



## **RECENT TRENDS OF TERRORISM RELATED BOMBINGS IN INDIA: A REVIEW**

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### **ABSTRACT**

This paper explores various news articles and published articles for determining the recent trends in terrorism related bombings in India. India has been a prime target of cross border terrorism since 1970s with uprising of Khalistan movement in the North-West India. Since then major terrorists attacks happened across India which reached its peak in year 2008. Improvised explosive devices were used in carrying out explosions by different terror groups in India. Car and bicycle were found to be the most used carrier for the bomb and RDX was the most used explosive followed by ammonium nitrate for carrying out attacks across the major Indian cities. Delhi and Mumbai were mostly targeted by terrorist groups because one is the capital of the country and latter is the financial capital of India. We discussed practical implications of these findings and way for improvement for preventing these types of attacks in future.

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### **INTRODUCTION**

With the rise of radical Islamic terrorism worldwide, terrorist attacks on non-Islamic countries are on a rise. India being a major population centre and vocal against atrocities of terrorist organizations and their illegal trade routes is always on the cross-hair of terrorist groups. Before diving into the details of these terror groups and their modusoperandi, we have to first know the definition of terrorism. What exactly is terrorism and how it is different from a violent act. According to Oxford Dictionary, "the unlawful use of violence and intimidation, especially against civilians, in the pursuit of political aims (TERRORISM | Definition of TERRORISM by Oxford Dictionary)." According to UN resolution, "an act can be called terrorism when it satisfies the following three key elements: (i) the perpetration of a criminal act (such as murder, kidnapping, hostage-taking, arson, and so on), or threatening such an act; (ii) the intent to spread fear among the population (which would generally entail the creation of public danger) or directly or indirectly coerce a national or international authority to take some action, or to refrain from taking it; (iii) when the act involves a transnational element(Scharf, 2011)(McGLINCHEY, 2017)(Brown, 2017)." According to Section 15, Chapter 4 of Unlawful Activity Prevention Act, 1967 of India "whoever does any act with intent to threaten or likely to threaten the unity, integrity, security, economic security, or sovereignty of India or with intent to strike terror or likely to strike terror in the people or any section of the people in India or in any foreign country, by using bombs,

dynamite or other explosive substances or inflammable substances or firearms or other lethal weapons or poisonous or noxious gases or other chemicals or by any other substances (whether biological radioactive, nuclear or otherwise) of a hazardous nature or by any other means of whatever nature to cause or likely to cause death of, or injuries to, any person or persons; or loss of, or damage to, or destruction of, property; or disruption of any supplies or services essential to the life of the community in India or in any foreign country; or damage to, the monetary stability of India by way of production or smuggling or circulation of high quality counterfeit Indian paper currency, coin or of any other material; or damage or destruction of any property in India or in a foreign country used or intended to be used for the defence of India or in connection with any other purposes of the Government of India, any State Government or any of their agencies; or overawes by means of criminal force or the show of criminal force or attempts to do so or causes death of any public functionary or attempts to cause death of any public functionary; or detains, kidnaps or abducts any person and threatens to kill or injure such person or does any other act in order to compel the Government of India, any State Government or the Government of a foreign country or an international or inter-governmental organization or any other person to do or abstain from doing any act; commits a terrorist act"(Unlawful Activity Prevention Act, 1967, 1967). In most cases, terrorism is politically and religiously motivated. Even after so many attacks in different countries over the years, the international community has failed to succeed in developing an

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accepted comprehensive definition of terrorism. This is because many countries use terrorist organizations as a proxy in asymmetrical warfare. For example, the United States of America funded terrorist organizations to fight USSR in Afghanistan (Mumford, 2013). But after USSR was defeated in Afghanistan, operatives of these terrorist organizations moved to neighbouring states like Pakistan and India. Pakistan used these terror operatives in Kashmir to fuel the insurgency in the state and since then India is fighting an undeclared war (Kamath, 2001). Intelligence agencies always try to remain one step ahead of the terrorist groups but by changing their mode of operation or by using other methods, they succeed in their nefarious designs.

India shares its border with Pakistan in North- West, with Nepal in the North, Bhutan and China in North-East, Bangladesh and Myanmar in the East and with Sri Lanka in the South. Most of these countries are friendly to India except Pakistan and China. Pakistan is the major source of insurgency in the North West region of India (Katoch, 2013). While China sponsor Insurgency in the North-Eastern part of the states. Most of the terrorist attacks are carried out by terror groups sponsored by these two countries.

Terrorism is further characterized as chemical, biological, radiological and cyber-terrorism. This review paper is primarily focused on chemical terrorism covering explosives. Explosive is a chemical substance or a mixture which when initiated by heat, shock, impact, friction or a combination of these conditions undergo rapid decomposition leading to detonation. In this process, rapid release of heat and high-pressure gases occurs that expand rapidly with sufficient force to overcome any confinement. The energy released by the explosive produces four basic effects 1) Fragmentation effect 2) Overpressure wave effect 3) Thermal effect and 4) Ground vibration. While fragmentation, overpressure wave and thermal effect cause most of the fatal injuries on human targets, ground vibrations and wind blast cause serious structural damage to the surrounding area. Terrorists use explosives in Improvised Explosive Devices or IED to target innocent civilians and security forces. IED or Improvised Explosive Device is a bomb constructed and deployed in ways other than conventional military action. For example, a car bomb or Vehicle Borne IED (VBIED) is a car laden with explosives which when rammed into the target explodes and cause complete obliteration of the target. A recent example of the use of VBIED by terrorists is ‘Pulwama Attack 2019’. A lone wolf attack was carried out by sympathizer of the Jaish-e-Muhammad terrorist group on the paramilitary convoy by a VBIED in Pulwama, Kashmir, India on 14th February 2019. 40 personnel of the Central Reserve Police Force (CRPF) were killed in action in this cruel attack (Das, 2019). The type of explosive used and the components used in making an IED is specific to the bomb maker of a terror organization. This specific signature of making a bomb is called a Bomb Signature. Determining a bomb signature is an extremely important and crucial step in the investigation of crime scenes involving explosives. Bomb signature gives us an idea of a bomb maker or his/her affiliation to a specific terror organization. This paper will focus on different bomb signatures determined over the years and how this signature is used in the linkage of IED to its maker.

**Terrorism in India**

The early 70s or post-cold wartime is the time when terrorism activity started in India with both Punjab insurgency and insurgency in Kashmir. Pakistan’s Interservice Intelligence (ISI) sponsored terrorist groups such as Babbar Khalsa and Khalistan Liberation Force rose in Punjab state of India intending to make a separate independent state Khalistan. In the meantime same ISI sponsored terrorist groups were activated in the Jammu and Kashmir state of India (Kamath, 2001). These terrorists groups were involved in mass killings and genocide of the native Kashmiri Pandit community and responsible for their mass exodus from the valley (Subramanian, 2020). While these states were suffering from insurgency, another terrorist organization LTTE (Liberation Tigers of Tamil Eelam) became active in the southern part of India. Although it was based in Northeastern Sri Lanka they carried a major attack on India in 1991 by assassinating then former Prime Minister of India Shri Rajiv Gandhi in a suicide bomb attack. Dhanu a female human bomb carried an RDX laden belt and detonated herself while greeting him. It was the first case of suicide bombing in India. Northeast India did not remain untouched by insurgency and terrorist attacks. The 1980s was the time when the insurgency in Northeast states started to rise. Though most of these insurgent groups were formed by native people, they demanded to make separate sovereign land according to the tribal groups. ULFA, NDBF, NSCN, NSCN (K) are examples of such groups. These groups are active and carry out small attacks and extortion from time to time. One of such attacks was carried out by NSCN(K) group in Manipur in 2015 in which 18 army personnel were killed in action. Some of the major and recent terrorist attacks in which explosives were used are listed in Table 1 (Kamath, 2001).

**Table 1** Types of bomb and explosive used in recent terror attacks in India.

Place of Explosion	Year	Type of Bomb Used	Explosive Used	Suspected Terrorist Group
Pulwama	2019	VBIED Timer based	RDX	Jaish-e-Muhammad
Jaipur	2008	bomb strapped to a bicycle	RDX	Harkat-ul-jihad-al-islami
Delhi	2008	Timer based bomb placed in an auto rickshaw and dustbin	Ammonium nitrate	Indian Mujahideen (IM), Student Islamic Movement of India (SIMI)
Mumbai	2006	Pressure Cooker Bomb	Mixture of RDX and Ammonium Nitrate	Indian Mujahideen (IM), Student Islamic Movement of India (SIMI), Lashkar-e-Taiba (LeT) Islamic
Delhi	2005	Bomb placed in a two scooter, a bus and a van	RDX	Revolutionary Front or Islamic Inquilab Mahaz
Mumbai	1993	Car bomb, Scooter bomb, and suitcase	RDX	D company

Note. Adopted from Kamath, P. M. (2001). Terrorism in India: Impact on national security. Strategic Analysis, 25(9), 1081–1987.

**Understanding the Bomb**

A bomb is made of several parts. These parts initiate a triggering sequence that culminates in the detonation of the explosive. This triggering sequence is also known as an “Explosive Train”.

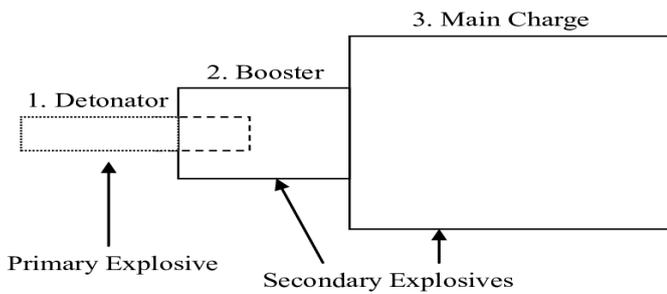


Figure 1 Schematic diagram of Three-Step Configuration of a High Explosive Train.

An explosive train consists of a 1) Primary High Explosive, which acts as a Detonator and 2) Secondary High Explosive which acts as a Main Charge. The main charge produces all four effects viz., Fragmentation, Overpressure effect, Thermal effect and Ground effect. An explosive train can be further classified into two types 1) Low Explosive Train and 2) High explosive train. Both of these trains have some common parts- Initiator which can be either electrical, chemical, or mechanical (spring type). The work of the initiator is to provide either electrical discharge, shock or heat which initiates extremely sensitive primary high explosive. Primer or Blasting cap consists of an extremely sensitive primary high explosive such as Mercury fulminate, Lead azide, Lead styphnate etc.

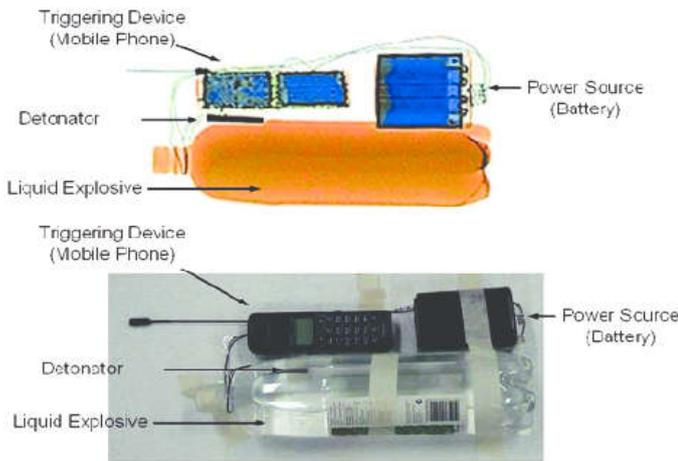


Figure 2 Basic arrangement of an improvised explosive device.

The purpose of primary high explosive is to provide detonation wave to the main charge which has relatively low sensitivity and only activated through shock and a high degree of heat. The only difference between the Low Explosive train and the High Explosive train is that the low explosive train consists of a low explosive such as Black Powder or Nitrocellulose as the main charge. While the latter will contain a Secondary High Explosive such as RDX, TNT, PETN as the main charge. The High Explosive train can be further classified as a Two-Step configuration and a Three-Step configuration. In a Two-Step configuration, a Primary and Secondary High explosive is used as Primer and Main charge, respectively. While in a Three-Step configuration a very low sensitivity Tertiary High Explosive such as ANFO (Ammonium nitrate fuel oil) is used as the main charge and Secondary High explosive is used as a Booster charge. Booster charge connects primer with the main charge and provides detonation wave and a high degree of heat to detonate a low sensitivity tertiary high explosive. A schematic diagram of a three-step configuration of a high explosive train is given in Fig 1.

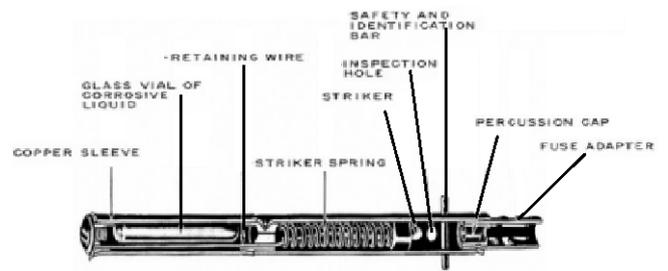


Figure 3 A pencil detonator with chemical delay mechanism.

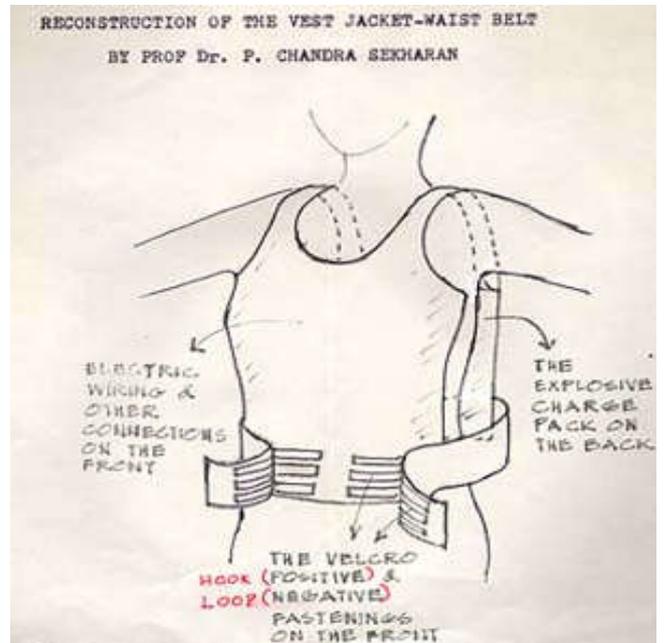


Figure 4 Reconstruction of the bomb vest jacket-waist belt.

### Improvised Explosive Device

An improvised explosive device is a bomb manufactured and deployed in a way other than conventional military use. It is a favourite weapon of terrorist organizations throughout the world to target unarmed combatants and civilians because it is easy to manufacture and can easily be concealed in different items. Before moving on to types of IED used by different terror organizations we need to first understand the parts and components involved in making an IED. A very basic IED contains a Safety fuse, an initiating device, a power source, the main charge, shrapnel (ball bearings, nails, glass shards etc) and a containment device such as an iron pipe, briefcase, a metal container or pressure cooker (as in the case of Mumbai serial blasts). A battery or a dry cell is used as a power source. Safety fuse can be of different types such as mechanical (spring-loaded), electrical (mobile phone), chemical (vial filled with corrosive acid) and physical (Detonating cord made of black powder). An initiating device as stated earlier is composed of a primary high explosive contained in a pencil-like device that acts as a detonator. It can be chemically, electrically or mechanically initiated. The main charge in an IED is mostly a secondary high explosive or a mixture of two secondary high explosives such as RDX, TNT, PETN, EGDN etc. The use of explosive as the main charge primarily depends on the availability of the type of explosive with the terrorist organization.

A well-funded group can have highly sophisticated and military-grade explosive but a newly founded group of terror enthusiasts can only have a homemade explosive mixture which can easily available from the market. Such an explosive

mixture is ammonium nitrate fuel oil. Ammonium nitrate is frequently used as a fertilizer. Therefore, it can easily be available in the market and a terrorist can easily get hands on it. Sugar, charcoal and sulfuric acid is one such mixture that can be converted into a homemade explosive. Shrapnel such as pieces of glass, nails, nuts and bolts are also used in IED. These shrapnel acts as flying projectiles which cause fragmentation injuries. Most of these injuries are fatal in close and medium ranges. They tore body parts and when hit objects such as wood, glass and concrete they convert these objects into secondary projectiles which cause further damage. A containment box provides confinement of gases which creates high pressure inside the box. On reaching its maximum limit the mechanical failure occurs and the box breaks down into pieces which further acts as primary projectiles. The power source, electrical safety fuse and pencil detonator are often connected with electrical wires. So, recovery of electrical wires and circuit boards at blast site often indicates the educational background of a bomb maker. More is the sophistication in making a circuit of the bomb more it will indicate that the bomb maker has good technical knowledge of electrical circuitry. In most cases, the bomb maker is either a radicalized electrical engineer or a chemical engineer. Fig 2 & 3 given above shows the basic arrangement of an IED and a pencil detonator with chemical delay, respectively.

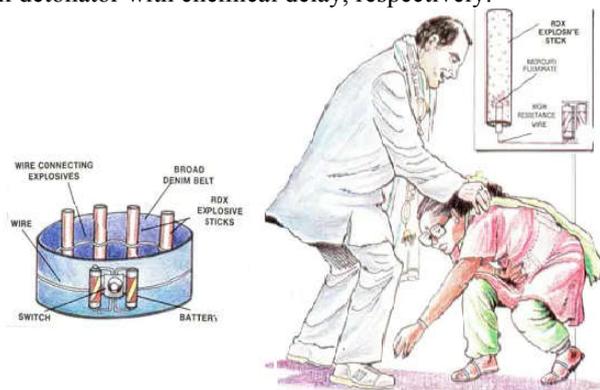


Figure 5 Schematic representation of the bomb belt and sequence of events leading to the explosion.

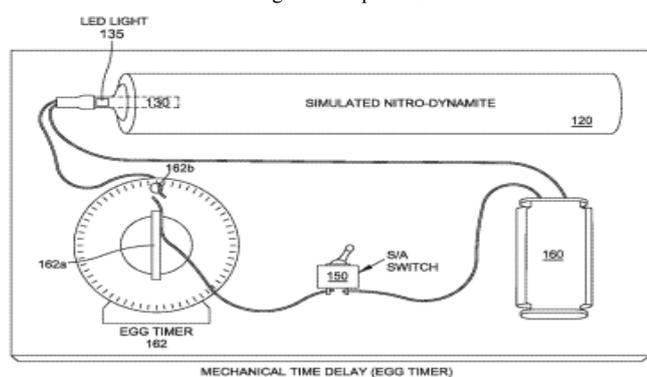


Figure 6 Schematic diagram of a simulated IED with a mechanical delay timer device.

**Types of IED used in major terror attacks in India**

**Rajiv Gandhi Assassination (1991)-** Former Prime Minister of India Shri Rajiv Gandhi was assassinated by a human bomb Dhanu in the year 1991 in a political rally in Tamil Nadu, India. Dhanu carried an RDX laden belt which she exploded while greeting the former prime minister. Half a kilogram of RDX was used in the explosive belt. RDX when mixed with plasticizer can easily be moulded in different shapes and sizes.

Plasticized RDX was used in this case which was packed on the back of the vest. An electric detonator containing mercury fulminate was used to detonate the RDX. The electric detonator was connected to a battery through an electric wire and the explosive train was initiated using a switch that was present at the front of the belt. Fig 4 & 5 shows the schematic diagram of the vest and sequence of events of the blast. Steel pellets were used as shrapnel to inflict maximum damage to the surrounding area. Along with the former prime minister, 14 others were killed and 43 were grievously injured (MITRA, 1991).

**Mumbai Serial Blasts (1993)-** 13 bombs were exploded in Mumbai within three hours. Bombay Stock Exchange, the headquarters of India’s airline, and three luxury hotels were targeted. 300 people were killed and 1200 were injured in this attack. Around 300 kilograms of RDX was used as the main charge in the bombs out of 3000 kilograms of RDX which was smuggled into India for the attack. The bombs were strapped onto scooters, inserted into cavities created in cars, and hidden in suitcase abandoned in public places and landmark buildings. All the bombs were initiated using a timer delay. An unexploded bomb was also recovered from a parked scooter that was connected with the ignition. A mixture of RDX and PETN (SEMTEX) was used as the main charge in this bomb. Using a timer delay shows the sophistication of the operation and the vast technical knowledge of the bomb maker. A timer could be a digital clock, or an optical clock or even a washing machine timer. Sometimes a chemical delay device is also used as a timer delay. The choice of explosives like RDX and PETN shows the involvement of major funding and military support because these explosives are military-grade explosives and cannot be procured by a common person. The use of cars and scooters also shows the amount of knowledge the executioner had about the working of the bombs. The cars and scooters worked as a whole device that converted into primary projectiles on an explosion. Fig 6 shows the schematic diagram of a mechanical time delay device connected to a simulated IED in which dynamite is used as the main charge (QUILLEN, 2002) (Karkaria, 2015).

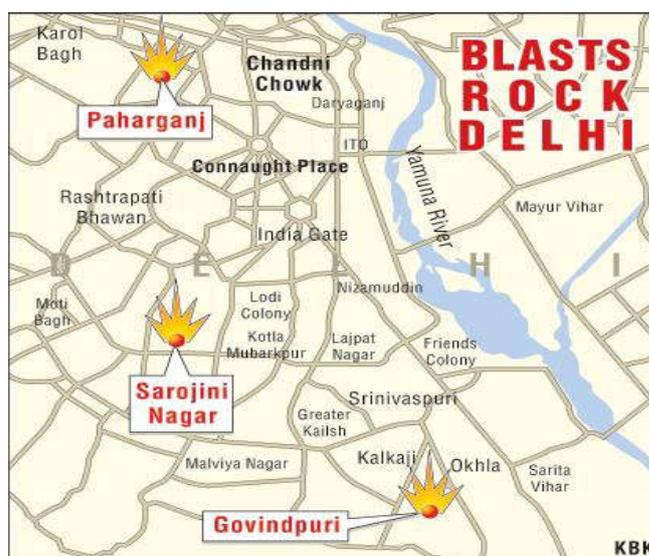
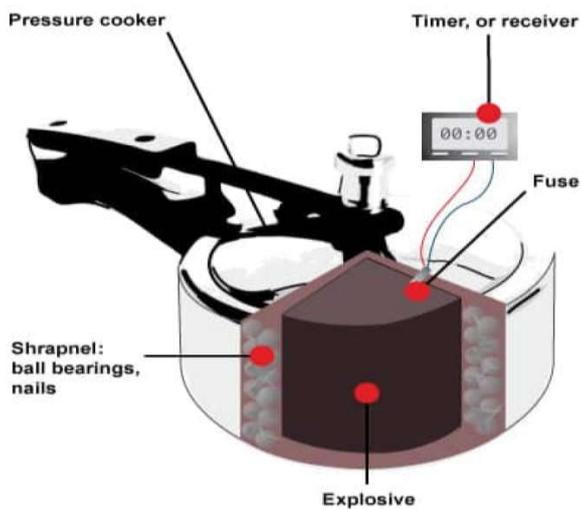


Figure 7 Map of Delhi showing places where series of explosions occurred



**Figure 8** A schematic representation of a Pressure cooker IED that was used in Mumbai serial blasts.

Note- Adopted from Lee, D. H. (2013, April 16). A history of pressure cooker bombs | CBC News. CBC.

**Delhi Serial Blasts (2005)-** On 29 October 2009 a series of three explosions occurred in Delhi, India within 1 hour. Two crowded markets and a Bus were targeted. Approximately 62 people were killed and at least 210 others were injured. These serial blasts were similar to the one that happens in Mumbai in 1993. The bomb was placed in a scooter, a Maruti van, and in a bus. The scooter and van were strategically placed in front of shops where a large crowd was used to gather to inflict maximum damage to human life. In this case, also RDX was used as the main charge which was connected to an electric detonator with a time delay device. The bomb was similar to the one used in Mumbai serial blasts. The similar make of bomb suggests the involvement of same terror group or same group of individuals or individuals having same technical training (*Report on Incidents of Terrorism 2005, 2006*).

**Mumbai Serial Blasts (2006)-** Mumbai is a major financial capital of India was again struck in 2006 with a series of seven explosions over seven minutes killing 209 people and injuring 700 others. This time Mumbai's suburban railway network was targeted using seven pressure cooker IEDs. A pressure cooker was used to increase the afterburn in a thermobaric reaction. A mixture of RDX and Ammonium Nitrate was used as the main charge in the pressure cooker IED. All bombs were placed in the first-class compartment of different trains and exploded when trains were packed with commuters returning home from work. This indicates that the explosions were well-thought activity and plans were hatched several months back as one has to observe the daily footfall of commuters and security details of the area. The pressure cooker bomb was made by inserting the main charge into a pressure cooker which was initiated by an electric detonator attached to the cover of the cooker. The detonator was connected with a time delay device. Any details about the time delay device were not found in the literature or any news report but the use of a digital clock as a timer can't be ruled out (Unnithan & Tare, 2011). The schematic diagram of a pressure cooker bomb is given in Fig 8(A *History of Pressure Cooker Bombs* | CBC News, 2013).

**Jaipur Serial Blasts (2008)-** A series of nine explosions rocked Jaipur city of Rajasthan, India on 13th May 2008 in which 63 people were confirmed dead and 216 more were

injured. Neogel-90, an industrial explosive was used as the main charge in these serial explosions. Neogel-90 is an ammonium nitrate-based explosive that is mostly used in industrial blasting and mining work. The explosives were covered with metal ball bearings and packed in boat-shaped wooden cases which were then strapped to bicycles and placed at most crowded tourist places around the city. Metal ball bearings caused most of the casualties by puncturing vital organs. Neogel-90 being an ammonium nitrate-based explosive has very low sensitivity for initiation and thus required a secondary high explosive to detonate. According to intelligence agencies, a small amount of RDX was used as a booster charge for detonating Neogel-90. The whole explosive train was initiated with an electric detonator which was connected to the timer delay device (*Jaipur Blasts, 2008*).

**Delhi Serial Blasts (2008)-** Delhi was again struck on 13th September 2008 with a series of five explosions that occurred in succession within few minutes. In the same year Jaipur, Bangalore and Hyderabad were also targeted. Total 106 people were killed and 526 were injured in 4 major cities of India. The bombs were placed in an auto-rickshaw and two dustbins in major crowd centres in Delhi. A mixture of ammonium nitrate and black powder was used as the main charge in these explosions. The bomb was intentionally placed in an auto-rickshaw with compressed natural gas (CNG) cylinder to maximize the damage caused by the blast. CNG cylinder exploded and caused a massive fire at the impact site. All bombs were stuffed with ball bearings and nails to increase fragmentation damage to the human targets. A similar make of bombs was used in Jaipur, Bangalore and Hyderabad which indicated that the same terror group was wreaking havoc in different cities of India. In this case, also, the bomb was connected to a timer delay which gave the terrorists enough time to place the bomb and escape from the scene (Sharma, 2008).

**Pulwama Attack (2019)-** On 14th Feb 2019 when the world was celebrating Valentine's Day and giving roses to their loved ones a well-thought attack was carried out by sympathizer of Jaish-e-Muhammad terrorist group on the paramilitary convoy by a Vehicle Borne IED in Pulwama, Kashmir, India. 300 kilograms of Ammonium nitrate-based explosive and Nitroglycerine was used in this attack including 80 kilograms of RDX which was placed in a Maruti Suzuki Eeco Van. The suicide bomber rammed his car with a bus in the convoy which caused an explosion in which the bus carrying Indian security personnel was completely obliterated instantly killing 40 security personnel. The modus operandi was similar to the previous attacks in which car bombs were used but the only difference here is the use of suicide bomber for ramming the vehicle in the convoy. This type of tactics was commonly seen in the middle east where ISIS terrorists used to carry out attacks against military targets using VBIED drove by a suicide bomber. All the explosives including ammonium nitrate and nitroglycerine or gelatin sticks were locally procured except RDX which was smuggled through the international border with Pakistan by terrorists and their overground workers. Nitroglycerine being an extremely sensitive primary high explosive must have been used as an initiator while RDX was used as a booster charge which helped in detonating the less sensitive ammonium nitrate main charge (Das, 2019). Fig 9 shows the schematic diagram of a VBIED (not related to the Pulwama attack) (Kova, 2018).

Propane and Petrol cans observed in the diagram are placed to increase the burning or thermal effect of the blast.

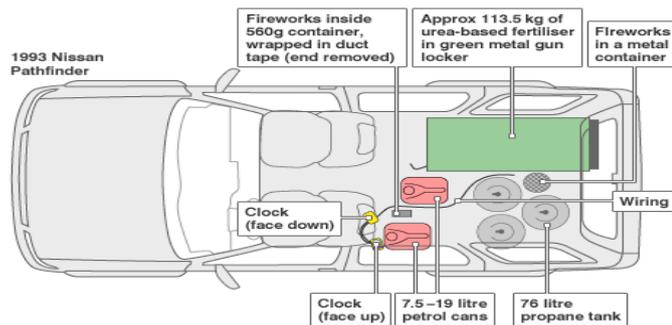


Figure 9 Schematic diagram of a Vehicle borne IED with an arrangement of explosive charge inside the vehicle.

Note- Adopted from Kova, V. (2018). Preventive measures for safe and healthy work with improvised explosive devices in multinational operations. *Vojnotehnički glasnik*, 66(3), 20.

**METHOD**

Data related to terror organization and terrorist activities were retrieved from archived news articles of reputed media houses and various journal articles. Information related to make of bomb and improvised explosive device is based on patents and experience of the author in the field. Personal information of individuals involving in terrorist activities is not included and only names of the terror organizations responsible for the attacks are mentioned. Extracted data is then presented in the form of bar graphs and charts for the ease of interpretation for the reader.

**Design**

This study took advantage of the internet archives and decided to include news articles from these archives. Data was extracted from news articles published between 1980 to 2020 as terrorism cases started to appear only after 1980 and from journal articles published by various strategic forums.

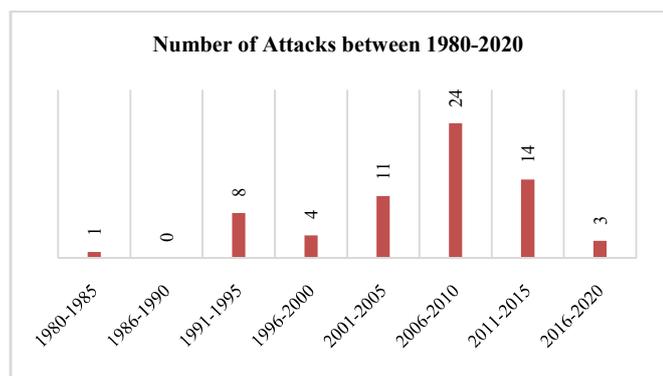


Figure 10 Graph representing the total number of terror attacks (both major & minor) across India in which explosives were used in the form of IED from 1980-2020.

**OBSERVATION & RESULTS**

As we are now aware of the major terrorist attacks in which explosives were used in the form of IED, we can now draw some observations based on it. From Fig 10 it is evident that attacks using explosives increased from the year 2001 which reached their peak between the year 2006-2010 especially in the year 2008 when 9 attacks occurred in 7 different cities. Attacks show a declining trend from the year 2011 with only 3 major attacks between the year 2016-2020.

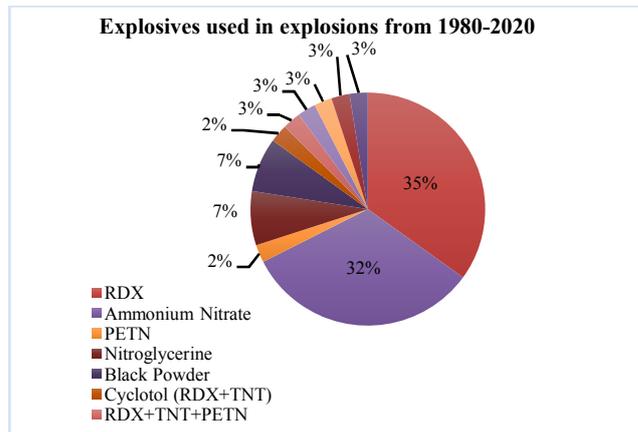


Figure 11 Explosives used as main charge in explosions from 1980-2020.

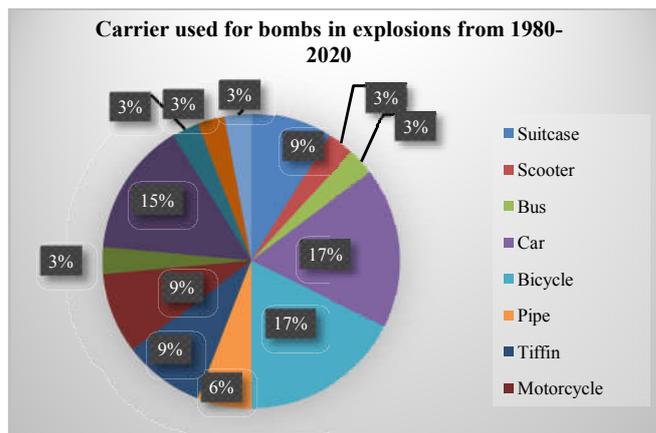


Figure 12 Containers used for bombs in explosions from 1980-2020.

Fig 11 shows the type of explosive used in attacks from the year 1980-2020. RDX was the most used explosive in these attacks followed by Ammonium nitrate and ammonium nitrate-based explosives. Both Nitroglycerine in the form of gelatin sticks and Black powder were used in 8% of attacks. A surprising trend of using a mixture of high explosives such as SEMTEX, RDX+TNT+PETN, Cyclotol (RDX+TNT), and RDX+ANFO was observed in some cases. Fig 12 shows the type of carrier used in these explosions. It is observed that car and bicycle are the most used carrier for placing bombs. Stolen cars were often used in these attacks. Being a big metal object it worked like a complete device that converts into a primary projectile on explosion causing extensive damage to the surrounding area. Bicycle being cheap and non-suspicious item is used by terrorists to carry out attacks. It can be placed in crowded areas as it occupies less space. It can be hidden easily and one can carry multiple of the cycles at one time in a truck and place them at multiple targets easily. Dustbins and Scooters were the second most favourite object of the terrorists for carrying out attacks. Dustbins in crowded markets can easily be found and are the best objects to hide a bomb in a garbage bag. Scooters again being two-wheeler occupies less space than a car and can be placed in cramped spaces easily. Availability and type of bomb is the deciding factor for the carrier used. Small bombs for carrying out low-intensity blast can be hidden in suitcase, tiffin box and cake boxes easily. A medium-sized bomb with 50-100 kg of explosive can easily be placed on a two-wheeler like a motorcycle, scooter, moped or bicycle. Explosives more than 100 kg required big vehicle like car & van to conceal the bomb.

## **CONCLUSION**

From the above discussion, we came to know about terrorism in India, major terrorist attacks carried out by different terror groups in India from the year 1980 to 2020 and types of explosives used in these terror attacks. We also came to know about the type of improvised explosive device used in major terror attacks. During the year 2006-2010, most of the terror attacks happen throughout India killing 518 and injuring 1,076 others. Most of the injured were permanently disabled for life. In these terror attacks, car and bicycle were the most used carrier for the bomb followed by a scooter or a two-wheeler. Bombs were used to hide in a specially formed cavity in the cars to make them hidden from routine security checks at the checkpoints across the major cities. The parts of the car converted into primary projectiles which cause extensive damage to the surrounding area and cause severe fragmentation injuries to the human targets. Human targets close to the bombs were simply blown to pieces with the sheer force of the explosion and the targets beyond close range received life-threatening injuries due to fragments of the carrier vehicle. Car bomb or VBIED is mostly used by Jaish-e-Muhammad (JeM) terror group which is based in Pakistan. Terror attack on Jammu & Kashmir Assembly and attack on CRPF convoy in Pulwama, both were carried out by JeM and in both attacks, VBIED is used. Scooter bombs and Cycle bombs were used by Harkat-ul-Jehad-i-Islami (HuJI), Indian Mujahideen (IM) terrorists and Student Islamic Movement of India (SIMI) terrorists. Terror module of IM and SIMI were based in India while HuJI was based in Bangladesh. IM was the parent module and SIMI and HuJI were inspired by the working of IM and thus they have similarity in their bomb signatures. One of the major difference between these three organizations was whenever IM carried out any attack in a major Indian city, it is used to send warning messages to news channels by email. These emails were either send from the cyber cafe or by personal computers by hacking the wifi of the cyber cafe. It indicates that the terrorists of these groups were well informed in computers and networking. Most of these terrorists were college students who were radicalized by terrorist groups in the name of religion. RDX was the most frequently used explosive by different terrorist groups in explosions due to its potency to kill anything in 5 meters radius and impart severe injuries up to 15-20 meters. Being a military-grade explosive it is impossible to procure RDX in India. Thus it is evident that foreign military role can't be ruled out in providing explosives to the terrorists. RDX is followed by Ammonium nitrate-based explosives. Ammonium nitrate is frequently used as NPK fertilizer and easily available in the market. Ammonium nitrate-based explosives are also used in industrial explosions and mining, for example, Neogel-90 and Neogel-901. Pilferage of these industrial explosives from storage houses or factories is another mode of procurement for terrorists. Terrorists frequently used timer devices such as digital clock, mobile phones and mechanical clocks for initiating explosive train. The timed device allows terrorists to place a bomb and escape before the explosion. In some cases, mechanical clocks failed to operate and either bomb remains unexploded or explodes before time causing fatal injuries to the terrorist himself. Therefore, terrorists tend to use a mobile phone or digital clock as a timer for foolproof execution. Mobile phones are remotely operated for initiation. A terrorist use to call on the mobile phone which is connected with an electric detonator which further connected with the main

charge. When the mobile phone connected to the bomb receives the call it generates a current which activates the electric detonator which in turn detonates the main charge. To counter this, VIP escort or high-security places often use mobile signal jammer based on a car or a platform. These signal jammers block frequency in the range of 850 to 1900 MHz which covers most of the 2G, 3G and 4G mobile signals. With evolving mobile technology and the onset of the 5G spectrum, a much higher frequency jammer will be required in future. A very interesting trend was also observed i.e., the use of metal ball bearings and nails as shrapnel to inflict fragmentation damage to human targets and the surroundings. These metal ball bearings when packed properly i.e., covering the whole explosive in a mosaic-like pattern, will act as a wall of shrapnel that travels in all directions. This wall will shatter any object which comes in its path up to a certain distance. Penetrating injuries, dismemberment of body parts will be primarily seen in cases where shrapnel being used. With evolving battlefield, which is an urban environment in today's scenario, and evolving technology we must adapt to the new techniques of detecting IED or components of IED which will prevent any major attack. In the present scenario attack with the use of drones as a carrier for an IED or by loitering munition (drone carrying explosive loiter over the target and hit it like a missile at an appropriate time) is a major cause of concern. It can be used to target crowded places, military installations, nuclear power sites, electric grids, VIP residences and other important facilities. As the drone gives live feed of the video to the operator, the video can be used to spread propaganda or to terrorize people further. These propaganda videos do two works simultaneously 1) they motivate people to join the terror groups i.e., recruitment, and 2) they terrorize common people. Counter drone technologies should be developed to counter these drones. These technologies use high power microwaves to fry the circuits of these drones rendering them ineffective at both long and short ranges. The Defence Research and Development Organization (DRDO) of India is now working on the same concept. In conclusion, we need to adapt to the changing environment at a much faster rate than in previous years with changing technology and urban battlefield environment. Increasing intelligence network, integrating different intelligence agencies and sharing intelligence on time is the only way to go. It is often seen at the local level that intelligence is received and no work has been done over the input to confirm it. So, a better terminal network of officers who can act upon this intelligence is required. From a Forensic point of view, new technologies are evolving for faster detection of trace amount of explosives with much higher sensitivity. Neutron Activation Analysis (NAA), Atomic Absorption Spectroscopy (AAS), Gas Chromatography-Mass Spectroscopy (GC-MS) and Ion Mobility Spectrometer (IMS) is already been used for the detection of explosives for several years. Out of these only IMS and GC-MS (up to a certain degree) are portable and can be carried to the crime scene easily. More portable techniques are required which a forensic examiner can carry to the crime scene and can examine traces of explosives with speed and high sensitivity. Detection at the crime scene will negate the probability of loss of trace evidence during transit. Nanotechnology is playing a great role in developing trace explosive detectors. Researchers are now working on nanomaterial-based trace analyzers which will be lighter and more portable than the present techniques. Nanosniffer™ is

such a device that used a microsensor for the detection of traces of explosives at the nanogram level. Improve, Adapt and Overcome is the only way ahead to outperform terrorist groups.

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