Jenkins, Bruce R. Butterworth, and Sachi Yagyu, *Evolving Patterns of Violence in Developing Countries*, Mineta Transportation Institute, August 2023. An earlier MTI study that focused on detection of explosives and prevention of attacks was reported in Brian Michael Jenkins and Bruce Robert Butterworth, *Does "See Something, Say Something" Work?* Mineta Transportation Institute, December 2018. The specific ways explosives are used was explored as one way of determining the level of sophistication of attacks in Brian Michael Jenkins and Bruce R. Butterworth, *How Sophisticated Are Terrorist Attacks on Passenger Rail Transportation*, Mineta Transportation Institute, June 2020.

carrying bombs. Bombs placed on railroad tracks had low lethality, as these attacks are aimed at disruption.

- In economically advanced countries, the majority of the bombing attacks were unsuccessful; the devices were discovered or malfunctioned, they failed to detonate, or they detonated during an unsuccessful explosives ordnance disposal (EOD) operation. In some cases, the outcome of an attack is unknown. Although bomber success is decreasing and failure is increasing, bombs, particularly in confined spaces, remain very lethal.

- In less-developed countries, the percentage of devices that detonated on target and on time is significantly higher. More bombs in these countries detonated as planned, and fewer were found by authorities. It is difficult to know for certain the causes for this difference, but the greater ease of acquiring explosives and weaker prevention and detection in the less-developed countries are important considerations. Expertise acquired during ongoing insurgencies in less-developed countries versus amateur lone operators in economically advanced countries may also be a factor.

- Worldwide, the percentage of bombs that detonated as planned has decreased. There has been little change in the percentage of bombs that failed to detonate as planned. However, there has been an increase in bombs that were detected, particularly in economically advanced countries.

- A higher percentage of attacks have been prevented in economically advanced countries. Generally, these should be seen as preventions, although failed bombs can also result from attacker incompetence. The latest data show a rise in prevention/attacker failure in these countries. In the less-developed countries, the data indicate a decrease in prevention/attacker failure.

- In both groups of countries, the identity of people who stopped attacks or found bombs is unknown in nearly half of the attacks. This percentage has remained constant in the economically advanced countries, but it has increased in the others. Of the attacks foiled in the economically advanced countries, 40% were foiled by passengers, citizens, or employees, but this group was credited with only 20.7% of the foiled attacks in other countries. The difference is reversed for security, police, and military officials, although the proportion has decreased in both country groups.

II. DATABASE AND EARLIER STUDIES OF ATTACKS ON SURFACE TRANSPORTATION

The earliest version of the MTI Database of Terrorist and Serious Criminal Attacks Against Public Surface Transportation was created in 1997. A more robust platform of off-line analysis was developed in 2008, and on-line analysis was implemented in 2011. The database draws from a variety of media reports and other sources, including the RAND Corporation's Database of Worldwide Terrorist Incidents, which contains incidents occurring from 1968 to 2009; the GTD; and the National Counterterrorism Center's Worldwide Incident Tracking System, as well as extensive media searches and direct contacts with transportation operators.

The MTI database includes the date of each attack, the time of the attack (including whether in peak or off-peak hours), the place in which it occurred (city, region, country), the resulting fatalities and injuries, and whether a suicide was involved. The attacks are categorized according to 74 different targets consolidated into 11 target groups, and 77 attack methods similarly consolidated into 13 attack method groups. Perpetrators are categorized into one of more than 85 specific attacker groups.

Bombings in the database are categorized by type of explosives, whether the explosives were used alone or in combination, and the purpose of the attack (e.g., derailment, kidnapping, robbery, hijacking). The data include the number of explosive devices used, how they were concealed or where they were placed (within 46 categories, such as "placed on vehicle road, bridge or tunnel"), and whether they were placed above or below ground, along with one of 8 outcomes, including "detonated on target and on time"; whether multiple devices were used to kill responding forces; and whether the attack was detected and stopped, and if so, by whom.

Between January 1, 1970, and October 15, 2023, there were 6,027 attacks (including both attacks that did and did not use bombs) targeting passenger trains and train stations; buses and bus stations; passenger ferries and terminals; rail infrastructure, facilities, and offices; and operating personnel and security staff. These attacks resulted in 13,347 deaths and 50,782 injuries. (If freight train, highway, and miscellaneous transportation targets are included, the total rises to 6,903 attacks resulting in 14,243 fatalities and 51,711 injuries.)

In our earlier analyses of attacks on public surface transportation,[2] we divided the countries of the world into three groups. The groups were determined by the specific objectives of the research, not by our assessment of economic development or other political objectives. We categorized the world's more advanced economies, essentially members of the Organisation for Economic Cooperation and Development (OECD), as Group 1. This group includes Europe (members of the European Union and associated states, but not Russia), Japan, the Republic of Korea, Singapore, the Republic of China (Taiwan), Hong Kong and Macau (but not the rest of China), Australia and New Zealand, Canada, the United States, and three Latin American countries—Chile, Costa Rica, and Mexico. Colombia, Israel, and Turkey, although members of OECD, were excluded from the analyses because of their

2 Jenkins and Butterworth, 2022; and Jenkins, Butterworth, and Yagyu, 2023.

histories of political violence during the past two decades. Including them would have added so many incidents that it would have distorted the analyses by overshadowing subtle trends in countries where attacks are rare. Examination of attacks in Group 1 provided a threat profile relevant to the United States.

We categorized the remaining countries of the world as Group 2, with the exception of Israel and the Palestinian territories, which we labeled Group 3. We isolated Group 3 because of the unique circumstances of this area and its high volume of activity, which would have distorted the overall findings. We hypothesized that attacks in Group 2 countries differ significantly from those in Group 1 countries, and this turned out to be correct.

Our analysis of evolving patterns of violence in developing countries considered the numbers of attacks, fatalities, and injuries in both Group 1 and 2 countries between January 1, 2004, and December 31, 2021. The analysis did not include freight trains and stations; vehicle highways, tunnels, and bridges (most attacks against these targets occur in Group 2 countries); United Nations convoys; or miscellaneous targets or multiple targets not clearly identified with a specific target group.

In addition to the broad conclusion that attacks in Group 2 countries differ significantly from attacks in Group 1, we discerned a number of trends that should be of interest to governmental authorities, transit authorities, transportation operators, and even explosives experts.

GLOBAL TRENDS IN ALL ATTACKS (NOT ONLY BOMB ATTACKS)

There were a total of 3,836 attacks on public surface transportation in Groups 1 and 2 between January 1, 2004, and December 31, 2021 (see Table 1). These attacks resulted in 7,412 fatalities and 21,847 injuries. The overall lethality rate was 1.9 fatalities per attack (FPA) and 5.7 injuries per attack (IPA). Explosives, in some cases combined with other methods, were used in 2,001 (57%) of the attacks. Bomb attacks killed 4,674 people (63% of the total fatalities) and injured 16,666 (76%), for an overall FPA of 2.3 and IPA of 8.3.

Table 1. Total Attacks, Fatalities, and Injuries in the Selected Target Categories

Time Period	Attacks		Fatalities		Injuries		Lethality	
	# Attacks	% Attacks	# Fatalities	% Fatalities	# Injuries	% Injuries	FPA	IPA
2004-5	302	9.0%	664	9.0%	3730	17.1%	2.2	12.4
2006-7	438	10.3%	763	10.3%	2833	13.0%	1.7	6.5
2008-9	272	8.9%	656	8.9%	2059	9.4%	2.4	7.6
2010-11	375	10.0%	744	10.0%	2169	9.9%	2.0	5.8
2012-13	556	18.1%	1341	18.1%	3336	15.3%	2.4	6.0
2014-15	749	20.3%	1502	20.3%	4097	18.7%	2.0	5.5
2016-17	439	10.7%	793	10.7%	1919	8.8%	1.8	4.4
2018-19	355	5.8%	429	5.8%	914	4.2%	1.2	2.6
2020-21	350	7.0%	520	7.0%	791	3.7%	1.5	2.3
Total/Percentages/Averages	3836	100.0%	7412	100.0%	21857	100.0%	1.9	5.7

Figure 1 shows a very slight increase in attacks over time and a very slight decrease in fatalities, with a sharper decline in injuries. The greatest numbers of attacks, fatalities, and injuries occurred in the 2014–2015 period, with a decline in the subsequent years. Figure 2 shows a very gradual decline in FPA and a somewhat steeper decline in IPA. The broken lines in the figures reflect the actual numbers by two-year period, while the solid lines indicate the trend.

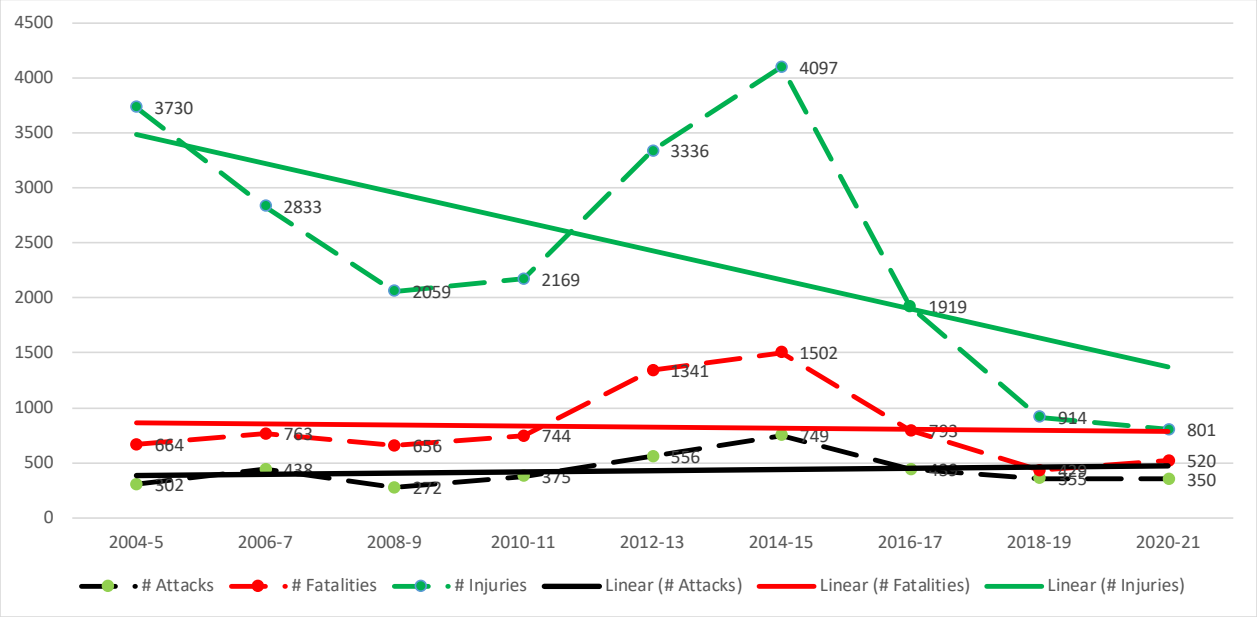

Figure 1. Attacks and Casualties Over Time

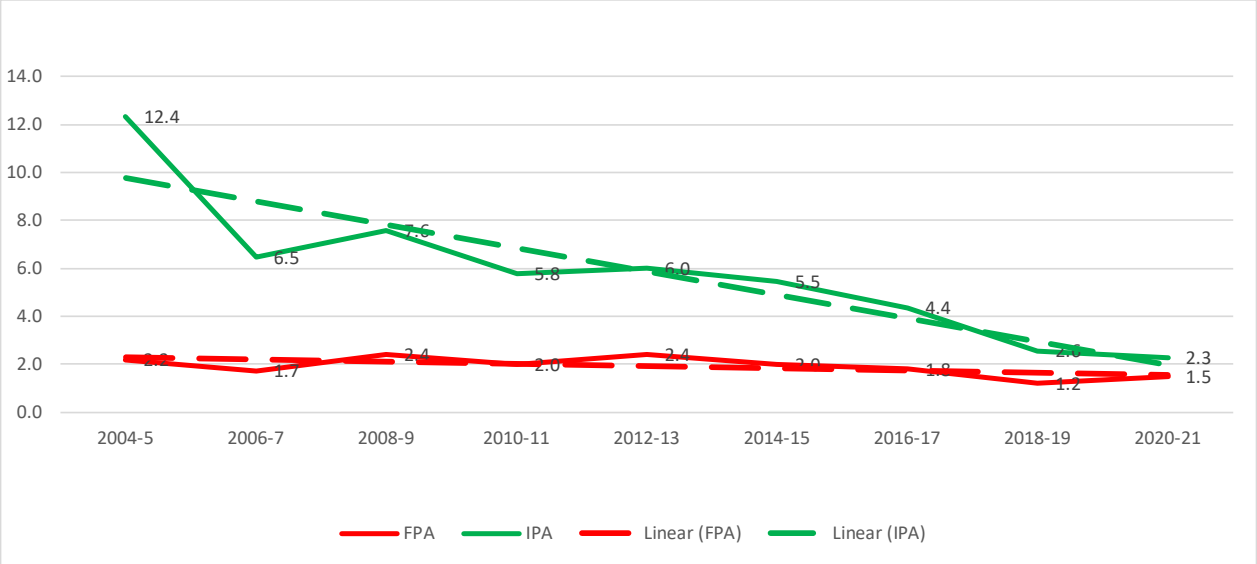

Figure 2. Lethality of Attacks Over Time

COMPARING ATTACKS ON SURFACE TRANSPORTATION IN GROUP 1 AND GROUP 2 COUNTRIES

Table 2 compares the numbers and lethality of attacks in the Group 1 and Group 2 countries. For the entire 18-year period examined, Group 2 countries account for nearly 87.6% of the attacks and 95.3% of the fatalities. There have been far more attacks and fatalities in the Group 2 countries, but the percentage of total attacks taking place in the groups has changed in recent years: The percentage in Group 2 countries increased until the 2012–2013 period, when it reached 95.5%, and then it declined to 62.3% in 2020–2021. There was a corresponding increase in the Group 1 percentages of the total.

The percentage of total fatalities in Group 2 countries decreased, from nearly 99.8% in 2012–2013 to 92.2% in 2016–2017, and then went back up to 97.3 % in 2020–2021. Group 2 countries experienced only 63.4% of the fatalities in 2004–2005, but this reflected two statistical outliers in Group 1 countries: bombings on trains in Madrid in 2004 and bombings on the London tube and bus systems in 2005.

Table 2. Comparison of Attacks in Group 1 and Group 2 Countries

Time Period	Group 1 Attacks		Group 1 Fatalities		Group 2 Attacks		Group 2 Fatalities		Lethality	
	#	% of All	#	% of All	#	% of All	#	% of All	Group 1 FPA	Group 2 FPA
2004-5	23	7.6	243	36.6	279	92.4	421	63.4	10.6	1.5
2006-7	25	5.7	0	0.0	413	94.3	763	100.0	0.0	1.8
2008-9	20	7.4	0	0.0	252	92.6	656	100.0	0.0	2.6
2010-11	18	4.8	4	0.5	357	95.2	740	99.5	0.2	2.1
2012-13	25	4.5	3	0.2	531	95.5	1338	99.8	0.1	2.5
2014-15	47	6.3	6	0.4	702	93.7	1496	99.6	0.1	2.1
2016-17	87	19.8	62	7.8	352	80.2	731	92.2	0.7	2.1
2018-19	99	27.9	20	4.7	256	72.1	409	95.3	0.2	1.6
2020-21	132	37.7	14	2.7	218	62.3	506	97.3	0.1	2.3
Total/Percentages/Averages	**476**	**12.4**	**352**	**4.7**	**3360**	**87.6**	**7060**	**95.3**	**0.7**	**2.1**

There is always a concern that percentages may reflect a reporting bias. News coverage is lacking in many developing countries, especially outside major cities. Moreover, much of the reporting does not reach the Internet.

We also acknowledge our own limitations in capturing incidents. Because of resource constraints, our Internet searches are limited primarily, although not exclusively, to reports in English or in other languages translated into English. Major incidents, especially those with casualties, are reported in the international news media, but the media may tend to ignore or simply not have access to information about low-level attacks in remote areas of developing countries. In addition, governments in many parts of the world are not interested in publishing statistics or publicizing incidents of violence. Despite our efforts to canvass local sources for information on attacks and to identify relevant research by individual scholars, incidents in remote parts of the world are likely to be underreported. As a result, our reporting on attacks outside of Group 1 countries is more illustrative than comprehensive.

To test the validity of our findings, we performed an examination of only incidents with fatalities, thereby eliminating the low-level events recorded in both Group 1 and Group 2 countries. The results are shown in Table 3. The percentage of attacks with fatalities in Group 1 countries is lower than it is for all attacks—just 4.7%, compared with 95.3% for Group 2. However, the proportion in Group 1 increased from 0.5% in 2012–2013 to 13.7% in 2020–2021. Therefore, while there may be some bias in the reporting, our finding of the overall upward trend holds.

Table 3. Comparison of Attacks with Fatalities in Group 1 and Group 2 Countries

Time Period	Group 1 Attacks		Group 1 Fatalities		Group 2 Attacks		Group 2 Fatalities		Lethality	
	#	% of All	#	% of All	#	% of All	#	% of All	Group 1 FPA	Group 2 FPA
2004-5	2	2.9	243	36.6	67	97.1	421	63.4	121.5	6.3
2006-7	0	0.0	0	0.0	101	100.0	763	100.0	4.0	7.6
2008-9	0	0.0	0	0.0	71	100.0	656	100.0	3.0	9.2
2010-11	1	1.0	4	0.5	99	99.0	740	99.5	2.0	7.5
2012-13	1	0.5	3	0.2	221	99.5	1338	99.8	3.9	6.1
2014-15	3	1.1	6	0.4	264	98.9	1496	99.6	1.8	5.7
2016-17	16	11.0	62	7.8	129	89.0	731	92.2	1.1	5.7
2018-19	11	12.2	20	4.7	79	87.8	409	95.3	7.5	5.2
2020-21	13	13.7	14	2.7	82	86.3	506	97.3	1.1	6.2
Total/Percentages/Averages	**47**	**4.1**	**352**	**4.7**	**1113**	**95.9**	**7060**	**95.3**	**7.5**	**6.3**

As noted earlier, the lower percentage of attacks with fatalities in Group 1 countries also reflects the nature of the attacks on public surface transportation in those countries: Many of the attacks are focused on environmental and related issues and are intended to be symbolic or disruptive rather than deadly. Attacks in Group 2 countries are far more lethal. If we do not include the London and Madrid bombings in the 2004–2005 period, the overall FPA for attacks in Group 1 countries falls from 7.5 to 2.3.

Figure 3 shows that the number of attacks in the Group 2 countries reached a high point in 2014–2015, then declined sharply. The trend in the Group 1 countries was gradually upward. Correspondingly, as shown in Figure 4, the percentage of attacks in Group 2 countries declined as the percentage in Group 1 countries increased.

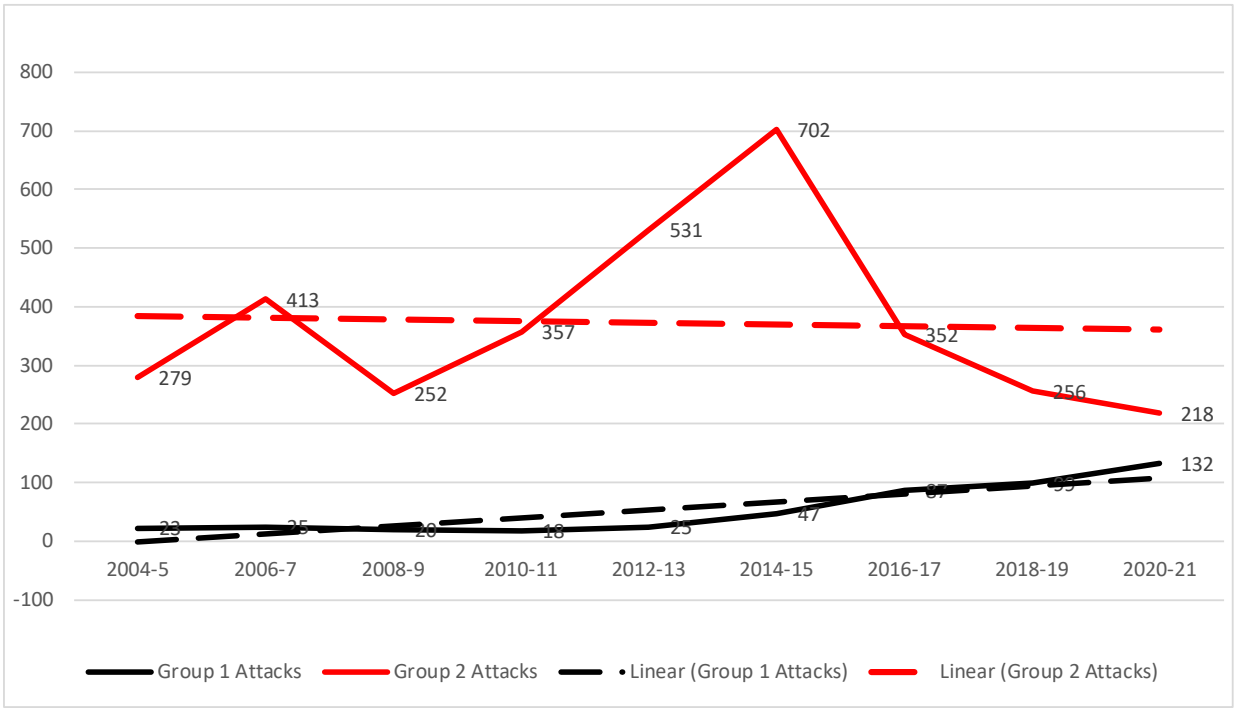

Figure 3. Number of Attacks in Country Groups Over Time

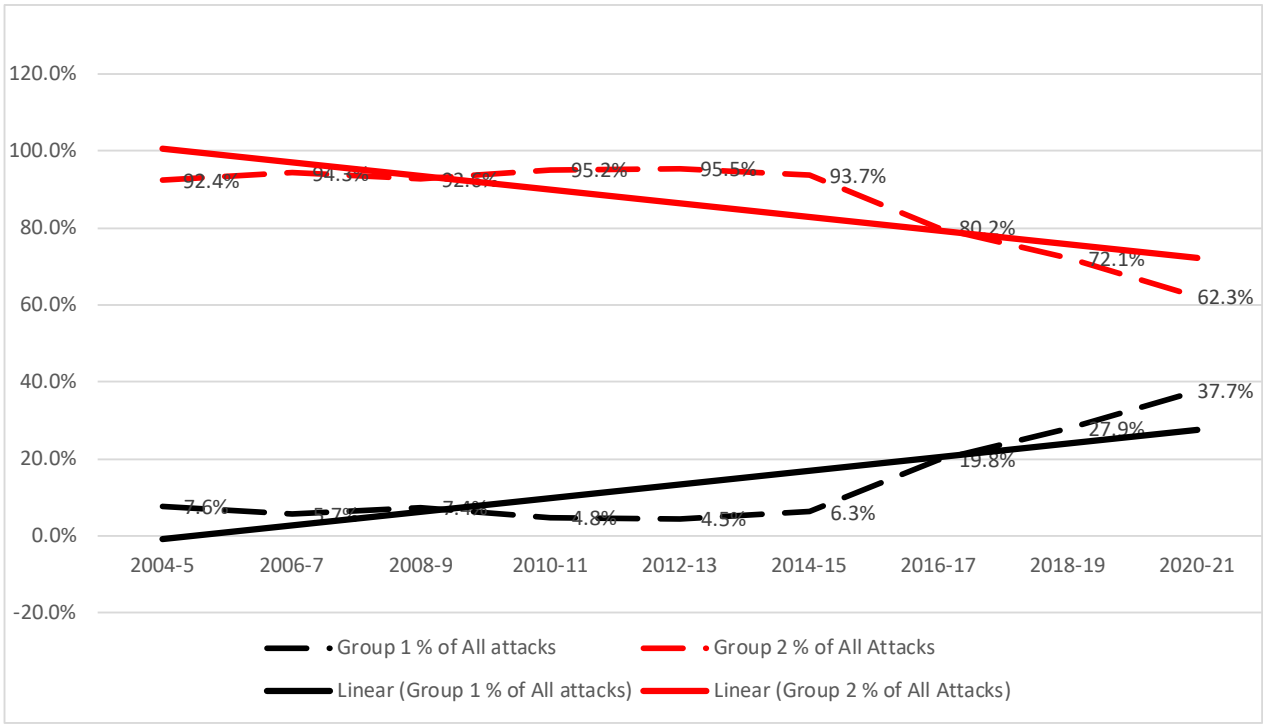

Figure 4. Percentage of Attacks in Country Groups Over Time

Total fatalities in Group 1 countries declined during the 18-year period covered in this analysis. Excluding the two statistical outliers (the Madrid and London attacks), the number of fatalities reached a peak in the 2016–2017 period, then declined. Except for this one peak, the trend line gradually ascends. When we consider only incidents with fatalities,

there is a gradual increase in both Group 1 and Group 2 countries over time, but there is a gradual decline in the percentage of attacks in Group 2 countries and a gradual increase in the percentage in Group 1 countries.

As shown in Figure 5, the lethality of incidents with fatalities declined in the Group 1 countries and increased very gradually in the Group 2 countries. The death tolls of the Madrid and London attacks at the beginning of the period push the trend downward. If, however, those attacks are excluded (see Figure 6), then the lethality trend increases in Group 1 countries.

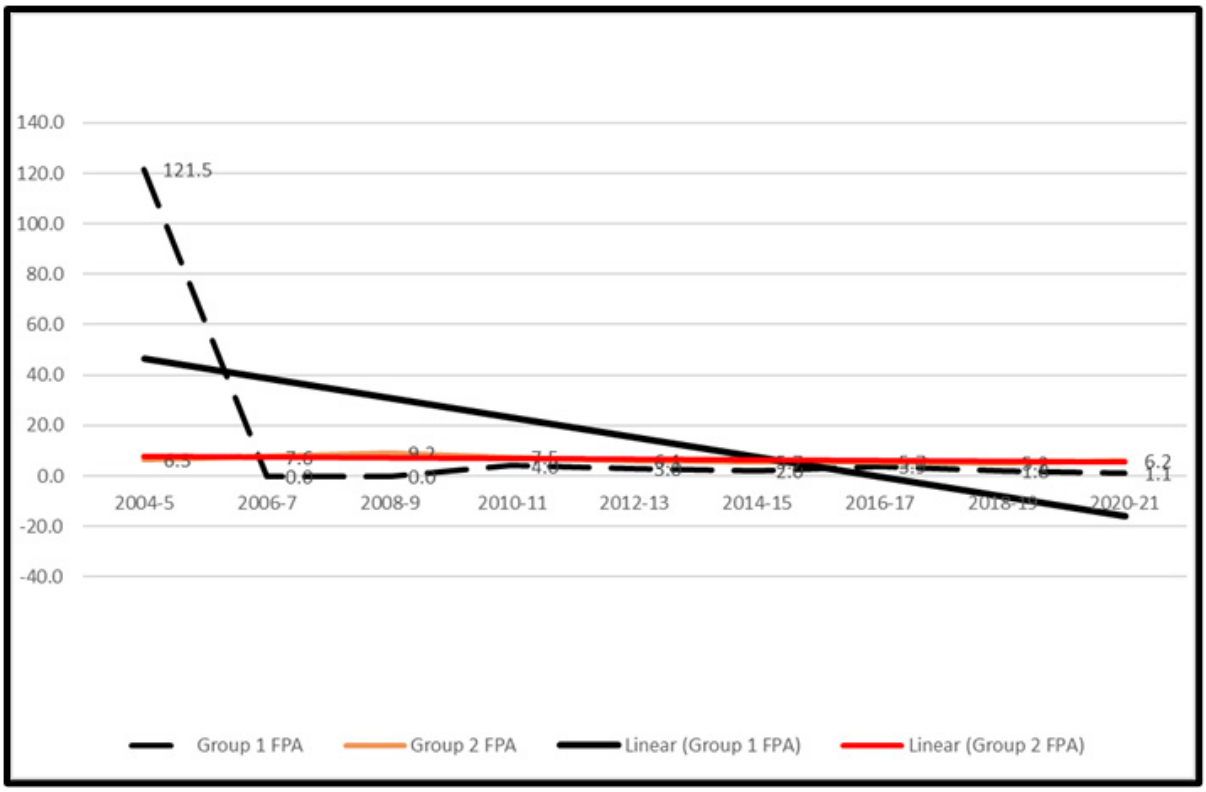

Figure 5. Lethality of Fatal Attacks by Country Group

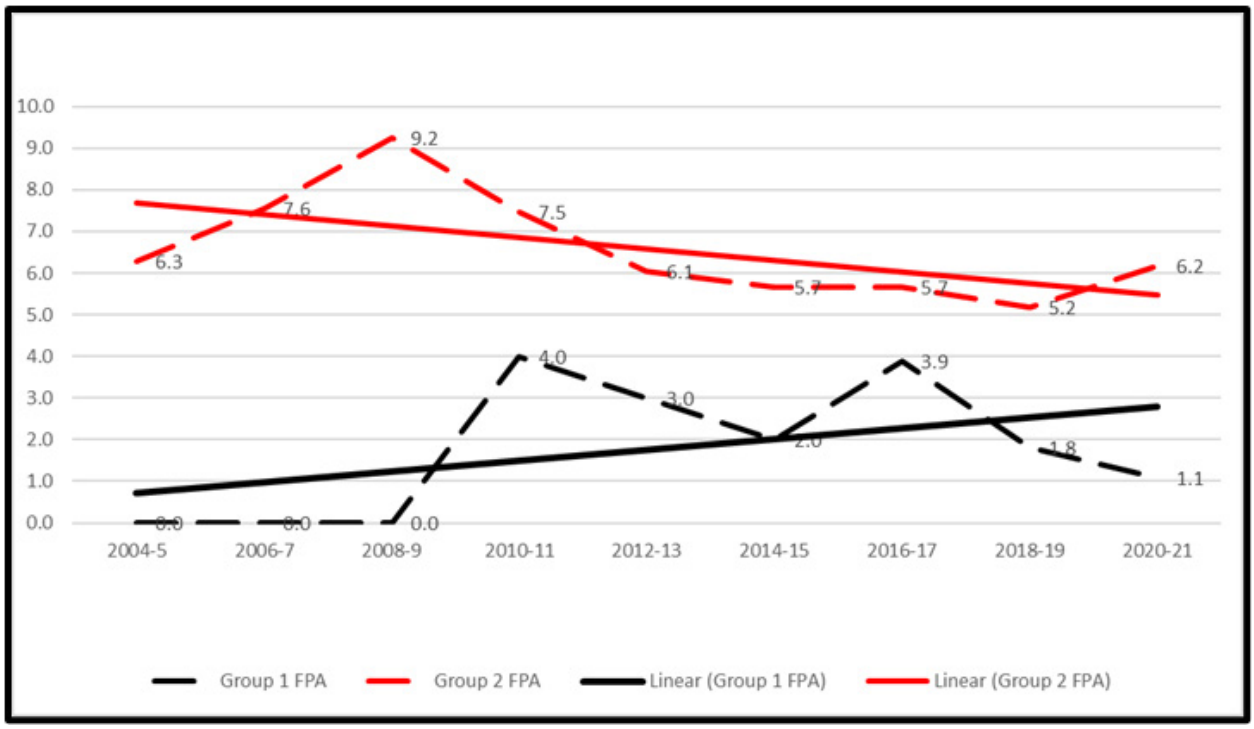

Figure 6. Lethality of Fatal Attacks by Country Group, Excluding the Madrid and London Bombings

In sum, Group 1 countries are experiencing an increasing percentage of the total number of attacks on public surface transportation and of fatalities. The lethality of attacks in Group 1 countries, excluding the two outliers, is also increasing.

KEY FINDINGS IN MTI'S 2022 AND 2023 STUDIES OF ATTACKS ON SURFACE TRANSPORTATION

1. Between January 1, 2004, and December 31, 2021, there were 3,836 attacks on public surface transportation, in which 7,412 people were killed and 21,847 were injured. Overall lethality was low: 1.9 FPA and 5.7 IPA. Over time, the frequency of attacks increased, and lethality decreased somewhat, with a spike occurring in both in 2014–2015.

2. There were far more attacks and fatalities in Group 2 than in Group 1, which is not surprising, given the larger population of Group 2 and the long-standing and varied terrorist separatist campaigns in these countries. However, the percentage of attacks in each group shifted: The Group 2 percentage increased until 2012–2013, when it accounted for 95.5% of all attacks, and then declined to 62.3% in 2020–2021. There was a corresponding increase in the Group 1 percentages.

3. The percentage of fatalities in the attacks also shifted. In Group 2, it decreased from nearly 99.8% in 2012–2013 to 92.2% in 2016–2017 and then went back up to 97.3 % in 2020–2021. There was a corresponding increase in Group 1, even excluding the highly lethal attacks that occurred in Madrid and London in 2004–2005.

4. Because it is difficult to capture attacks with no or few fatalities, particularly in Group 2, we looked only at attacks with fatalities to test the validity of our findings. The results substantiated our overall findings, showing that any bias toward underreporting of attacks without fatalities did not change the results. Somewhat surprisingly, however, there was a slight increase in attacks and fatalities in Group 1.

5. The percentage of attacks with fatalities was lower in Group 1 than in Group 2, which reflects the nature of the attacks on public surface transportation in the two groups. Many of the attacks in Group 1 are focused on environmental and related issues and are intended to be symbolic or disruptive rather than deadly. There is more violence associated with issues in Group 2 countries, where populations are far more reliant on public surface transport and attacks are far more lethal.

III. BOMBING ATTACKS ON PUBLIC SURFACE TRANSPORTATION

We now consider only attacks using explosive devices, comparing the attacks in Group 1 and Group 2 countries. It is not surprising that explosives are frequently used in attacks on public surface transportation. Of the 3,836 attacks in the MTI database between January 1, 2004, and December 31, 2021, 57% involved explosives used alone or with other methods. Attacks with explosives accounted for 4,674 (63%) of the 7,412 fatalities and 16,666 (76%) of the 21,847 injuries, resulting in an FPA of 2.3 and an IPA of 8.3, which was higher than the overall average of 1.9 FPA and 5.7 IPA.

Attackers use explosives to sabotage rail lines, causing disruption and economic damage and sometimes deadly derailments. Surface transportation facilities, which are easily accessible public venues filled with crowds of strangers, have often been seen as killing fields by terrorists seeking high body counts. Bombings have been the most lethal method of attacks on surface transportation venues, with one exception, an arson attack on a subway in South Korea in 2003.

The analysis presented below includes only events that occurred between January 1, 2004, and December 31, 2021. In its early years, the MTI chronology was more illustrative than comprehensive, and although it is continually being improved (with the addition of missed events and new details for existing entries),[3] confining our study to data on events in recent decades enables more detailed analyses with greater confidence. The exclusion of earlier events also enables us to escape the distorting effects of history. The intensive bombing campaigns carried out by the IRA in Northern Ireland and England and by ETA in Spain during the last quarter of the 20th century dominate the data for Europe, making it difficult to discern 21st century trends.

Finally, considering only recent incidents avoids the analytical problems arising from the division of Europe into Western and Eastern zones with very different political experiences. The 18 years examined here are divided into nine two-year increments (2004–2005, 2006–2007, etc.), ending with 2020–2021. This helps us “smooth out” some of the sharp peaks and valleys in the charts and graphs.

3 Each year, MTI reviews a past year of attacks added to the GTD, and each year a few attacks are found in the GTD that were not found earlier (just as the GTD misses attacks that MTI has found). Almost all of the additional attacks found have occurred in Group 2 countries, and the attacks produced few, if any, fatalities. Knowing this and trying to avoid a false decline in attacks or fatalities, we assumed that the number of attacks that we missed in 2019 (and that were subsequently added), 47, would be the same in 2020 and 2021. This assumption proved very accurate when we received the actual data for 2020. The numbers assumed for 2021 will almost certainly be verified by actual data when they are available.

The issues addressed and the findings of the analysis are summarized below by answering five sets of questions:

1. **Number of bombs used alone or in combination with other attack methods:** How often was only one bomb used, more than one bomb used, and bombs used in combination with other attack methods? How does the lethality of those combinations compare?

    - Explosives were used in a majority of the attacks: Nearly 51% of all attacks used explosives, 5.7% used explosives in combination with other methods, and only 43.6% used no explosives.

    - The differences between Group 1 and Group 2 are stark. Explosives were used in 16.2% of Group 1 attacks and another 0.8% in combination with other methods; 83.4% of the attacks in Group 1 used no explosives at all. In contrast, 55.7% of the attacks in Group 2 used explosives, and another 6.3% used explosives in combination with other methods. Only 37.9% of the attacks used no explosives.

    - In most bombing attacks, only 1 bomb was used. Nearly 84% of the bombing attacks involved only 1 bomb, 15.3% involved 2 to 5 bombs, and 0.8% involved 6 or more. In Group 1, 78.5% of the attacks involved only 1 bomb, and 84.1% of the attacks in Group 2 involved only 1 bomb; 19% of the attacks in Group 1 involved 2 to 5 bombs versus 15.2% in Group 2; 2 attacks in Group 1 (2.5%, including the Madrid attack) involved 6 or more devices, compared with 0.7% of those in Group 2.

2. **Frequency and lethality:** How often were bombs used in each country group? How lethal were these bombs, in total and over time?

    - In Group 1, only 120 bombs were used, with a lethality of 2.2 fatalities per device (FPD) and 23.1 injuries per device (IPD), but both figures are distorted by the Madrid and London attacks, particularly the IPD. By contrast, there were nearly 20 times (2,394) more devices used in Group 2, with lethality being lower (1.8 FPD and 5.6 IPD), but again because of Madrid and London.

    - Over time, the number of explosives used in Group 1 attacks has decreased, although if the Madrid and London attacks are excluded, the decline is slight. There is also a downward trend in Group 2.

    - The lethality of bombs in Group 1 decreases when the Madrid and London attacks are included but increases when they are not included. In Group 2, lethality has gone up and down, but the overall trend is slightly upward.

3. **Placement methods:** Which methods of concealing and placing bombs were used most frequently and most lethally, in total and over time?

    - In Group 1, bombers most frequently placed their bombs inside a bus or train passenger compartment (35.8%), on railway tracks (20.8%), and inside train stations (20%). No significant changes in the pattern of placement methods has occurred over time, except for a few peaks in one 2-year period. In Group 2, the most frequent placements were on railway tracks (35%), in passenger compartments (19.2%), and at stations or stops (20%).

    - In Group 1, suicide bombing was the most lethal form of attack (6.5 FPD), followed by non-suicide bombs placed in passenger compartments. The FPD of the Madrid and London attacks, along with that of a 2016 attack in Brussels, emphasize the lethality of explosives detonated in confined areas. Bombs placed on railway tracks generated no fatalities, the objective being disruption, not body count.

    - In Group 2, VBIED attacks—both suicide and non-suicide (13.6 and 8.6 FPA, respectively)—were the most lethal, followed by suicide attackers carrying bombs (5.0 FPA). As in Group 1, bombs placed on tracks had low lethality, as these attacks are aimed at disruption. Basque groups in Europe or Maoist groups in India often made such attacks, but no long-term trends are discernible.

4. **Bomber success and failure:** In what percentage of bombings did the attackers succeed or fail? (Here, the percentage of bombs detonated or released on target and on time as planned determines success, and the percentage found by authorities before the bombs detonated or failed to detonate as planned determines failure.) We look at this in total and over time.

- In Group 1, only 37.5% of the bombing attacks were successful; the rest were discovered (44%) or malfunctioned or failed to detonate (16.7%). The remainder detonated during an unsuccessful explosives ordnance disposal (EOD) operation, or the outcome is unknown. Over time, it appears that bomber success in Group 1 is decreasing and failure (e.g., due to detection by government and transit operators) is increasing. Nevertheless, bombs, particularly in confined spaces, remain very lethal.

- In Group 2, the percentage of devices that detonated on target and on time (76%) is slightly more than twice that in Group 1 (37.5%); only 2.3% of the devices in Group 2 attacks detonated early or away from the target, in comparison with 11.7% in Group 1. Only 20.3% of devices were subjected to EOD in Group 2 countries, while in Group 1 countries, the percentage was slightly more than twice that (44.1%). In sum, more bombs in Group 2 countries detonated as planned, and fewer were found by authorities. It is difficult to know for certain the causes for this difference, but the greater ease of acquiring explosives and weaker prevention and detection in Group 2 should be considered leading candidates. Again, the competence of those engaged in ongoing insurgencies versus “amateurs” carrying out one-off attacks may also be a factor—experience counts.

- In both groups, the percentage of bombs that detonated as planned decreased, although the decrease was smaller in Group 2 than in Group 1. There was little change in the percentage of bombs that failed to detonate as planned. There has, however, been an increase in bombs that were detected, particularly in economically advanced countries.

5. **Who stopped the bombing attacks:** What categories of individuals (e.g., drivers, employees, passengers, citizens, security officials) stopped the largest percentage of attacks (almost all of which involved explosives, involving either one or multiple explosive devices), in total and over time? (Ninety-four percent of the failed attacks involved only the use of bombs.)

    - There were some differences between the two groups regarding the percentage of attacks prevented. The percentage in Group 1 (10.5%) was higher than that in Group 2 (9.8%). Generally, these should be seen as attacker failures (prevention of success), although failed bombs can also result from attacker incompetence.

    - Over time, there are some differences in attacker failure. In Group 1, the latest data show a rise in prevention/attacker failure. In Group 2, the data indicate a decrease in failure.

    - In both groups, the largest category of people who stopped attacks or found bombs is “unknown”: 44% in Group 1 and 49.2% in Group 2. In Group 1, 40% of the people who found the devices were passengers, citizens, or employees, but only 20.7% of these individuals were the ones responsible for stopping attacks in Group 2. Finally, the difference is reversed for security, police, and military officials, who stopped only 16% of the attacks in Group 1 but 30.1% of the attacks in Group 2.

    - Over time, the “unknown” category of individuals who foiled bombing attacks in Group 1 has remained constant, but it increased in Group 2. The percentage of attacks foiled by passengers, citizens, drivers, and employees increased in Group 1 but decreased in Group 2. The percentage foiled by security, police, and military officials decreased in Group 1 and also in Group 2.

HOW BOMBS AND THEIR LETHALITY ARE COUNTED AND MEASURED IN THE MTI DATABASE

Counting Devices

Information available about attacks sometimes allows a precise count of the number of devices used and whether they detonated as planned, or failed, or were found and underwent EOD by what are popularly known as “bomb squads.” In the most recent and/or lethal cases, very precise information is available about the number of devices and what happened to them. But for many other attacks, only general descriptors are available. In the MTI database, the term “several” is interpreted to mean 3; a “dozen” is 12; and “dozens” means 24. For one attack, the number of devices was listed as “hundreds,” so to avoid

skewing the data based on this vague description, MTI set an upper limit of 40. In addition, two attacks were reported to involve dozens of devices (considered to be 24 devices). All of these attacks took place in Group 2 countries, and all were in the 2016–2017 period.

Calculating Lethality

Lack of enough information causes a similar problem in calculating lethality. In attacks where several devices were used, we seldom know how many fatalities and injuries were caused by *each* device. To address this problem, we divide fatalities and injuries evenly among the devices used to determine FPD and IPD. For example, 13 devices were used in a 2004 attack on the Atocha train station in Madrid, but only 5 detonated as planned, when the train was in the station—the attackers were attempting to collapse the station. Five other devices detonated away from the target, and another 3 did not detonate. A total of 191 people were killed. For this analysis, we spread the 191 fatalities evenly across all the devices and assumed that each killed 14.7 (the number was not rounded so that we could perform a more precise statistical analysis).

We could instead divide the total fatalities and injuries by only the devices that detonated on time and on target to determine fatalities per device exploded (FPDE). In the case of the Madrid attack, this would mean that the 191 fatalities would be divided among the 5 devices that exploded at the target (the station), for a lethality of 38.2 FPDE. But many of the deaths were caused by the 5 devices that exploded before they reached the target, so this would create an erroneous impression. Therefore, we used the FPD calculation, considering the devices that failed to explode altogether equal to those that detonated on time and on target and those that malfunctioned or detonated early.

Counting Outcomes

In the MTI database, each device is assigned an "outcome," which allows us to know with some confidence how many explosives detonated on time and on target, how many failed to do so, and how many were found and rendered safe by EOD experts (a small number also donated when being moved, almost always by poorly trained personnel, not EOD experts). The following outcomes are assigned:

1. **Detonated or released on target:** The attacker succeeded.

2. **Detonated early, away from target, or malfunction:** The attacker failed because the device detonated early or away from the target due to poor timing or placement.

3. **Failed to detonate:** The attacker failed because the device did not detonate at all.

4. **EOD successful, rendered safe:** The attacker failed because the device was found and successfully disarmed.

5. **Detonated during unsuccessful EOD:** The attacker failed, but in a few cases, the device detonated, injuring or killing persons trying to move it or render it safe (we believe very few of these were caused by properly trained EOD personnel).

6. **Unknown:** The narrative did not indicate what happened to the device.

Only one outcome, “detonated or released on target,” indicates that the device detonated as planned and was therefore successful. (This does not mean that the amount or type of explosive was adequate to maximize casualties.) In the other outcomes, the device either did not work at all, did not work as planned, or was found before it detonated; therefore, it failed. In a few cases, what happened to the device is unknown.

Determining Placement and Concealment Method

The MTI database also indicates the method by which the bomb was concealed or placed. The attacks examined in this report were assigned one or more of 47 specific methods. For example, bombs placed inside a bus or train compartment are assigned one of three categories of “concealed/placed inside pax compartment”: unspecified or other (a default value in the absence of any information), leave-behind bag or parcel, or in structure (toilet, floor, wall, etc.). Similarly, categories are available for bombs placed outside or inside a station. For this analysis, we have consolidated the categories into twelve basic types, including “inside passenger compartment,” “inside station or at a stop,” and “outside station or stop.”

ATTACKS EXCLUDED FROM THE ANALYSIS

The MTI database includes attacks using both explosive and incendiary devices; it also includes attacks where explosive or incendiary devices are used in combination with other attack methods such as automatic or semiautomatic weapons or derailments. Also, there are some attacks, all in Group 2 countries and all in the 2016–2017 period, in which many devices were used—two attacks involved 24 devices each, and one involved hundreds of devices (which we would have limited to 40 for this analysis). We exclude these attacks from the analysis because their inclusion would overstate lethality by adding the effects of the multiple methods or would understate it by including a large number of devices that had almost no lethality, generally, and more important, in any specific 2-year periods.

Attacks With Incendiary Devices

Attacks with incendiary devices vary slightly from arson, where a flammable substance is lighted by hand. Arson take less skill than detonating an incendiary device, which involves using some mechanism, often a crude one, to ignite a flammable substance away from the perpetrator. The device could be as simple as a Molotov cocktail, in which a cloth wick is used.

There were only 152 attacks using incendiary devices in the Group 1 and Group 2 countries combined. The lethality of the attacks, which involved 290 devices, was very low, and most of the attacks occurred in one country during one 2-year period.

In Group 1 countries, 101 incendiary devices were used in 51 attacks. The attacks, 21 of which were against rail infrastructure, resulted in no fatalities and only 22 injuries.

In Group 2 countries, 189 incendiary devices were used in 101 attacks, killing 57 people and injuring 446. Nineteen of the attacks produced all the fatalities, and all of the attacks were directed at buses. Fifteen of the 19 attacks (the 15 attacks that resulted in 46 fatalities) took place in Bangladesh, and all but one occurred between 2012 and 2014, a period of considerable political strife in which buses were targeted by mobs, protesters, and criminals.

The overall lethality of incendiary device attacks is low: 0.4 FPA and 0.2 FPD. If we exclude the incendiaries targeted against buses in Bangladesh, lethality drops to 0.1 FPA and 0.04 FPD.

In summary, incendiary devices are far less lethal than explosive devices, and most of the incendiary device attacks have taken place in one country. Explosive devices—bombs—were used in far more countries over a longer period of time and were far more lethal. In Group 1 and Group 2 countries combined, 1,943 attacks involved 2,582 bombs, which killed 4,455 people and injured 16,033. The fatality and injury rates per bomb attack were 2.3 FPA and 8.2 IPA, many times greater than those of incendiary attacks (1.7 FPD and 6.2 IPD).

This is not to suggest that fire caused by arson or by incendiaries (or by explosives, for that matter) is not lethal. On February 18, 2003, a subway fire in Daegu, South Korea, was started by a passenger wanting to commit suicide. He ignited two milk cartons filled with a flammable liquid on a crowded train, killing 198 people and injuring about 150, the largest single death toll in any attack in economically advanced countries and the third most lethal in all countries combined. The fire engulfed one train and an adjoining train. (The most lethal attack involving bombs in the MTI database is a July 11, 2006, attack by Lashkar-e-Tayyiba [LeT], a jihadist group, on commuter trains leaving Mumbai, in which seven bombs detonated, killing 200 and injuring 625.)

In another attack, on February 18, 2007, improvised explosive devices (IEDs)—which could be considered improvised incendiary devices (IIDs)—consisting of fuel oil and chemicals were planted by the jihadist Kashmiri Separatist Group in the baggage compartment of the Samjhawta Express in India. The resulting detonation killed 66 people and injured more than 50, and 66 people were subsequently killed as a wall of flame engulfed the wooden passenger compartments.

These examples show that flames and fast-rising temperatures and smoke from fire can be very quickly lethal, especially if they are in confined areas from which escape is difficult.

Bombs Used in Combination With Other Methods

In Group 1 countries, bombs were used with other methods in only 4 out of 468 attacks. In Group 2 countries, combinations were used in only 214 out of 3,369 attacks. However, the lethality of many of these attacks was very high in Group 2. Derailments involving bombs placed on the tracks killed as many as 27 people, with few fatalities caused by the bombs themselves. There were 160 such attacks, which resulted in 82 deaths, for a lethality of 0.5 FPA. However, when grenades or other bombs (such as VBIEDs) were

used in combination with automatic or semiautomatic weapons in 33 attacks, 16 against bus targets and 13 against train or rail targets, as many as 31 people were killed, with lethality at 3.2 FPA. But in each situation, there is no way of knowing which weapon caused the most deaths. Because including these attacks might overstate the lethality of explosives, we excluded them from our analysis, except when they are addressed as a separate attack group.

Outliers

As discussed earlier, some attack narratives contain only a general description, not any numbers. Three of the attacks mentioned above caused no fatalities, despite the fact that one took place in a train station. Including these attacks would understate bomb lethality in general, particularly for the 2016–2017 period in Group 2 countries. Therefore, we excluded them from our analysis.

OVERALL VOLUME AND LETHALITY OF BOMB ATTACKS

In the following discussion, we exclude bombs used in combination with other attack methods. However, we include them in the analysis immediately below that compares all variations of the use of bombs.

Nearly 51% of the attacks in Group 1 and Group 2 countries used explosives, 43.6% used no explosives, and the remaining 5.7% used explosives in combination with other methods (see Table 4). Overall, explosives predominated over other attack methods.

However (also shown in Table 4), there are striking differences between Group 1 and Group 2 countries. Only 16.6% of the attacks in Group 1 countries used explosives (another 0.8% used them in combination with other methods); the vast majority of attacks (83.4%) used none at all. In Group 2 countries, nearly 55.7% of the attacks used explosives alone, and 6.3% used them in combination, while only 37.9% used no explosives. Attacks in the developing world use explosives, alone or in combination with other methods, far more often than attacks in the economically advanced countries. (Because we are not dealing with lethality here, we have included the 3 attacks that used a large number of devices.)

Table 4. Attacks Using Explosives Alone or in Combination with Other Methods

Country Groups	Attacks Using Only Explosive Devices	% of All Attacks	Attacks Using No Explosives	% of All Attacks	Attacks Using Explosives and Other Attack Methods	% of All Attacks	Total
Group 1	75	15.8%	397	83.4%	4	0.8%	476
Group 2	1872	55.7%	1275	37.9%	213	6.3%	3360
Group 1 & 2	1947	50.8%	1672	43.6%	217	5.7%	3836

Many of the bombs used in Group 2 attacks were “crude bombs,” which are sometimes thrown. While that may account for part of the difference between attacks in the two sets of countries, there is also another reason, stated in an earlier report:

Particularly in Group 1 countries, controls on explosives and precursor chemicals have been strengthened. Dynamite and commercial blasting caps were once easily obtained in the United States and accounted for most of the bombings in the 1970s. Their use required minimal skill. In contrast, buying black powder from a gun store entails risks of attracting attention. Small quantities of explosives can be removed from fireworks, but it is difficult to amass large amounts. Purchases of fertilizer in large quantities by unknown customers are monitored.

With commercial explosives more highly controlled, would-be bombers must manufacture the explosive components, which is technically more challenging. In addition, traveling to obtain bombmaking skills has become more perilous. Finally, since most of the attacks in Group 1 countries are one-offs that are planned, prepared, and carried out by a single attacker rather than a group, there is no learning curve to improve skills. Each would-be bomber begins with the skills he has and can learn from the Internet or other available sources. Not surprisingly, the success rate of bombings has declined, which may indicate the increased difficulty of gaining explosives in Group 1 countries, increased prevention of more deadly attacks (which almost always involve explosives in those countries), or a shift in the mix of attackers to those both unable or unwilling to create large body counts.[4]

Bomb attacks usually involve only one device, as shown in Table 5: 83.9% of all the attacks used only 1 device, 15.3% involved between 2 and 5 devices, 0.8% involved from 6 to 24 devices, and one attack used as many as 40 devices.

In Group 1, 78.5% of the bomb attacks involved only 1 device, 19% involved 2 to 5 devices (this includes the London attack, which involved 4 devices), and only 2 (2.5%), including the attack in Madrid, in which 13 devices were used, involved more than 6 devices. In Group 2, 84.1% of the bomb attacks involved only 1 device, 15.2% involved 2 to 5 devices, and 0.7% involved more than 5 devices.

Table 5. Number of Bombs Used in Attacks

Country Groups	Attacks With Devices	Attacks With 1 device	% of All Attacks	Attacks with 2-5 Devices	% of All Attacks	Attacks with 6+ Devices	% of All Attacks
Group 1	79	62	78.5%	15	19.0%	2	2.5%
Group 2	2086	1754	84.1%	317	15.2%	15	0.7%
Group 1 & 2	2165	1816	83.9%	332	15.3%	17	0.8%

4 Jenkins and Butterworth, 2022.

FREQUENCY AND LETHALITY OF BOMB ATTACKS OVER TIME

In Group 1, attacks using bombs and no other attack method involved 120 devices with a lethality of 2.2 FPD and 23.1 IPD (see Table 6). Nearly 20 times as many devices (2,394) were used in attacks in Group 2. This is not particularly remarkable, given the large populations of developing countries. The FPD for Group 2 was actually somewhat lower (1.8 versus 2.2), and IPD was also lower (5.6 versus 23.1), although this is due to the large number of fatalities and injuries in the Madrid and London attacks in Group 1 (which resulted in a total of 243 fatalities and 2,500 injuries).

Table 6. Number and Lethality of Devices Used in Bomb Attacks

Country Groups	# Devices	# Fatalities	# Injuries	FPD	IPD
Group 1	120	265	2778	2.2	23.1
Group 2	2394	4301	13520	1.8	5.6
Group 1 & 2	2514	4566	16298	1.8	6.5

As shown in Figure 7, there was a downward trend in the number and percentage of bombs used in Group 1, despite an upward trend for the 2012–2017 period. However, if the 17 devices used in the Madrid and London attacks were excluded, the other 15 bomb attacks would have generated a less steep downward trend, close to level.

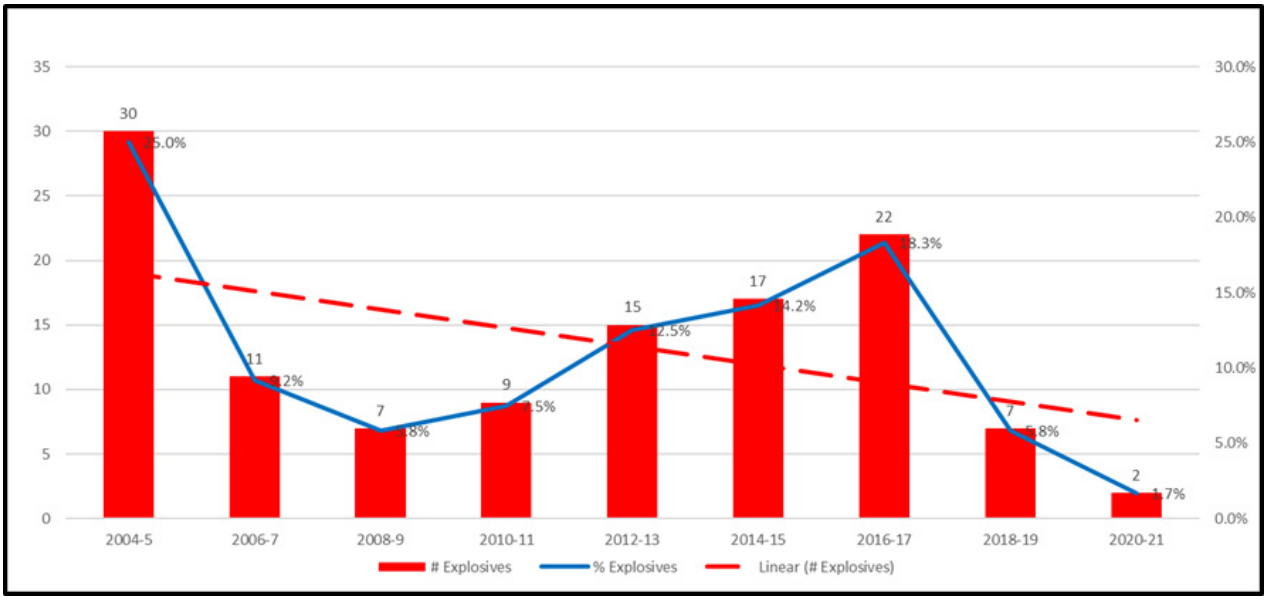

Figure 7. Number and Percentage of Bombs in Group 1 Attacks Over Time

As shown in Figure 8, there was also an overall downward trend in the number of explosives used in Group 2 attacks, despite an upward trend between 2008 and 2015.

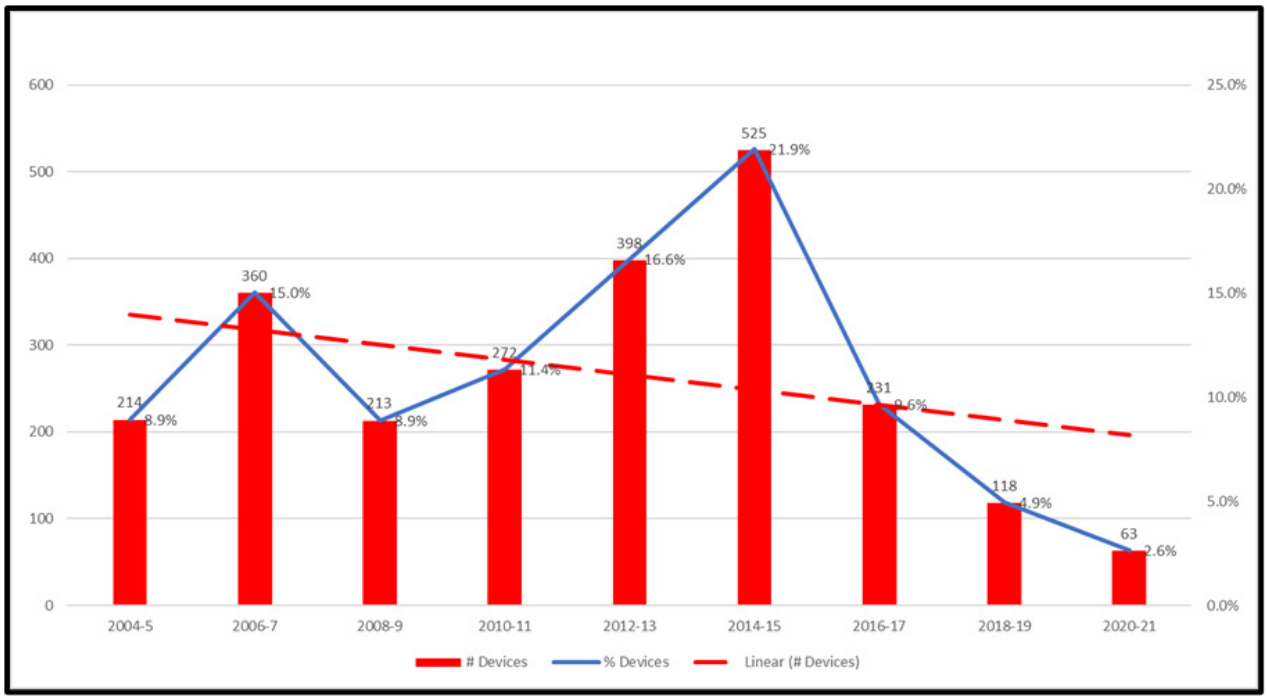

Figure 8. Number and Percentage of Bombs in Group 2 Attacks Over Time

In terms of lethality of bomb attacks, Figure 9 shows that FPD decreased for Group 1 if the bomb attacks in Madrid and London in the 2004–2006 period are included. If they are excluded (Figure 10), lethality increased in the 2016–2019 periods.

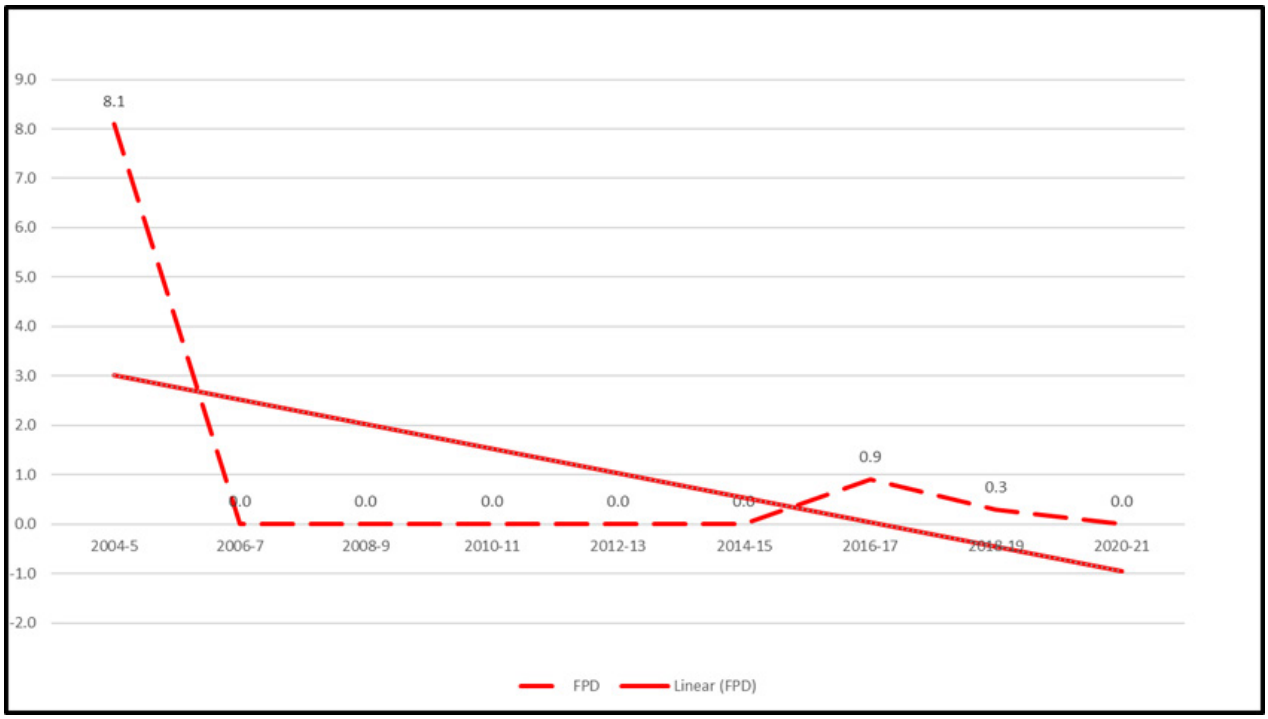

Figure 9. Lethality of Explosive Devices in Group 1 Attacks Over Time, Including Madrid and London Attacks

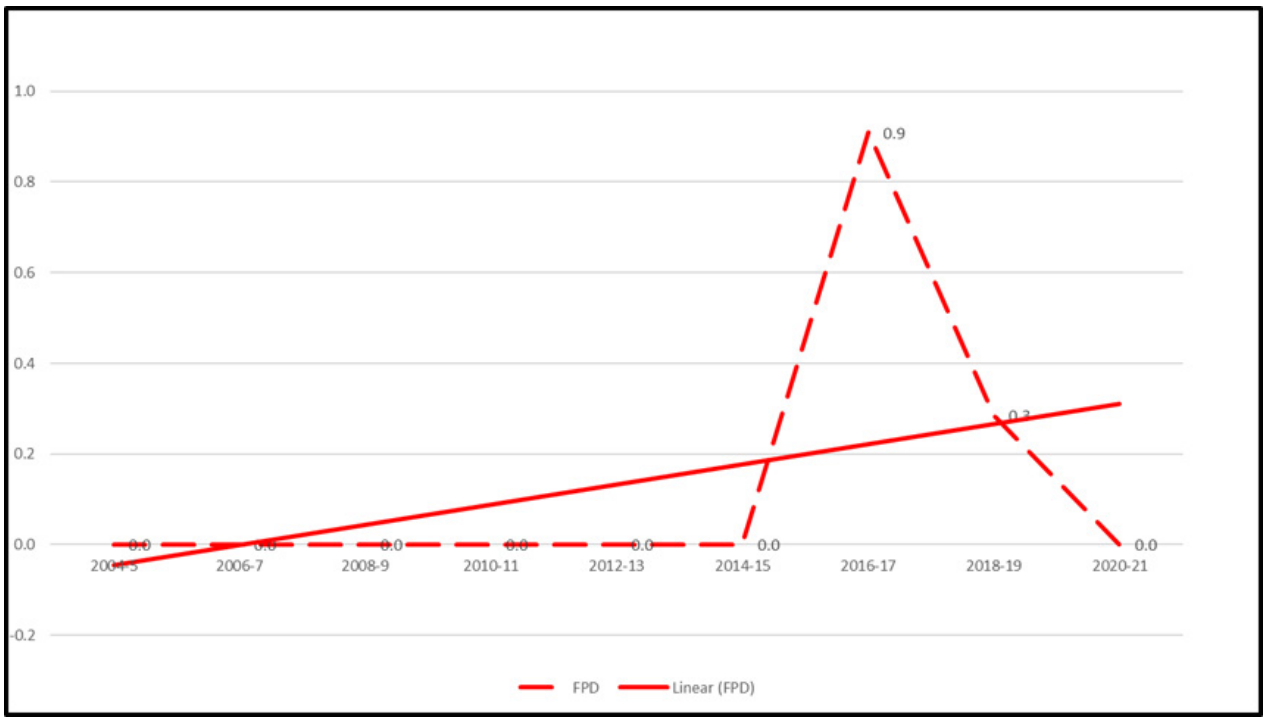

Figure 10. Lethality of Explosive Devices in Group 1 Attacks Over Time, Excluding Madrid and London Attacks

In contrast, the FPD of bombs used in Group 2 attacks went up and down, but the overall trend was slightly upward (Figure 11).

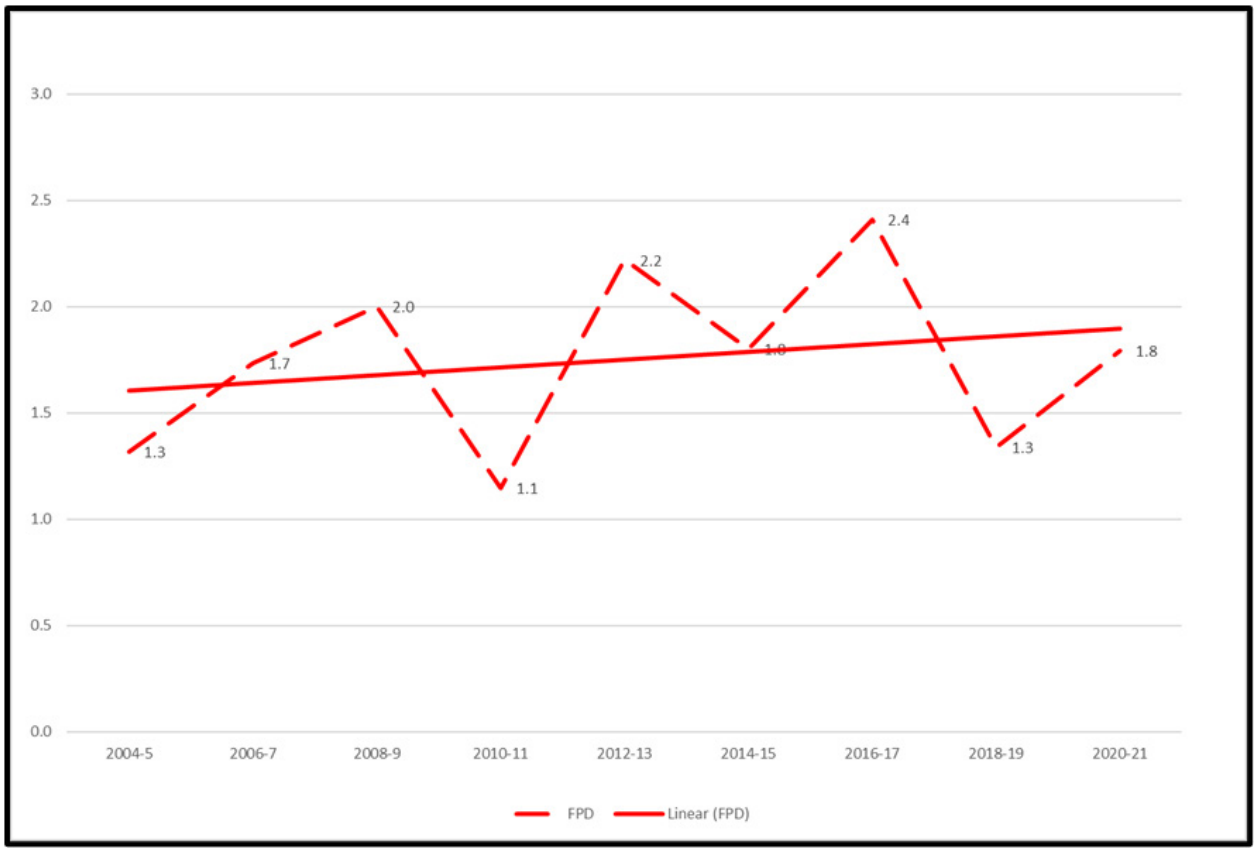

Figure 11. Lethality of Explosive Devices in Group 2 Attacks Over Time

METHOD OF PLACEMENT AND CONCEALMENT

Devices Used in Group 1 Attacks

As shown in Table 7, the most frequently used method of placing bombs in Group 1 attacks was to leave them inside a train or bus passenger compartment (35.8%), followed by placing them on railroad tracks (20.8%), then by placing them inside train stations or stops (20%); these three methods were used for 76.7% of all the bombs used. A few other methods were used infrequently and without much lethality. Bombs were placed outside a station or stop in 9.2% of the attacks and on a vehicle road in 2.5% of the attacks. One placement method was unknown.

In terms of lethality, suicide bombers carrying explosives (9.2% of attacks) generated 6.5 FPD, about 3 times the overall average. Next in lethality were non-suicide bombs detonated inside passenger compartments, where enclosed spaces maximized the effect of pressure waves and shrapnel (4.4 FPD). Bombs detonated inside stations produced no fatalities, and those detonated outside of stations produced only 2 fatalities,

Figure 12 shows the great variation in placement methods over time. The only finding that does not seem to be random is a peak for many placement methods in the three 2-year periods from 2010 to 2016, which matches the increase in attacks and an increase in placement on roads in 2016–2017.

Figure 13 shows the low lethality of attacks in Group 1 countries in which bombs were placed inside passenger compartments (with the exception of the Madrid attack) and of suicide bombings in London (2005) and Brussels (2017).

Table 7. Bomb Placement and Concealment Methods in Group 1 Attacks

Bomb Placement Method	# Devices	% Devices	# Fatalities	% Fatalities	# Injuries	% Injuries	FPD	IPD
INSIDE PAX COMPARTMENT	43	35.8%	191	72.1%	1854	66.7%	4.4	43.1
ON RAIL TRACKS	25	20.8%	0	0.0%	0	0.0%	0.0	0.0
INSIDE STATION OR AT STOP	24	20.0%	0	0.0%	0	0.0%	0.0	0.0
OUTSIDE STATION OR STOP	11	9.2%	2	0.8%	14	0.5%	0.2	1.3
SUICIDE BOMBER	11	9.2%	72	27.2%	874	31.5%	6.5	79.5
ON A VEHICLE ROAD	3	2.5%	0	0.0%	2	0.1%	0.0	0.7
VBIED	2	1.7%	0	0.0%	34	1.2%	0.0	17.0
OTHER OR UNKNOWN	1	0.8%	0	0.0%	0	0.0%	0.0	0.0
Total/Percentages/Averages	**120**	**100.0%**	**265**	**100.0%**	**2778**	**100.0%**	**2.2**	**23.1**

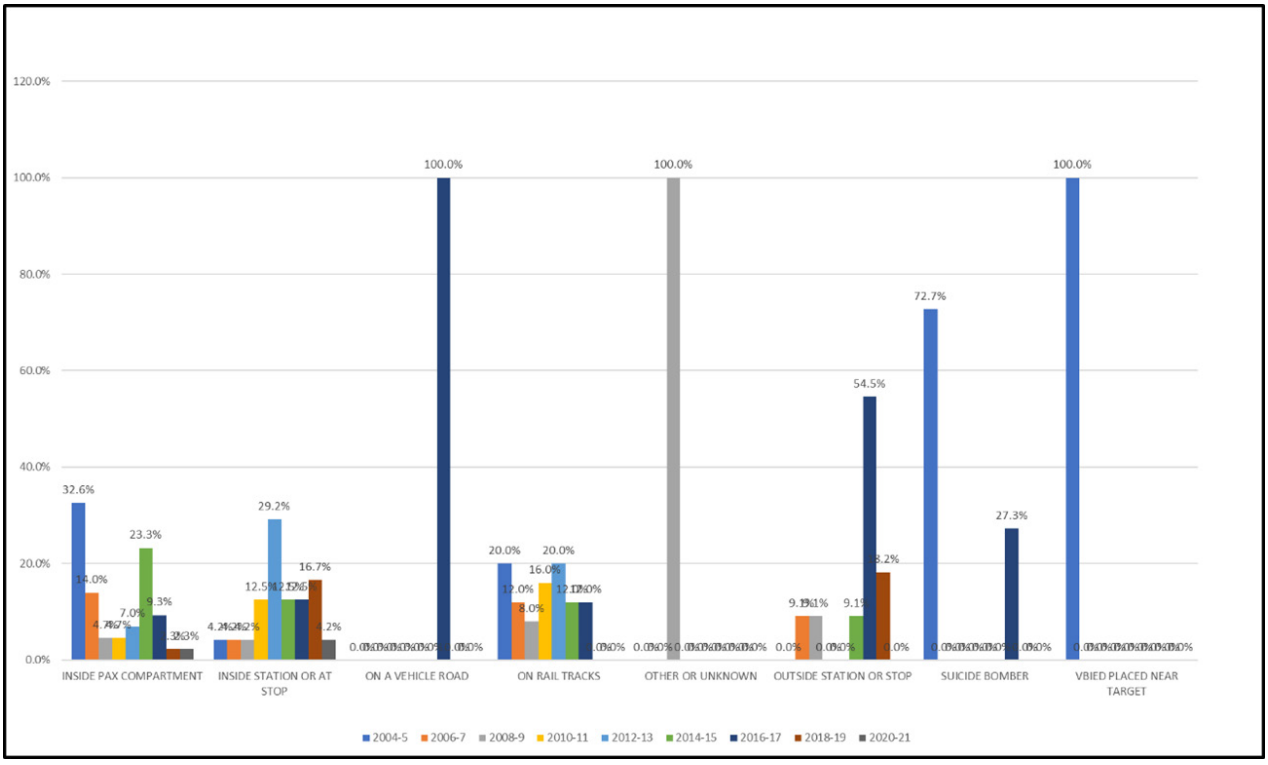

Figure 12. Percentage of Bomb Placement and Concealment Methods in Group 1 Attacks Over Time

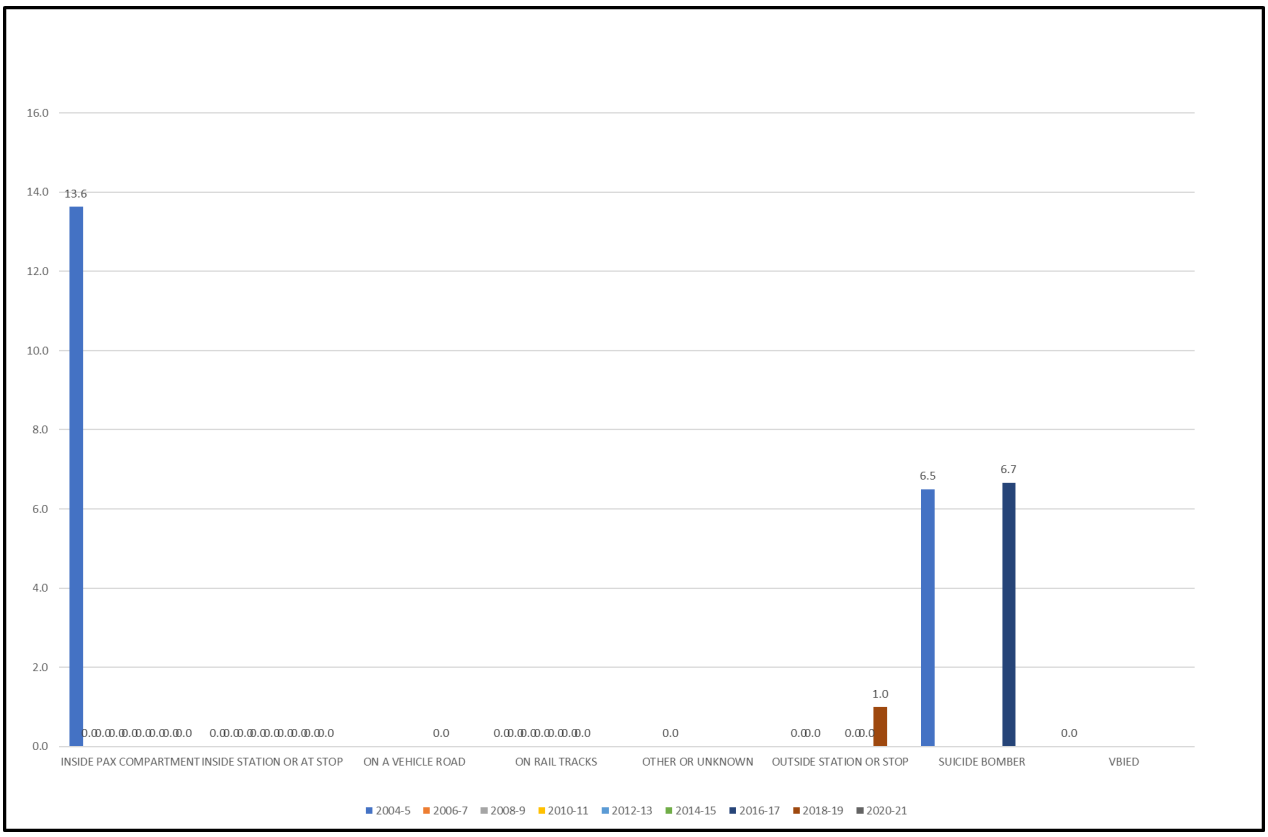

Figure 13. Lethality of Bomb Placement and Concealment Methods in Group 1 Attacks Over Time

Devices Used in Group 2 Attacks

In Group 2 countries, there were far more bombing attacks than in Group 1, and their lethality, which trends slightly upward, was also much greater. The distribution among the top placement methods is also different from that in Group 1.

As shown in Table 8**,** the most frequently used methods of placing or concealing bombs in Group 2 attacks were placement on railway tracks (34.9%), followed by placement inside train and bus passenger compartments (19.2%), then placement inside stations or stops (12.6%). These three placement methods, which are different from the most frequently used methods in Group 1 attacks, were used for 66.7% of all devices placed. The next most frequent placement was on a vehicle road (8.6%), followed by physical throwing (7.3%). There were no incidents in Group 1 in which bombs (e.g., grenades) were thrown.

The pattern of lethality in Group 2 is also far different from that in Group 1. Suicide bombers and bombs detonated inside passenger compartments were the most lethal methods in Group 1 attacks, while in Group 2, the most lethal methods by far involved VBIEDs, both suicide (13.6 FPA) and non-suicide (8.6 FPA), followed by suicide attackers carrying bombs (5.0 FPA), which, interestingly, was less lethal than in Group 1 countries (4.9 FPA). Also, bombs placed on railway tracks in Group 2 countries caused very few fatalities, reflecting the fact that most bomb attacks in these countries (e.g., those conducted by Maoist groups in India or Basque groups in Europe) are most often aimed at disruption.

Figure 14 shows considerable variability in device placement methods in Group 2 countries over time. The only trend that does not seem to be random is a peak in the three 2-year periods from 2010 to 2015. Also, in contrast to Group 1, only one placement method in Group 2 increased in the last 2-year period examined here, placement on vehicle roads.

Figure 15 shows wide variations in the two most lethal device placement methods, placement on the exterior or interior of trains or buses, and non-suicide VBIEDs.

Table 8. Bomb Placement and Concealment Methods in Group 2 Attacks

Bomb Placement Method	# Devices	% Devices	# Fatalities	% Fatalities	# Injuries	% Injuries	FPD	IPD
ON RAIL TRACKS	835	34.9%	40	0.9%	342	2.5%	0.0	0.4
INSIDE PAX COMPARTMENT	459	19.2%	1092	25.4%	3799	28.1%	2.4	8.3
INSIDE STATION OR AT STOP	302	12.6%	352	8.2%	1567	11.6%	1.2	5.2
ON A VEHICLE ROAD	206	8.6%	822	19.1%	1359	10.1%	4.0	6.6
PHYSICALLY THROWN	174	7.3%	111	2.6%	1053	7.8%	0.6	6.1
SUICIDE BOMBER	100	4.2%	489	11.4%	1314	9.7%	4.9	13.1
OUTSIDE STATION OR STOP	80	3.3%	78	1.8%	433	3.2%	1.0	5.4
OTHER OR UNKNOWN	77	3.2%	189	4.4%	769	5.7%	2.5	10.0
VBIED	71	3.0%	612	14.2%	1404	10.4%	8.6	19.8
ON EXTERIOR OR INSIDE TRAIN OR BUS STRUCTURE	60	2.5%	109	2.5%	320	2.4%	1.8	5.3
SUICIDE VBIED	30	1.3%	407	9.5%	1159	8.6%	13.6	38.6
Total/Percentages/Averages	**2394**	**100.0%**	**4301**	**100.0%**	**13520**	**100.0%**	**1.8**	**5.6**

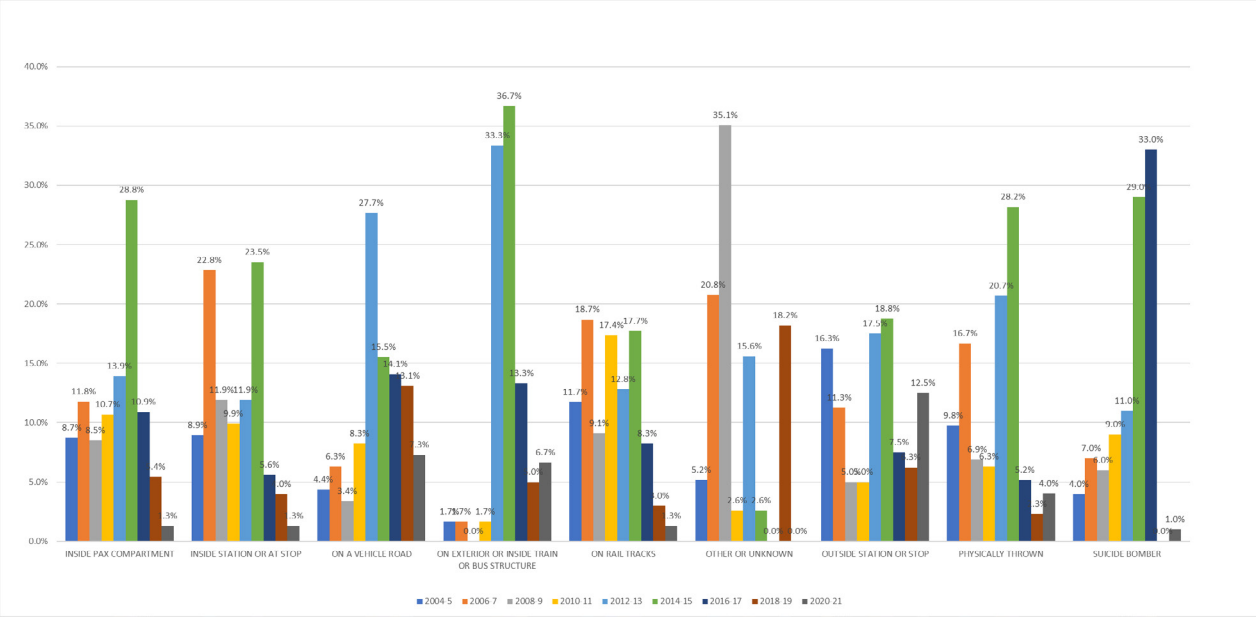

Figure 14. Percentage of Bomb Placement and Concealment Methods in Group 2 Attacks Over Time

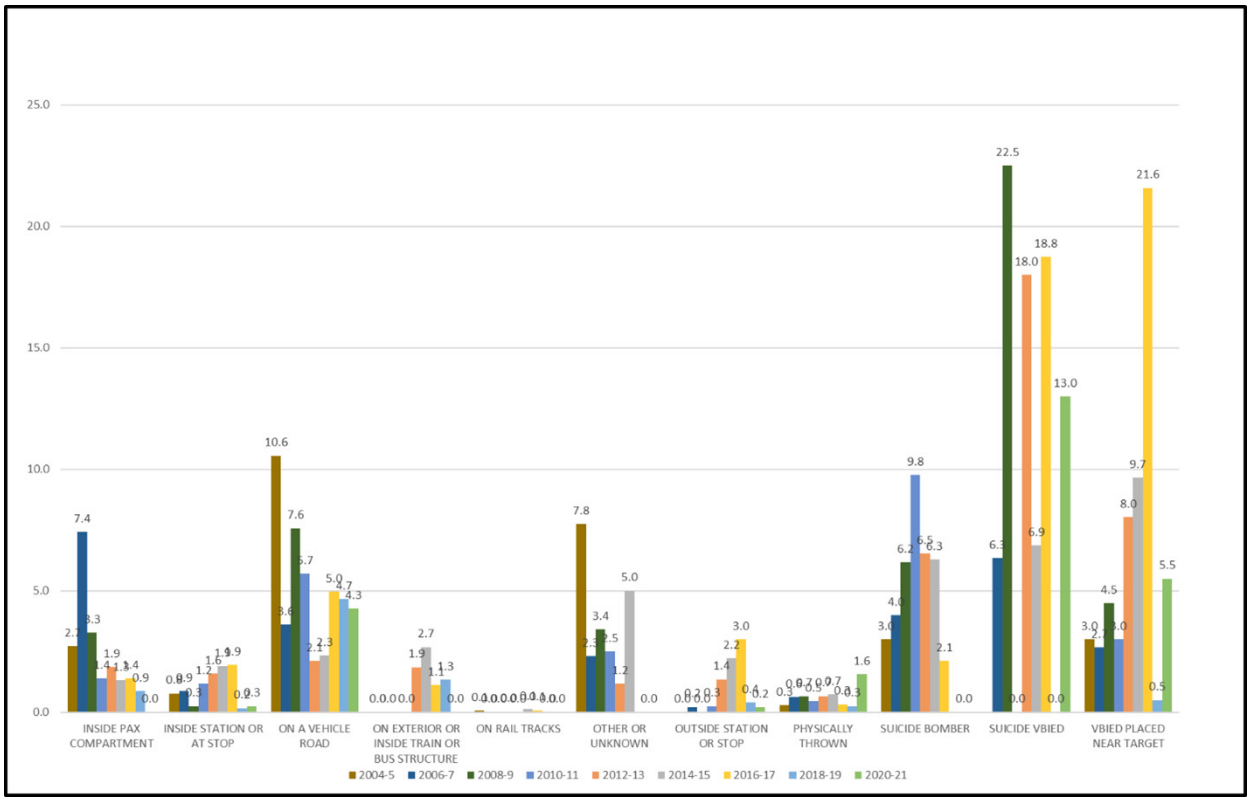

Figure 15. Lethality of Bomb Placement and Concealment Methods in Group 2 Attacks Over Time

ATTACKER SUCCESS AND FAILURE

Our analysis of the success or failure of attacks excludes attacks using combinations of bombs and other methods and also excludes the outlier attacks, because both distort the lethality of bombers.

We compress the outcomes of the attacks into four categories: (1) attacker success (the device went off as planned); (2) attacker failure (the device did not detonate as planned); (3) the device was found and subjected to EOD; and (4) unknown (the outcome is unknown).

We then further compress the data into a single category for attacker success and a single one for attacker failure (eliminating those with unknown outcomes) to determine whether attackers using bombs have become more or less successful over time.

Group 1 Analysis

As Table 9 shows, 120 explosive devices were used in attacks in Group 1 countries (there were also 4 attempts to use a bomb in a derailment that produced no fatalities and 1 attack in which an explosive device was used along with automatic weapons, killing 4 people). Of the attacks using the 120 devices, 37.5% were successful in that they detonated or were released on target; another 11.7% detonated early or away from the target; almost 44% percent were discovered and rendered safe; 5% failed to detonate; and 0.8% detonated during an unsuccessful EOD operation. The outcomes of the remaining 1.7% are unknown.

In terms of attacker successes or failures, bombs failed 44.2% of the time (combining the two outcomes that were failures), as shown in Table 10.

Table 9. Outcome of Bomb Attacks in Group 1 Countries

Device Outcome	# Devices	% Devices	# Fatalities	% Fatalities	# Injuries	% Injuries	FPD	IPD
EOD Successful, Rendered Safe	52	43.3%	0	0.0%	0	0.0%	0.0	0.0
Detonated or Released on Target	45	37.5%	132	50.0%	1461	52.6%	2.9	32.5
Detonated Early or Away from Target, or Malfunctioned	14	11.7%	86	32.6%	901	32.4%	6.2	64.4
Failed to Detonate or Release	6	5.0%	44	16.6%	415	15.0%	7.3	69.2
Unknown	2	1.7%	2	0.8%	0	0.0%	1.0	0.0
Detonated during Unsuccessful EOD	1	0.8%	0	0.0%	0	0.0%	0.0	0.0
Totals/Percentages/Averages	**120**	**100.0%**	**265**	**100.0%**	**2778**	**100.0%**	**2.2**	**23.1**

Table 10. Bomber Success or Failure in Group 1 Attacks

Attacker Success	# Devices	% Devices	# Fatalities	% Fatalities	# Injuries	% Injuries	FPD	IPD
Failure: Found by Authorities	53	44.2%	0	0.0%	0	0.0%	0.0	0.0
Success: Detonated as Planned	45	37.5%	132	50.0%	1461	52.6%	2.9	32.5
Failure: Device did not Detonate as Planned	20	16.7%	131	49.3%	1317	47.4%	6.5	65.8
Unknown	2	1.7%	2	0.8%	0	0.0%	1.0	0.0
Totals/Percentages/Averages	**120**	**100.0%**	**265**	**100.0%**	**2778**	**100.0%**	**2.2**	**23.1**

As Figure 16 shows, attacker success in Group 1 decreased over time, and the percentage of bombs that were found increased significantly, particularly in the 2019–2021 period. The overall percentage of devices that failed to detonate as planned also decreased slightly.

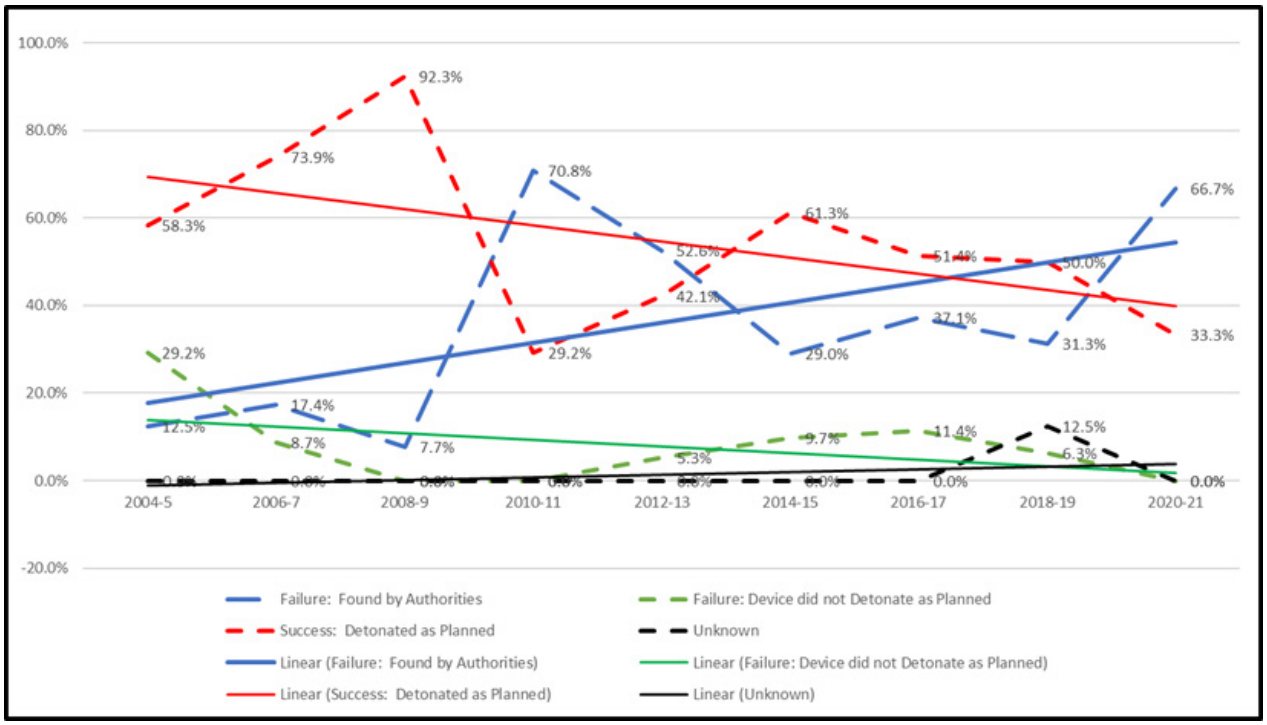

Figure 16. Outcome of Attacks in Group 1 Countries

Excluding attacks in which the outcomes of the devices are unknown, it appears that bomber success in Group 1 is decreasing, and failure (including government and transit operator success) is increasing, as shown in Figure 17.

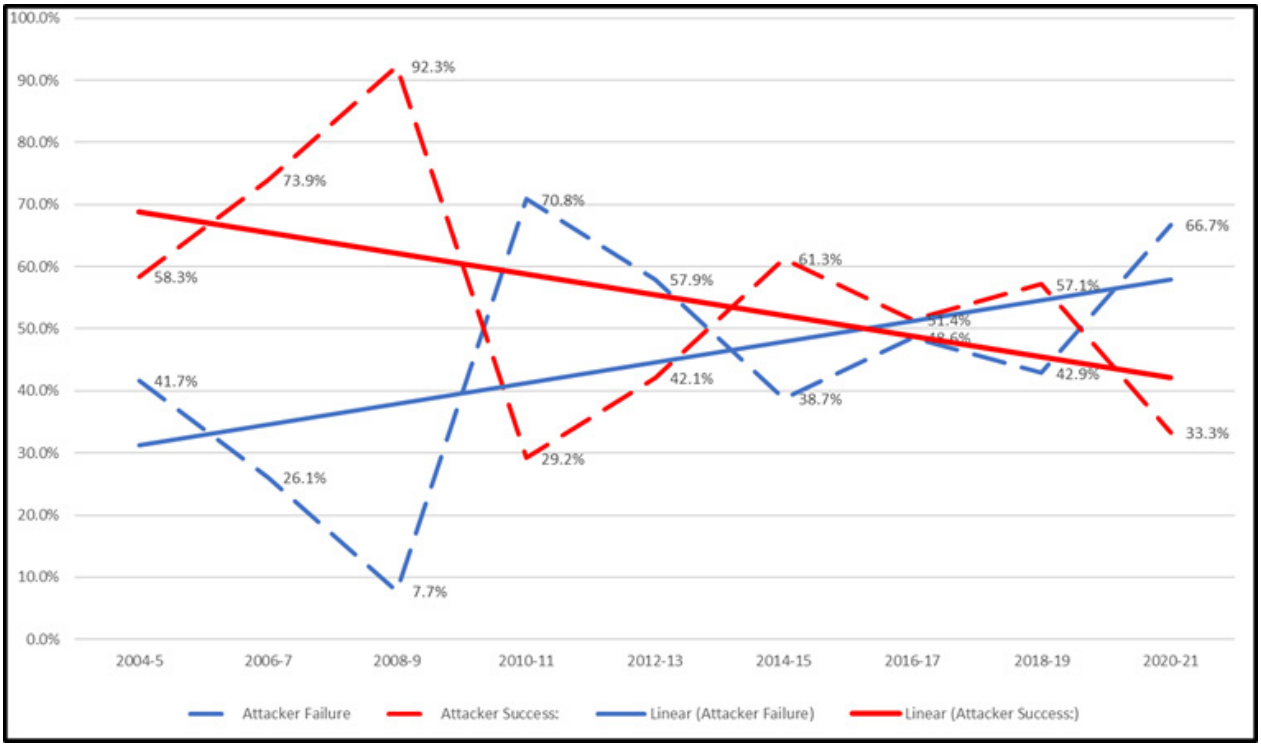

Figure 17. Bomber Success or Failure in Group 1 Attacks

It is important to note that while bombings and bomber success are on the decline, bombs still remain a threat. A suicide IED detonated in Manchester, England, in 2017 killed 17 people; in 2013, bombings killed three people and injured hundreds at the Boston Marathon; and in 2017, a suicide bomber partially detonated a bomb in a New York subway station, wounding four people.

Group 2 Analysis

The trends in bombing attacks in Group 2 countries are somewhat different from those in Group 1.

As shown in Table 11, 2,394 explosive devices were used in Group 2 attacks. The percentage of devices that detonated on target and on time (76%) is more than twice that in Group 1 countries (37.5%). Only 2.3% of the devices in Group 2 countries detonated early or away from the target, in comparison with 11.7% in Group 1. In addition, only 20.3% of the devices in Group 2 countries were subjected to EOD, while in Group 1 countries, 44.1% were detected by EOD.

As shown in Table 12, attackers were successful in 76% of the attacks in Group 2, and 23.9% of the bombings were considered failures. The outcomes of the remaining 0.1% are unknown.

It is difficult to know for certain the causes for the difference between the outcomes of attacks in Group 1 and Group 2, but the greater ease of acquiring explosives and weaker prevention and detection in Group 2 should be considered leading candidates.

Table 11. Outcome of Bomb Attacks in Group 2 Countries

Device Outcome	# Devices	% Devices	# Fatalities	% Fatalities	# Injuries	% Injuries	FPD	IPD
Detonated or Released on Target	1819	76.0%	4195	97.5%	13109	97.0%	2.3	7.2
EOD Successful, Rendered Safe	475	19.8%	19	0.4%	81	0.6%	0.0	0.2
Detonated Early or Away from Target, or Malfunctioned	56	2.3%	69	1.6%	309	2.3%	1.2	5.5
Failed to Detonate or Release	28	1.2%	10	0.2%	4	0.0%	0.4	0.1
Detonated during Unsuccessful EOD	13	0.5%	8	0.2%	17	0.1%	0.6	1.3
Unknown	3	0.1%	0	0.0%	0	0.0%	0.0	0.0
Totals/Percentages/Averages	**2394**	**100.0%**	**4301**	**100.0%**	**13520**	**100.0%**	**1.8**	**5.6**

Table 12. Bomber Success or Failure in Group 2 Countries

Attacker Success	# Devices	% Devices	# Fatalities	% Fatalities	# Injuries	% Injuries	FPD	IPD
Success: Detonated as Planned	1819	76.0%	4195	97.5%	13109	97.0%	2.3	7.2
Failure: Found by Authorities	488	20.4%	27	0.6%	98	0.7%	0.1	0.2
Failure: Device did not Detonate as Planned	84	3.5%	79	1.8%	312	2.3%	0.9	3.7
Unknown	3	0.1%	0	0.0%	0	0.0%	0.0	0.0
Totals/Percentages/Averages	**2394**	**100.0%**	**4301**	**100.0%**	**13520**	**100.0%**	**1.8**	**5.6**

Figure 18 shows that the percentage of bombs that detonated as planned in Group 2 attacks decreased, although not by as much as in Group 1, and the percentage of those that did not detonate as planned increased, but far less dramatically than in Group 1. The percentage of those found by authorities went up, but not as much as they did in Group 1.

Figure 18. Outcome of Attacks in Group 2 Countries

As shown in Figure 19, the rate of attacker success in Group 2 has decreased, and the rate of attacker failures (and operator and government success) is increasing but not as dramatically as in Group 1.

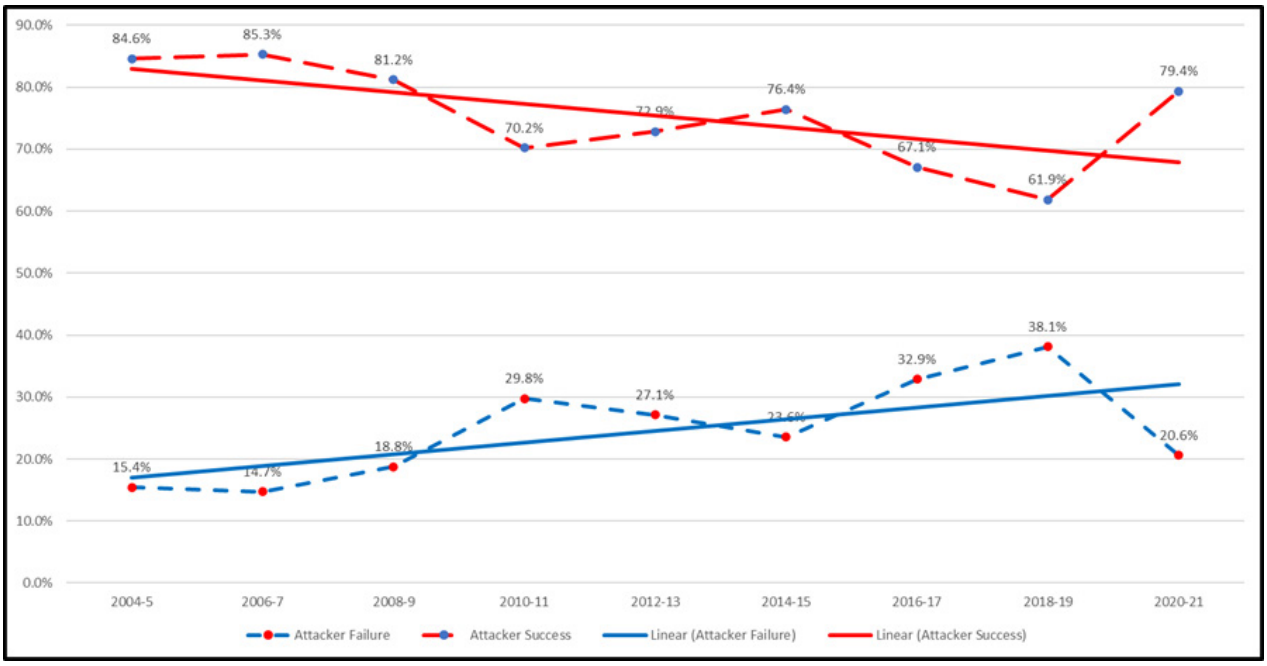

Figure 19. Bomber Success or Failure in Group 2 Attacks

PREVENTION: STOPPING BOMBINGS AND OTHER ATTACKS

Our analysis of prevention considers only attacks that were stopped before they started. The 79 attacks in which some or even all bombs or incendiary devices were found after the attack was initiated—all but 4 were in Group 2 countries—are considered to be attacks not prevented.

We count attacks rather than devices, because while some of the attacks that were stopped involved only one bomb, others involved multiple bombs. A few others also involved attack methods other than explosives, such as incendiaries or sabotage. Table 13 shows the numbers and percentages of bombing attacks that were prevented in both Group 1 and Group 2 countries. As indicated in the first column of the table, 91.6% of the derailments that were prevented involved a bomb on the tracks rather than mechanical sabotage. The three multiple-weapons attacks all involved explosive devices. The overwhelming majority of attacks (357 out of 379, or 94.1%) involved explosives.

Table 13. Bombing Attacks Prevented in Group 1 and Group 2 Countries

Attack Method	Group 1 & 2 Attacks Prevented	Group 1 & 2: % Attacks Prevented	Group 1 Attacks Prevented	Group 1 % Attacks Prevented	Group 2 Attacks Prevented	Group 2 % Attacks Prevented
Explosives	330	87.1%	33	66.0%	297	90.3%
Derailment (91.6% Track Bomb)	29	7.7%	3	6.0%	26	7.9%
Arson & IIDs	11	2.9%	8	16.0%	3	0.9%
Sabotage	6	1.6%	6	12.0%	0	0.0%
Multiple Weapons	3	0.8%	0	0.0%	3	0.9%
Total/Percentagres	379	100.0%	50	100.0%	329	100.0%

Group 1 Analysis

In Group 1 countries, 10.5% of the bombing attacks were prevented. As shown in Table 14, the individual who found the device or called an alarm is unknown in 22 of the attacks (44.0%); in 20 attacks (40%), the discoverer was either a passenger, a citizen, or an employee; and in 8 attacks (16%), the device was discovered by military, police, or security officials, with an occasional lead from intelligence.

Table 14. Preventers of Bombing Attacks in Group 1 Countries

Prevention/Detection Categpory	# Attacks	% Attacks
Unknown	22	44.0%
Passenger-Citizens-Employees	20	40.0%
Security-Police-Military-Intel	8	16.0%
Total/Percentages	**50**	100.0%

There is no way to know for certain, but if the 22 “unknown” preventers are allocated the same way as the 28 “known preventers,” 36 preventers (20 actual plus a theoretical 16 of the unknown attackers) would be passengers, citizens, or employees, and the remaining 14 (8 known plus 6 hypothetical) would be security, police, military forces, or, in a few cases, intelligence organizations.

Figure 20 shows the percentage of attacks that were prevented in two-year periods since 2004. The linear trend is downward; however, there are sharp peaks and valleys, with the percentage rising to 50% in 2008–2009, then falling to 6.1% in 2018–2019, then rising again to 37.9% in 2020–2021. As noted previously, the downward trend cannot be explained by the inclusion of spontaneous attacks on operating or security personnel or sabotage in remote track areas by environmentalist extremists. The results remain the same even when these attacks are excluded. Nevertheless, prevention percentages climbed steeply in the most recent period.

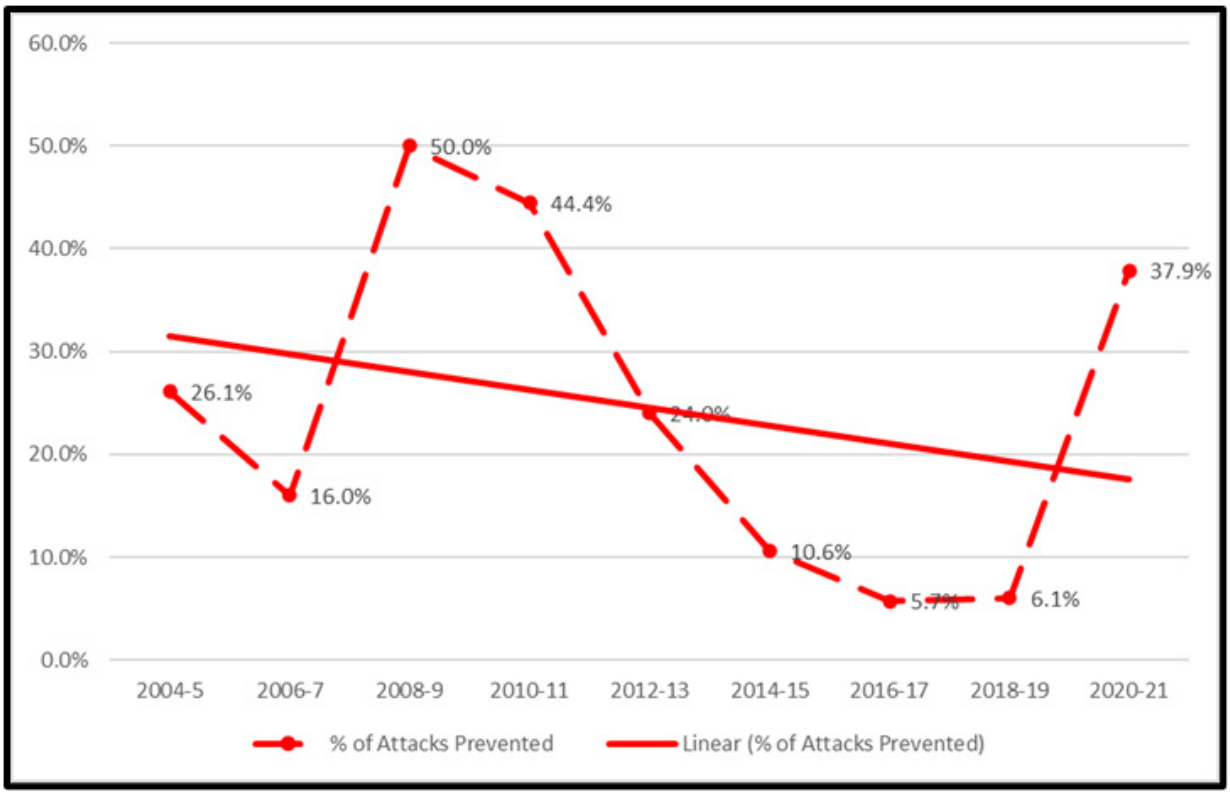

Figure 20. Percentage of Attacks Prevented in Group 1 Countries

Figure 21 shows the percentages of attacks prevented by different categories of parties or individuals. There has been a consistent upward trend in the percentage prevented by unknown individuals, and a very slight increase in those prevented by passengers, citizens, drivers, and employees. The percentage of those prevented by security, police, and military officials has decreased. There are considerable variations in each period, which is understandable, as the number of prevented attacks is fairly small.

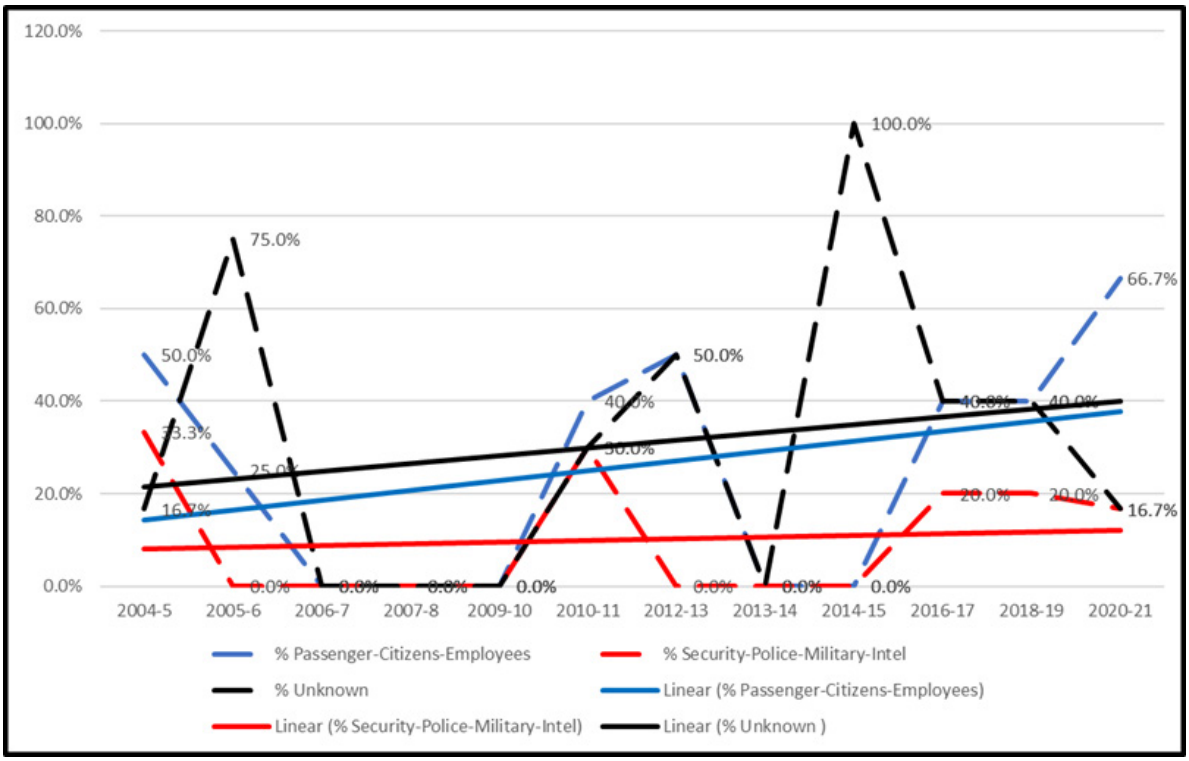

Figure 21. Individuals or Groups Responsible for Preventing Bombing Attacks in Group 1 Countries

Group 2 Analysis

As shown in Table 15, a lower percentage of attacks were prevented in Group 2 countries (9.8% of all attacks versus 10.5% for Group 1). The individual who found a device or called an alarm is unknown in 162 (49.2%) of the prevented attacks; in 99 of the attacks (30.1%), the preventer was a military, security, or police official, with an occasional assist from intelligence sources, and in 68 (20.7%) of the attacks, passengers, citizens, or employees stopped the attack or found the device.

Table 15. Preventers of Bombing Attacks in Group 2 Countries

Prevention/Detection Categpory	# Attacks	% Attacks
Unknown	162	49.2%
Security-Police-Military-Intel	99	30.1%
Passenger-Citizens-Employees	68	20.7%
Total/Percentages	**329**	100.0%

If the 162 “unknown” preventers are allocated the same way as the 167 “known” preventers, then 159 (99 actual and 60 assumed), or 48%, of all the prevented attacks would have been prevented by passengers, citizens, or employees; the remaining 170 (99 known plus 71 assumed), or 52%, of all prevented attacks, would have been prevented by security, police, military forces, and, in a few cases, intelligence organizations.

As Figure 22 shows, the trend of attack detection in Group 2 has increased slightly over time, although since 2016–2017, it has dropped from 13.6% to 5.5%, suggesting a possible decline in the future.

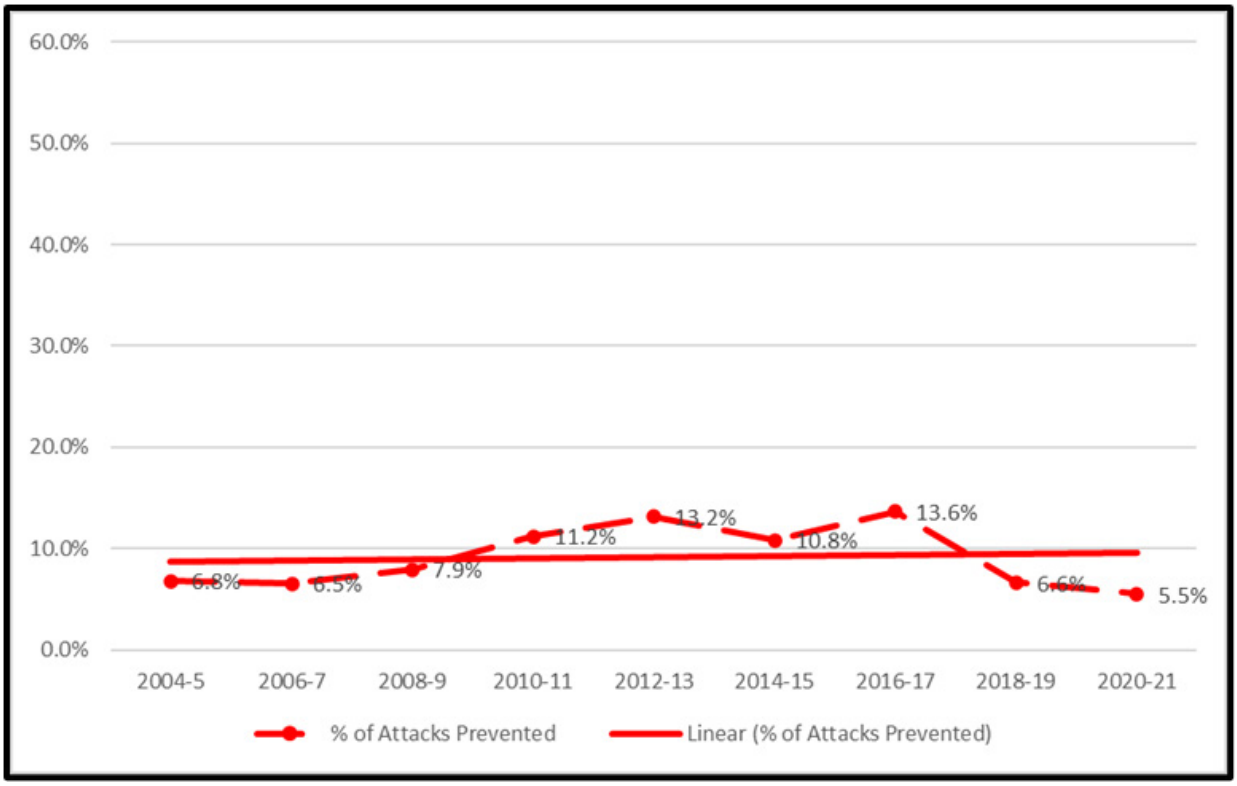

Figure 22. Percentage of Attacks Prevented in Group 2 Countries

Figure 23 shows the change in the percentage of attacks prevented in Group 2 countries by individuals or groups. The percentage of attacks whose detection was attributed to unknown individuals or groups has increased; the percentage attributed to security, police, or military sources has decreased; and the percentage attributed to drivers, transit employees, or citizens has decreased even more.

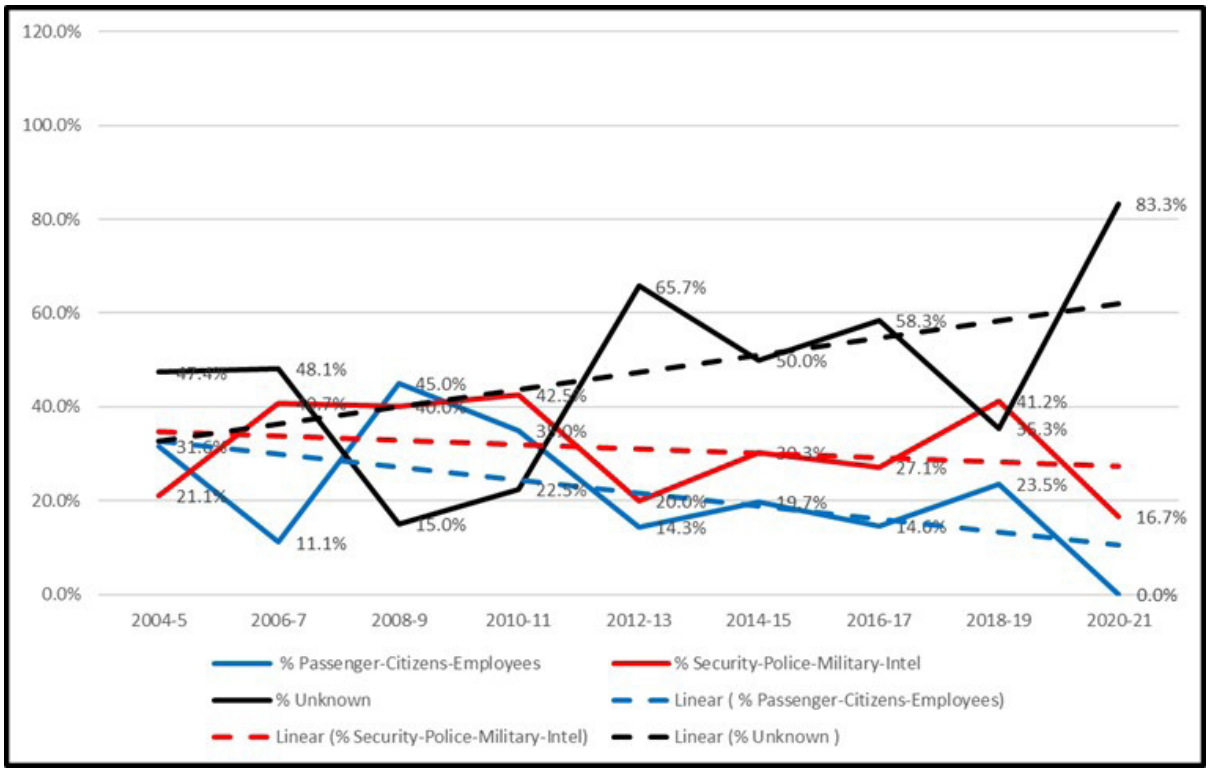

Figure 23. Individuals or Groups Responsible for Preventing Bombing Attacks in Group 2 Countries

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