How Sophisticated are Terrorist Attacks on Passenger Rail Transportation

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Brian Michael Jenkins and Bruce R. Butterworth

Executive Summary

Summary of Key Findings

Terrorist attacks on passenger rail transportation are statistically rare events in the developed world—only about seven attacks per year are carried out against all of the economically advanced countries combined. However, uncovered plots and attempts indicate continuing terrorist interest in attacking transportation targets.

The vast majority of terrorist attacks on passenger rail transportation are aimed at disrupting travel or causing casualties. Most of the attacks (87%) and 100% of the casualties result from attacks on passengers aboard trains and in stations, i.e., where the people are.

We have defined sophistication by identifying four criteria, of which at least one must be met: The attack must (1) involve the recruitment of inside assistance, the use of insider knowledge, or the acquisition of specialized skills through training; (2) require the penetration of manned or closely monitored security systems; (3) involve the use of sophisticated weapons, devices, or means (for an IED to be considered sophisticated, it must do more than simply explode—it must have a timing or remote detonating system that guarantees detonation at a remote time or in a specific location, or it must be miniaturized or disguised so as to evade detection); and (4) must be complex—it must involve multiple actors with individual roles or coordinated simultaneous or near-simultaneous attacks at different locations.

Using those criteria, we find few of the terrorist attacks on public surface transport are sophisticated.

None of the attacks to date have involved penetrating any formidable security measures; two may have involved access to inside information; six involved devices or techniques that could be considered sophisticated; five involved coordinated multipart attacks that could be considered complex.

These counts, however, include four duplicates—that is, cases in which one incident meets more than one criterion. In all, eleven attacks (3.2%) could be considered sophisticated by meeting just one of the four criteria, and four attacks (1.2%) meet two criteria. None of the attacks meet more than two of the criteria of sophistication.

Slaughter does not require sophistication. The deadliest attacks are seldom the most sophisticated.

This does not mean that the possibility of more sophisticated terrorist attacks on transportation targets

should be ignored. It simply underscores the broader conclusion that terrorist attacks in general are rarely sophisticated—they don't have to be.

Terrorists attack "soft" targets, so they have little need to obtain inside information, penetrate security systems, create sophisticated devices (with complicated timing or detonating systems, undetectable chemicals, or cleverly concealed), or carefully time multiple attacks.

Where their preferred targets are more protected, terrorists may try to overcome security measures. The best example of this scenario is commercial aviation. Attacking airliners has been a terrorist obsession since the emergence of contemporary terrorism in the late 1960s, while defeating security seems to have become a quest for bombmakers to demonstrate their skills. However, the commercial aviation example is unique, certainly in transportation and possibly among all targets.

1. Discussion

How sophisticated are terrorist attacks, specifically, those directed against passenger rail? Persons charged with security responsibilities must make assumptions about the attributes of the adversaries they are likely to face. What targets will they most likely strike? What tactics and weapons will they most likely use? It is easy to say that security must prepare for all tactics and weapons, but resources are limited and decisions must be made about how to allocate them. One question that periodically comes up in discussions of the threat is, how sophisticated are terrorist operations?

In the following Security Perspective, we look at recent trends in tactics and weapons. Then, utilizing the Mineta Transportation Institute (MTI) database of attacks on public surface transportation since 1970, we assess the level of sophistication of attacks on passenger rail targets over the past 50 years.

Proliferation of Primitive Attacks

On April 4, 2020, an assailant stabbed seven shoppers and pedestrians along the streets of Romans-sur-Isère, a town in southeastern France. He killed two people and wounded five others before being taken into custody by police.[1] The attack was the third public stabbing in France in 2020. Other stabbing attacks were carried out by terrorists or mentally unstable individuals in Germany and the United Kingdom. While stabbings traditionally have accounted for a large share of all homicides, the use of public stabbing as a terrorist tactic is a recent phenomenon. The publicity surrounding these attacks seems also to inspire mentally unstable persons, who, according to a 2019 MTI report, accounted for nearly one-third of all attacks at surface public transportation venues.[2]

Another MTI report pointed to a long-term increase in terrorist vehicle ramming attacks, but that increase also appears to reflect a contagion effect in which one attack inspires another. Here again, the phenomenon transcends political extremism, with mentally unstable persons responsible for nearly half of the attacks, although the two categories often blur.[3]

Stabbings and vehicle rammings are primitive tactics. The weapons—a knife, a vehicle—are readily accessible, and although some of the attacks are well-planned, planning is not necessary. Some of the attacks appear to be spontaneous.

With few exceptions, the lethality achieved in these attacks is very low. Stabbing attacks have averaged fewer than one person killed (not counting the perpetrators). Vehicle rammings have caused an average of 2.6 fatalities per attack, but that figure includes a single incident in Nice, France, in which a driver plowed a truck through a crowd gathered to watch Bastille Day fireworks, killing 86 people. If that incident is not included, the average number of fatalities per vehicle ramming drops to 2.1.[4]

At the Other End of the Spectrum

At the other end of the spectrum are sophisticated terrorist attacks, including the 9/11 attack. Although the 9/11 attackers used primitive weapons to hijack the airliners—box cutters, utility knives, and pepper spray—the attack was a sophisticated operation that took years to plan and prepare. In contrast to terrorist attacks by a single attacker or tiny conspiracies with limited resources, al Qaeda's planners drew upon the resources of a global terrorist network for recruiting, finance, and operational support. The operation went through several iterations during planning, ultimately settling on four closely coordinated hijackings.

To carry out the attack, al Qaeda's leaders selected and vetted 19 hijackers and infiltrated them into the United States. Six of them enrolled in U.S. flight schools to learn to fly large commercial jets. Others provided the "muscle" for the operation. Many of the attackers were instructed to obtain new passports, some of which were altered by al Qaeda document specialists to facilitate entry into the United States. All were instructed to obtain U.S. driver's licenses so that they would not have to use Middle Eastern passports, which might have attracted more attention.[5]

That al Qaeda was able to assemble a group of this size whose members, despite months of being on their own, away from handlers and continuous external reinforcement, would remain dedicated to carrying out a suicide attack is remarkable.

The attackers carefully studied flight schedules that would enable them to select the flights with the right aircraft and takeoff locations and times that would ensure that all four aircraft would be in the air at the same time and would enable them to hit their targets within minutes of one another while they still had nearly full fuel tanks.

The attackers also spent months watching security procedures at airports, taking reconnaissance flights, and making test runs with the weapons they thought they could pass through security. Meetings to ensure continuing coordination between al Qaeda's central planners and operatives in the United States were held in Malaysia, Germany, and Spain. Despite the movement of people and money, the planners and operatives were able to keep the entire operation secret for the better part of two years.

In terms of its scale, precise planning, acquisition of special skills, deployment, organizational support, reconnaissance, operations security, and final coordination of a complicated operation, the 9/11 attack certainly could be called sophisticated.

The Post-9/11 Trajectory Differs from What was Anticipated

In the shadow of 9/11, more centrally directed, large-scale attacks were expected. The new terrorism was seen as bent upon mass destruction. Analysts anticipated that terrorist violence would continue

to escalate by orders of magnitude, from the tens to the hundreds to the thousands to the tens or even hundreds of thousands.

To cause casualties at this level would require the use of chemical, biological, radiological, or even nuclear weapons. The discovery that al Qaeda had been experimenting with chemical and biological weapons and that its leader, Osama bin Laden, had sought to acquire nuclear weapons seemed to confirm the assumption that such weapons would be used.

The post-9/11 trajectory of terrorism turned out to be quite different. The U.S.-led invasion of Afghanistan destroyed al Qaeda's bases and scattered its leadership, but operatives inspired by jihadist ideology—many of whom were alumni of al Qaeda's training camps—carried on a global terrorist campaign. Between September 11, 2001, and April 2006, jihadist extremists carried out 33 major attacks worldwide.[6] They struck targets in Pakistan, India, Tunisia, Yemen, Indonesia, Kenya, Saudi Arabia, Morocco, Turkey, the Philippines, Spain, Egypt, the United Kingdom, and Jordan. These attacks prompted intensive counterterrorist campaigns and increased international cooperation. Numerous terrorist plots were thwarted.

Meanwhile, concerted efforts led to the arrests or deaths of a number of al Qaeda's leaders. Those still at large were forced deeper underground. It became dangerous for them to communicate. Their finances were squeezed. By mid-2006, the global jihadist campaign began to wane despite the boost to jihadist recruiting given by the U.S. invasion of Iraq. Al Qaeda increasingly used exhortation of home-grown terrorists as opposed to central direction and assistance.

The trend toward decentralization and reliance on remote recruiting of homegrown terrorists continued in the following decade. Concerted counterterrorist campaigns continued to degrade al Qaeda's operational capabilities. Its central leadership became increasingly isolated, although Osama bin Laden remained a charismatic communicator and engaged leader until his death in 2011.

His successor, Ayman al Zawahiri, created a network of autonomous regional al Qaeda affiliates in North Africa, Yemen, Somalia, and later Syria, further shifting power from the center to the periphery. Al Qaeda in the Arabian Peninsula (AQAP) and al Shabaab in Somalia launched their own global communications operations, departing from the stilted sermon-like communications of al Qaeda central to launch online publications that advertised action as much as religious devotion.

Al Qaeda already had an alliance with a nominal affiliate in Iraq, which ultimately emerged as the Islamic State of Iraq and (greater) Syria, or ISIS. The leaders of ISIS were not primarily interested in launching terrorist operations abroad. They were more interested in recruiting individuals to come to Syria to build and defend their newly created Islamic State. Nonetheless, they exhorted homegrown terrorists to carry out attacks and supported a terrorist campaign in Europe led by French and Belgian expats. ISIS was far more effective than al Qaeda in its use of social media and with communications in general.

Remote recruiting has had an effect on terrorist attacks. Most of the recent attacks have been carried out by self-selecting individuals inspired by violent images and ideologies rather than by groups. Today's terrorists lack resources. One arrest usually ends the campaign—there is no institutional learning, on-the-job training, or acquisition of skills through practice. The result is evident in the emergence of less-sophisticated tactics, such as stabbing and car ramming.

The lack of central direction also may explain why there seems to be little evidence of growing sophistication in terrorist attacks over the past 10 or 15 years. Counterterrorist measures—breaking up large terrorist organizations; denying them sanction; forcing them to rely on exhortation; hindering the formation of new domestic groups; preventing continuing campaigns that allow learning—have kept skill levels low.

Attributes of Sophisticated Attacks

There are several ways in which an attack might be considered sophisticated.

The attack plan itself may be considered sophisticated if, for example, it involves multiple operatives with different assigned roles, requires specialized skills or training (e.g., attending flight schools to learn to fly commercial jets), or envisions closely coordinated operations against multiple targets. The 9/11 attacks exemplify these criteria.

Adversaries may be able to recruit inside assistance or gain access to information about a target that is not easily available to the public. The 9/11 hijackers, as far as we know, did not have insider assistance, nor did they obtain information that was unavailable to the public. Nonetheless, using public sources, they were able to obtain information about flights, details of various commercial aircraft, and information on the types of aircraft flown on various routes to select their targets.

In a sophisticated attack, the attackers may need to penetrate manned or closely monitored security perimeters or overcome significant physical barriers. Again, the 9/11 hijackers met this criterion. They did so not by force, but by guile. They carefully observed and studied security procedures, acquired documentation (driver's licenses) that would arouse less suspicion, and avoided weapons that were within the rules but likely to raise alarms if discovered—the exception was pepper spray, which was prohibited. They also conducted test runs to ensure that their methods worked.

(In the authors' opinion, they also benefited from the appalling and therefore seemingly obvious failure on the part of the airlines to wholeheartedly implement aviation security measures that were in effect at the time, along with the government's unwillingness to impose stronger measures and demand their full implementation. Security systems that appear unprofessional and weak draw the attention of attackers, and we regrettably believe this one did.)

Sophisticated attackers may employ advanced weapons or specialized devices. This criterion refers to something more than an improvised explosive device that works. The 9/11 hijackers did not employ advanced or sophisticated weapons.

We recognize that assessing sophistication calls for judgments. There is no precise distinction between a more sophisticated attack and a less sophisticated attack. In the vast majority of cases, however, the distinction is clear.

Examples of Sophisticated Terrorist Operations

A number of terrorist attacks have displayed sophisticated planning in the form of complex multipart attacks, e.g., the coordinated hijackings of five airliners by Palestinian terrorists in 1970. In that

operation, the planes were hijacked over a four-day period (September 6 through 9) on flights from Amsterdam, Frankfurt, Zurich, and Bombay, all bound for New York. Three of the four aircraft—those departing from Zurich, Frankfurt, and Bombay—were flown to Dawson's Field, formerly Royal Air Force (RAF) station Zerqa, and an airstrip under Palestinian control in Jordan. The plane that left from Amsterdam was blown up in Cairo. After de-planing the passengers, the three planes in Jordan were blown up on September 12. (There was also a failed attempt on September 6 to hijack an El Al aircraft bound for New York from Amsterdam. The hijacker was killed by an Israeli air marshal after the pilot threw the aircraft into a steep dive, and an accomplice was released as part of the negotiations that led to the release of the remaining passengers held by the hijackers in Jordan.)

In 1995, terrorists planned to sabotage 11 commercial airliners flying across the Pacific. Had the plot succeeded, the number of casualties could have surpassed those of 9/11. The terrorists built devices using small amounts of various liquid explosives and battery and detonating components that could evade detection and could be hidden in small items such as toys. They tested the devices in a Manila theater and then on a commercial flight from Manila to Tokyo to make sure they would work. An accidental fire at the apartment where the bombs were being assembled led to discovery of the plot.

In near-simultaneous attacks in 1998, al Qaeda terrorists detonated truck bombs at the U.S. embassies in Nairobi, Kenya, and Dar es Salaam, Tanzania. Al Qaeda also planned a more complex terrorist barrage to coincide with New Year celebrations in 2000. The plot involved the sinking of a U.S. destroyer, but it failed.

Terrorists rarely attack targets where they have to penetrate security. However, in conflict zones, they have sometimes carried out large-scale assaults on protected targets. Some of these involved crashing vehicle-borne explosive devices (VBIEDs) into barriers to open the way for more VBIEDs or ground forces. In September 1986, hijackers dressed as security personnel and driving what appeared to be a security vehicle gained access to Pan Am flight 73, a 747 aircraft preparing for takeoff in Karachi, Pakistan. The flight crew managed to escape the aircraft, prompting the hijackers to demand another flight crew. At some point during negotiations, the power to the aircraft failed and, perhaps anticipating an assault, the hijackers massed the passengers and cabin crew in the center of the aircraft and began killing them. In the end, 22 passengers died and another 125 were injured.

The greatest terrorist creativity and sophistication has been shown in their bomb-making skills. Terrorists want to make bombs that can be transported without accidentally going off, can be reliably detonated on command or with some remote detonating system, and can pass through security systems to get at highly desired targets such as commercial airliners. The challenge in using large vehicle-borne devices is ensuring that the entire quantity of explosives detonates at the target. Where groups have continued bombing campaigns over a period of time, skilled bomb-makers have emerged, and their bombs have become more sophisticated.

In the 1984 Brighton Hotel bombing in England, the Provisional Wing of the Irish Republican Army (IRA), then in the second decade of its terrorist campaign, operating on good information, concealed a bomb in the room above the suite where the prime minister of the United Kingdom would be staying for a conference the following month. The device was wrapped in plastic wrap (cling film) to mask any emissions that explosive-detection K9s (police dogs) might detect. The unique feature of the device was a long-delay timer that detonated the bomb 28 days later. The prime minister escaped injury, but five other people were killed.

A small bomb that brought down Pan Am 103 in 1988 was concealed in a radio cassette player in a suitcase smuggled aboard a connecting flight. The bomb contained a two-stage timing and barometric-pressure device that would cause it to detonate after the connecting Pan Am flight reached altitude. The perpetrators had inside knowledge of the luggage transfer systems—one was a former head of airline security for the Libyan national airline, Libyan Arab Airlines. Another fairly sophisticated device was carried by the so-called "shoe bomber" in 2001. In this case, a miniature device using home-made explosives (triacetone triperoxide, TATP) and other components, was concealed in a shoe. It is not certain, however, that the bomb would have brought the aircraft down, and the bomber's difficulty igniting it prompted cabin crew and passengers to subdue him.

In 2010, AQAP built two bombs, concealed them in computer ink cartridges, and shipped them first aboard passenger flights. They were then to be transferred to a FedEx and also a UPS all-cargo flight bound for the United States, with the bombs presumably to detonate while those flights were over U.S. cities. Fortunately, because of intelligence provided by Saudi authorities, they were discovered at en route stopovers, one at East Midlands Airport in the United Kingdom and one in Dubai in the United Arab Emirates. It is uncertain whether they would otherwise have been detected.

There were further reports in 2016 and 2017 of tiny bombs concealed in electronics on airplanes.[7] In general, however, the availability of volunteers for suicide missions obviated the need for elaborate mechanisms to ensure remote detonation.

The 1995 sarin attack on Tokyo's subways was the only large-scale terrorist chemical attack on public transportation. Scientists in the Aum Shinrikyo cult were able to manufacture at least a crude version of sarin nerve gas, which a team of five operatives dispersed on five subway cars on three separate lines converging near government offices in Tokyo. After dispersing the chemical, the attackers fled the subway to meet a waiting car, where they self-administered atropine, an antidote to the sarin, as a precaution. Aum Shinrikyo had also experimented with biological weapons and was believed to be interested in acquiring nuclear weapons.

In 1974, Muharem Kurbegovic, the so-called "alphabet bomber," waged a one-man bombing campaign on behalf of Aliens of America, an imaginary group that he invented. Although later described as a "lone-wolf terrorist" when that term became popular, he was diagnosed as a paranoid schizophrenic. His campaign reflected his training as a chemical engineer and his technical talent as well as his severe mental illness. His bombs were effective, but more worrisome was the discovery that at the time of his arrest, he was working in his home laboratory on producing a binary nerve agent, which he planned to use in a future attack.

Few Terrorists are Sophisticated Adversaries

The attacks described above represent the upper edge of terrorist sophistication; they include multiple hijackings, spectacular coordinated attacks, mass bombing plots, the use of miniaturized explosive devices, crazy cults obsessed with weapons of mass destruction, and mad bombers. Most terrorist attacks do not fall into those categories.

Unlike sophisticated criminals or wartime commandos who must penetrate often daunting security measures to reach a specific target, often within a narrow time frame, terrorists can

attack anything, anywhere, any time. This means that they can choose the easiest targets to attack—they do not have to overcome formidable security measures. Attacks in public places obviate the need for inside information.

If presented with security barriers, terrorists can shift their sights to easier targets or merely carry out an attack in the vicinity of a desired symbolic target and still gain the publicity they seek. They can try to carry out "standoff" attacks—drive-by shootings, mortar attacks, or the use of drones. Or they can exploit the extreme dedication of their operatives and plow through security, using suicide attackers. *Sophisticated terrorist attacks are therefore rare because, quite simply, they are unnecessary.*

2. The Level of Sophistication of Attacks on Passenger Rail Transportation

Methodology—What's In and What's Out

What is the level of sophistication of attacks on public surface transportation? To answer this question, we looked at attacks on passenger rail in MTI's database of roughly 5,800 attacks on public surface transportation between 1970 and the end of 2019. We excluded cases where we could safely assume that an attack on rail infrastructure was targeted on freight trains and not passenger trains.

The MTI database excludes incidents in most war zones. We realize that this term is arbitrarily defined, as countries may experience armed conflict on different scales ranging from occasional acts of terrorism to ongoing terrorist campaigns to localized insurgencies to all-out war. We have therefore excluded the higher registers of violence, because trying to separate and count individual acts of terrorist violence in the midst of warfare is not only difficult but would distort the data. Including war zones would also mean that the findings would have less meaning for those faced with ordinary security concerns.

We included only events that occurred in economically advanced countries, which are generally members of the Organization for Economic Co-operation and Development (OECD). However, we excluded the following OECD members, which seem to be not comparable enough to be in the set of events we are focusing on: Turkey, with an active Kurdish insurgency (a total of 33 attacks and 17 fatalities); Colombia, battling until recently two long-running leftist guerilla groups, The Revolutionary Armed Forces of Colombia and the National Liberation Army of Colombia (a total of 6 attacks and no fatalities); and Mexico, which has unique problems with criminal gangs (2 criminal attacks and no fatalities).

If we had included these countries, we would have added 41 attacks (to our set of 346) and only 17 fatalities (to our total of 676). *More important, none of the attacks met any of the criteria for sophistication we have established.*

Limiting the inquiry to more-advanced countries also excludes activity in areas that have been affected by persistent high-level insurgencies (e.g., India, Pakistan, Sri Lanka, Thailand). Including them would drown out the already tiny percentage of sophisticated attacks seen in the more economically advanced countries.

Because of the unique circumstances that prevail in Israel, the West Bank, and Gaza, we also excluded

them for the purposes of this analysis. Finally, we excluded cyber-attacks unless the adversaries were able to achieve physical sabotage via the Internet. We know of only one such case.

We realize that the exclusions give us a smaller denominator, which affects the percentage of attacks that might be described as sophisticated. It would seem to raise the proportion of sophisticated attacks. However, the percentage of attacks that could be described as sophisticated, even with the smaller denominator, is extremely low, underscoring the hypothesis that very few terrorist attacks on public surface transportation could be described as sophisticated. In contrast to attacks on aviation, attacks on ground transportation, almost by definition, need not be very sophisticated.

Table 1. Geographic Distribution of Attacks, by Frequency

Country	Attacks	Fatalities	Average FPA[a]	# Injuries	Average IPA[b]
United Kingdom	56	63	1.1	999	17.8
Spain	51	197	3.9	2093	41.0
France	43	26	0.6	360	8.4
Italy	41	118	2.9	580	14.1
Germany	40	4	0.1	58	1.5
United States	27	13	0.5	104	3.9
Japan	16	14	0.9	5030	314.4
Greece	9	0	0.0	0	0.0
Switzerland	7	2	0.3	8	1.1
Chile	6	1	0.2	14	2.3
Ireland	6	0	0.0	4	0.7
Belgium	5	20	4.0	173	35
Taiwan	5	4	0.8	49	9.8
Austria	5	0	0.0	8	1.6
Czech Republic	5	0	0.0	4	0.8
Netherlands	4	9	2.3	3	0.8
Sweden	4	2	0.5	0	0.0
Australia	4	0	0.0	22	5.5
South Korea	2	198	99.0	147	73.5
Canada	2	3	1.5	29	14.5
Hong Kong	2	0	0.0	18	9.0
Singapore	1	2	2.0	7	7.0
Lithuania	1	0	0.0	0	0.0
Norway	1	0	0.0	0	0.0
Poland	1	0	0.0	12	12.0
Slovak Republic	1	0	0.0	3	3.0
Slovenia	1	0	0.0	0	0.0
TOTAL/AVERAGES	**346**	**676**	**2.0**	**9725**	**28.1**

[a] FPA = fatalities per attack;

[b] IPA = injuries per attack.

Terrorist attacks on passenger rail in more developed countries are statistically rare events. A total of 346 events have occurred over a period of almost 50 years—an average of about seven incidents a year, spread over 27 countries. However, as shown in Table 1, five countries (the United Kingdom, Spain, France, Germany, and Italy) account for more than two-thirds (67%) of the total. The United Kingdom leads the list, owing to the long IRA terrorist campaign that was waged from the early 1970s to the 1990s. The IRA attacks, however, were seldom deadly—in contrast, one attack by jihadists in 2005 caused 52 of the 63 fatalities in the United Kingdom.

Spain places second to the United Kingdom in number of attacks on passenger rail, owing to the long terrorist campaign waged by Basque separatists. The United States has suffered 27 such attacks since 1970, which equates to slightly more than 0.5 attacks per year. In addition, at least nine terrorist plots against public surface transportation targets have been uncovered by U.S. authorities.

Table 2. Geographic Distribution of Attacks, by Fatalities

Country	Attacks	Fatalities	Average FPA[a]	# Injuries	Average IPA[b]
South Korea	2	198	99.0	147	73.5
Spain	51	197	3.9	2093	41.0
Italy	41	118	2.9	580	14.1
United Kingdom	56	63	1.1	999	17.8
France	43	26	0.6	360	8.4
Belgium	5	20	4.0	173	35
Japan	16	14	0.9	5030	314.4
United States	27	13	0.5	104	3.9
Netherlands	4	9	2.3	3	0.8
Germany	40	4	0.1	58	1.5
Taiwan	5	4	0.8	49	9.8
Canada	2	3	1.5	29	14.5
Switzerland	7	2	0.3	8	1.1
Sweden	4	2	0.5	0	0.0
Singapore	1	2	2.0	7	7.0
Chile	6	1	0.2	14	2.3
Greece	9	0	0.0	0	0.0
Ireland	6	0	0.0	4	0.7
Austria	5	0	0.0	8	1.6
Czech Republic	5	0	0.0	4	0.8
Australia	4	0	0.0	22	5.5
Hong Kong	2	0	0.0	18	9.0
Lithuania	1	0	0.0	0	0.0
Norway	1	0	0.0	0	0.0
Poland	1	0	0.0	12	12.0
Slovak Republic	1	0	0.0	3	3.0
Slovenia	1	0	0.0	0	0.0
TOTAL/AVERAGES	**346**	**676**	**2.0**	**9725**	**28.1**

[a] FPA = fatalities per attack;
[b] IPA = injuries per attack.

As Table 2 shows, South Korea leads the list of fatalities per attack because of a single deadly arson attack in 2003 that killed 198 people. Spain places second, again owing largely to a single attack—the 2004 bombing of the Madrid commuter trains in which 193 people were killed. Italy's third place reflects another single incident—a 1980 Bologna train station bombing that killed 85 people. And the United Kingdom places fourth, owing to coordinated bombings in London's Tube and one bus in

2005, which killed 52 people. In short, the largest totals reflect single deadly attacks.

Table 3. Attack Method, by Frequency

Attack and Weapon	Attacks	Fatalities	Average FPA[a]	# Injuries	Average IPA[b]
IED, Unspecified	138	417	3.0	4142	30.0
IID (Improvised Incendiary Device)	39	0	0.0	27	0.7
Arson	32	199	6.2	173	5.4
Assault, Stabbings	29	12	0.4	91	3.1
Derailment, Track Bomb - IED, Unspecified	22	6	0.3	55	2.5
Sabotage, Other	22	0	0.0	0	0.0
Assault, Automatic or Semi-Automatic Weapons	12	16	1.3	38	3.2
Derailment, Bolts/Tracks Removed	11	1	0.1	66	6.0
VBIED	7	2	0.3	91	13.0
IED, Hoax Device	6	0	0.0	0	0.0
Unconventional weapons	4	12	3.0	5000	1250.0
Armed Hijacking	4	5	1.3	0	0.0
Assault, Unspecified or Other	4	0	0.0	2	0.5
Derailment, Other or Unknown	4	0	0.0	12	3.0
Grenade	2	2	1.0	0	0.0
Multiple Weapons, Other	2	2	1.0	4	2.0
Armed Robbery	2	1	0.5	2	1.0
IED, Other	2	0	0.0	0	0.0
Assault, Unarmed	1	1	1.0	1	1.0
Kidnapping	1	0	0.0	2	2.0
Other	1	0	0.0	0	0.0
Vehicle Used as Weapon	1	0	0.0	19	19.0
TOTAL/AVERAGES	**346**	**676**	**2.0**	**9725**	**28.1**

[a] FPA = fatalities per attack;
[b] IPA = injuries per attack.

As Table 3 shows, Improvised explosive devices (IEDs) and incendiary devices (IIDs), including bombs on train tracks, vehicle bombs, grenades, and hoax devices, and other IEDs, were used in 216 attacks, or 62% of the total number of incidents.

Thirty-three cases (10%) involved some type of sabotage by mechanical means other than explosives; 32 cases (9%) involved arson—setting fires as opposed to using an IID; 29 cases (8%) involved stabbings; and 19 cases (5%) involved assaults, hijackings, etc., using firearms. Seventeen cases (5%) involved other attack methods.

Table 4. Attack Method, by Lethality

Attack and Weapon	Attacks	Fatalities	Average FPA[a]	# Injuries	Average IPA[b]
IED, Unspecified	138	417	3.0	4141.5	30.0
Arson	32	199	6.2	173	5.4
Assault, Automatic or Semi-Automatic Weapons	12	16	1.3	38	3.2
Assault, Stabbings	29	12	0.4	91	3.1
Unconventional weapons	4	12	3.0	5000	1250.0
Derailment, Track Bomb - IED, Unspecified	22	6	0.3	55	2.5
Armed Hijacking	4	5	1.3	0	0.0
VBIED	7	2	0.3	91	13.0
Grenade	2	2	1.0	0	0.0
Multiple Weapons, Other	2	2	1.0	4	2.0
Derailment, Bolts/Tracks Removed	11	1	0.1	66	6.0
Armed Robbery	2	1	0.5	2	1.0
Assault, Unarmed	1	1	1.0	1	1.0
IID (Improvised Incendiary Device)	39	0	0.0	27	0.7
Sabotage, Other	22	0	0.0	0	0.0
IED, Hoax Device	6	0	0.0	0	0.0
Assault, Unspecified or Other	4	0	0.0	2	0.5
Derailment, Other or Unknown	4	0	0.0	12	3.0
IED, Other	2	0	0.0	0	0.0
Kidnapping	1	0	0.0	2	2.0
Other	1	0	0.0	0	0.0
Vehicle Used as Weapon	1	0	0.0	19	19.0
TOTAL/AVERAGES	**346**	**676**	**2.0**	**9724.5**	**28.1**

[a] FPA = fatalities per attack;
[b] IPA = injuries per attack.

As Table 4 shows, arson attacks have resulted in the highest number of fatalities per attack (FPA). However, this reflects a single incident in Daegu, South Korea, in which a man ignited two milk containers filled with gasoline inside a subway train, killing 198 people.

In general, bombings using unspecified IEDs were the most lethal form of attack, with an average FPA of 3.0. Attacks with unconventional weapons were the third most lethal, but all of the 12 fatalities occurred in the 1995 sarin attack on Tokyo's subways. Armed assaults have an FPA of 1.3, as do four armed hijackings. The lethality rate drops sharply after that—a total of 80 attacks (or just over 23%) resulted in zero fatalities, and 105 attacks (or just over 30%) resulted in two or fewer fatalities.

Lethality does not necessarily reflect sophistication—some of the deadliest attacks have been primitive attacks, while some of the most sophisticated attacks resulted in no fatalities. Primitive attacks, however, generally run into limits. The 2016 vehicle ramming attack in Nice, France, resulted in 86 fatalities, but it is hard to imagine casualty levels from a single vehicle ramming ascending much higher. Stabbing attacks by lone attackers have an even lower ceiling. To reach higher registers of violence requires deadlier weapons (including hijacked airliners) or multiple coordinated attacks. Arson may be an exception.

Table 5. Target Category, by Frequency

Target Group	Attacks	Fatalities	Average FPA[a]	# Injuries	Average IPA[b]
Passenger Trains	163	374	2.3	7092	43.5
Passenger Train Stations	137	302	2.2	2633	19.2
Other Railway Infrastructure	39	0	0.0	0	0.0
Unspecified	7	0	0.0	0	0.0
TOTAL/AVERAGES	**346**	**676**	**2.0**	**9725**	**28.1**

[a] FPA = fatalities per attack;

[b] IPA = injuries per attack.

Table 5 suggests that people are the real target. Most attacks on surface transportation target trains, followed by train stations. This is underscored by the fact that only 13% of the attacks have been aimed at railway infrastructure—these are primarily attacks on signaling systems and overhead power lines, and some attacks against the tracks themselves.

Finally, Table 5 (which does not change when it is prioritized by fatalities rather than by attacks) also shows that all of the casualties in attacks on rail transportation occurred on trains or in train stations, and that there is very little difference in lethality between the two. There is a significant difference in IPA, but this is due entirely to the sarin attack on Tokyo's subways, where approximately 5,000 people were subsequently treated at hospitals.

Death or Disruption

Terrorists rarely attack rail transportation because they object to railroads; they attack rail systems to create public alarm, cause widespread disruption and inconvenience, and impose costs on the national economy. These were the primary goals of early terrorist campaigns like that carried out by the provisional IRA in the United Kingdom and ETA, the Basque terrorist group that operated mostly in Spain.

There are a few cases in which environmentalists attacked rail systems because they objected to the environmental impact of new construction of high-speed rail systems or they wanted to call attention to specific issues such as the construction of nuclear power plants. Several cases also involved attacks on rail systems as a means of extortion.

In recent decades, terrorists have attacked public surface transportation systems because they see crowded stations and commuter trains as killing fields. Unlike the terrorists of the 1970s, they seek high body counts. Their use of inherently indiscriminate tactics—IEDs, VBIEDs, mass shootings, attempts to derail passenger trains—suggest that slaughter is the objective.

High body counts are rarely achieved in public surface transportation attacks. The overall FPA is 2.0. A single attack carried out not by a terrorist, but by a mentally unstable individual with cartons of gasoline, accounts for nearly 30 percent of the fatalities caused by all such attacks over nearly 50 years. Putting this case aside, the overall average FPA is 1.4. Just three attacks—the Korea arson attack, the Madrid commuter train bombing, and the Bologna train station bombing—account for 70% of the total fatalities.

Defining Sophistication

By our definition, a sophisticated attack must include at least one of the following attributes:

- It must involve the recruitment of inside assistance, the use of insider knowledge, or the acquisition of specialized skills through training.
- It must require the penetration of manned or closely monitored security systems.
- It must involve the use of sophisticated weapons, devices, or means. For an IED to be considered sophisticated, it must do more than simply explode. It must have a timing or remote detonating system that guarantees detonation at a remote time or in a specific location, or it must be miniaturized or disguised so as to evade detection.
- The operation itself must be complex—it must involve multiple actors with individual roles or coordinated simultaneous or near-simultaneous attacks at different locations.

We do not consider the number of bombs used in an attack by itself to be an indicator of sophistication; it is the timing of these detonations to be nearly simultaneous at a number of different locations, along with other factors, that suggests sophistication, as was the case in the 2004 Madrid attack.

Very Few Sophisticated Attacks on Passenger Rail Targets

Very few of the 346 attacks we examined met any of these criteria. There were only four attacks in which insider knowledge was certain or sources speculated it was involved: the 1995 derailment of the Sunset Limited in the United States; two other cases in Europe; and one in Australia. These attacks comprise 1.2% of the total number of incidents. In another nine incidents, the attackers may have had access to other than publicly available information, but we could not be certain. All but one of these incidents involved sabotage rather than attacks on people on trains or in stations.

In only six attacks (1.7% of the total) could the device or technical means used be considered sophisticated: the 1984 bombing of a train in Northern Italy when it was inside of a tunnel; the 1995 derailment of the Sunset Limited; the 1995 sarin attack in Tokyo; the 2004 Madrid bombings in which the timing devices were key in detonating 10 bombs simultaneously; the 2008 derailment of trams in Lodz, Poland, by a 14-year old teenager who built a device that enabled him to electronically take control of the tram system; and a series of sabotage incidents in 2019 in New South Wales, Australia.

In no case did the attackers penetrate any monitored security systems. However, the teenager in Lotz may have accessed an unauthorized area or signal unit.

Five attacks (or 1.4%) of the total were categorized as sophisticated because they involved multiple near-simultaneous attacks at several different locations.

Only two attacks involved a sophisticated device, substance, or technique *and* the possibility of insider knowledge: the Sunset Limited derailment and the sabotage incidents in New South Wales, Australia. Also, two other attacks involved multiple near-simultaneous attacks and sophisticated

devices: the 1995 Sarin attack in Tokyo, and the 2004 Madrid train bombings.

None of the attacks displayed all four of the attributes of sophistication defined in this study.

Lowering the criteria for sophistication in any of the categories would add some attacks, but only a few.

Our results are based upon a preliminary analysis of publicly reported information; we did not have access to internal investigative reports. However, the overall conclusions would not be likely to change if we had such access.

Some Examples of Sophisticated Attacks on Passenger Rail Targets

1984 Train Bombing in Italy

A remotely detonated bomb left on the luggage rack of a passenger coach exploded when the train was well inside a long tunnel. Remote detonation while the train was in a tunnel make this attack sophisticated. Fatalities 15; injuries over 200.

1995 Derailment of the Sunset Limited in Arizona

This has been labeled a sophisticated attack because the saboteur wired the track to ensure a continuing current through the track, which enabled him to cut the track without triggering a safety system that signals any break. Fatalities 1; 65 injuries.

1995 Sarin Attack in Tokyo

The weapon—nerve gas—was sophisticated, although the method of dispersal was crude and reduced its effectiveness. Five attackers carried out coordinated attacks and were picked up by drivers outside each station. No security was penetrated. Inside information was unnecessary, but the use of nerve gas in a coordinated multipart operation makes the attack sophisticated. The fact that each of the five attackers was administered the antidote for sarin immediately after the attack is another sign of sophistication. Fatalities 12; injuries as many as 5,000.

2004 Train Bombings in Madrid

Within three minutes, 10 explosions occurred on four commuter trains near Madrid. The bombs, hidden in backpacks left on the trains, were remotely detonated using cellphones. Three more bombs failed to explode. The number of attackers and devices involved, the use of detonation via cellphones, and the near simultaneity of the explosions make this a sophisticated attack. Fatalities 193; injuries as many as 2,000.

2008 Derailments in Poland

A teenager created an electronic device that enabled him to take control of the train system in Lotz and cause trains to crash. No fatalities; 12 injuries.

2018 Sabotage in New South Wales, Australia

Vandals caused extensive damage to the infrastructure and rolling stock of the Zig Zag Railway, a small train for tourists, which climbs over the steep Blue Mountains, using a series of switchbacks. (In Australia, the term "zig zag" is synonymous with the American term "switchback.") Authorities said that the saboteurs removed security locks, disabled a hand brake, and manipulated the switches, indicating detailed knowledge of the system. No fatalities; no injuries.

The Ten Deadliest Attacks on Passenger Rail Targets

As the list below shows, the deadliest attacks on passenger rail systems are seldom sophisticated.

2003 South Korea Arson Attack on Subway (198 Dead)

In an attempt to commit suicide, a single attacker with two containers of gasoline started a fire on a subway train. The fire killed nearly 200 people. This was a primitive attack.

2004 Madrid Commuter Train Bombings (193 Dead)

The remote, near-simultaneous detonation of multiple devices make this attack sophisticated.

1980 Bologna Train Station Bombing (85 Dead)

A time bomb with 51 pounds of explosives was left in a suitcase in a crowded waiting room. The fact that the bomb detonated make this a modestly sophisticated attack.

2005 Multiple Bombings on the London Tube and a Bus (52 Dead)

No inside information was needed; no security was penetrated; homemade bombs worked, although one may have been faulty. The four attacks were closely coordinated in time but overall were not very sophisticated—at most, a modestly sophisticated attack.

2016 Bombing of Brussels Metro Stations (20 Dead)

A suicide bomber detonated a device on a crowded metro train. It can be argued that this attack was connected with a coordinated attempt by three suicide bombers at the Brussels Airport that killed at least 14 more people and therefore might also be considered sophisticated.

1984 Train Bombing in Italy (15 Dead)

Because an explosive device was remotely detonated while the train was inside a tunnel, thereby increasing the effects of the explosion, this is considered a sophisticated attack.

1995 Sarin Attack on Tokyo Subways (12 Dead)

The employment of sarin nerve gas and the fact that it was a multipart operation make this a sophisticated attack.

1974 Italicus Train Bombing in Italy (12 Dead)

A time bomb was placed in a passenger car but, unlike the bomb in the 1984 explosion, it failed to go off in a long tunnel, as was possibly anticipated. This was not a very sophisticated attack.

1995 Saint Michel RER Station in Paris (7 Dead)

A small bomb exploded in a crowded subway car. This was an unsophisticated attack.

1993 Shooting on Long Island RR (6 dead).

A single mentally unstable passenger with a pistol opened fire on passengers, killing six and wounding 19. This was a primitive attack. (An attack in Italy—also unsophisticated—in July 1970 also resulted in six dead.)

Slaughter Does Not Require Sophistication

Of the ten deadliest attacks, three could be regarded as sophisticated (the 1984 attack on a train in Italy, the 1995 Tokyo sarin attack, and the 2004 Madrid bombings). Two of the attacks were definitely primitive. That leaves five bombings in which the principal achievement was that the one or more of the devices worked. We would describe these as unsophisticated or only modestly sophisticated.

The biggest issue in deciding whether an attack was sophisticated concerns bombings. In our analysis, the mere fact that a bomb exploded did not make it a sophisticated attack. We looked for something more - a sophisticated concealment technique or detonating system or a complex operation with multiple devices being remotely detonated simultaneously. With that criterion established, differences arise in a very small number of cases, none of which required either inside information or penetrating security and seven of which required no more than a single attacker.

3. Conclusions

Terrorist attacks on passenger rail transportation are statistically rare events in the developed world—there have been only about seven attacks a year against all of the economically advanced countries combined. However, uncovered plots and attempts indicate continuing terrorist interest in attacking public surface transportation targets.

The vast majority of terrorist attacks on passenger rail transportation are aimed at disrupting travel or causing casualties. Most of the attacks (86%) and 100% of the casualties have occurred aboard trains and in stations—where the people are.

Terrorist attacks on public surface transport are rarely sophisticated. None to date have involved penetrating any formidable security measures; two possibly involved access to inside information; four involved devices or techniques that could be considered sophisticated; five involved coordinated multipart attacks that could be considered complex.

The above counts, however, include four duplicates, that is, four incidents include more than one criterion. In all, there were eleven attacks (3.0% of the total) that could be considered sophisticated by meeting just one of the four criteria and only four attacks (1.2%) that met two criteria. None of the

attacks displayed more than two of the criteria of sophistication.

Slaughter does not require sophistication—the deadliest attacks are seldom sophisticated.

This does not mean that the possibility of more sophisticated terrorist attacks on transportation targets should be ignored. It simply underscores the broader conclusion that terrorist attacks on these targets are rarely sophisticated—they don't have to be. Terrorists attack "soft" targets, so they have little need to obtain inside information or penetrate security systems.

Where terrorists' preferred targets are protected, the attackers may try to overcome security measures. The best example of such a scenario is commercial aviation. Attacking airliners has remained a terrorist obsession since the emergence of contemporary terrorism in the late 1960s, and defeating security seems to have become a quest for bombmakers to demonstrate their skills. However, the commercial aviation example is unique.

Endnotes

1. Guenfoud, Ibtissem, "2 Dead, 5 Wounded in Suspected Terrorist Knife Attack in France," ABC News, April 4, 2020, available at https://abcnews.go.com/International/dead-wounded-suspected-terrorist-knife-attack-france/story?id=69975220.

2. Brian Michael Jenkins, Bruce R. Butterworth, Jean-François Clair, and Joseph E. Trella, III, "An Exploration of Transportation Terrorist Stabbing Attacks," Mineta Transportation Institute, Project SP 03-19, March 2019, available at https://transweb.sjsu.edu/sites/default/files/SP0319-Terrorist-Stabbing-Attacks-Transportation_0.pdf

3. Brian Michael Jenkins and Bruce R. Butterworth, *"Smashing Into Crowds" -- An Analysis of Vehicle Ramming Attacks*, San Jose, CA: Mineta Transportation Institute, 2019, available at https://transweb.sjsu.edu/research/SP1119-Vehicle-Ramming-Update.

4. Ibid.

5. The 9/11 Commission, Final *Report of the National Commission on Terrorist Attacks Upon the United States,* Washington, DC: U.S. Government, 2004, is the official report of the events leading up to the September 11, 2001, attacks. This report and its accompanying staff reports remain the most authoritative account of the planning and preparations for the attacks. Subsequent publications have added a great deal of material about U.S. perceptions of terrorist threats and U.S. actions (including failures) prior to 9/11 but have relied on the 9/11 Commission for the account of the adversaries. One notable exception is Terry McDermott, *Perfect Soldiers: Who They Were and Why They Did It,* New York: HarperCollins Publishers, 2005, which provided new information about the Hamburg terrorist cell. Another exception is Terry McDermott and Josh Meyer, *The Hunt for KSM: Inside the Pursuit and Takedown of the Real 9/11 Mastermind, Khalid Sheikh Mohammed*, New York: Little, Brown and Company, 2012. An account of the frustrations experienced by the 9/11 Commission in getting all of the information it wanted is given in John Farmer [Senior Counsel to the 9/11 Commission], *The Ground Truth: The Untold Story of America Under Attack on 9/11*, New York: Riverhead Books, 2009.

6. Brian Michael Jenkins, *Unconquerable Nation: Knowing Our Enemy, Strengthening Ourselves*, Santa Monica, CA: The RAND Corporation, 2006, available at https://www.rand.org/pubs/monographs/MG454.html.

7. Ron Nixon, Adam Goldman, and Eric Schmitt, "Devices Banned on Flights from 10 Countries Over ISIS Fears," *The New York Times,* March 21, 2017, available at https://www.nytimes.com/2017/03/21/us/politics/tsa-ban-electronics-laptops-cabin.html.

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About the Authors

Brian Michael Jenkins is the director of the Mineta Transportation Institute's Allied Telesis National Transportation Security Center and, since 1997, has directed the Institute's continuing research on protecting surface transportation against terrorism and other serious forms of crime.

Bruce R. Butterworth is a Senior Transportation Security Researcher at MTI and former Director of Aviation Security Operations at the Federal Aviation Admin-istration. Bruce has taken a leading role in creating MTI's unique database of attacks on public surface transportation.

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