



Title:	Document Version:
D3.1 Progress report on models of patterns of human behaviours	0.8

Project Number:	Project Acronym:	Project Title:
H2020-740466	LETSCROWD	Law Enforcement agencies human factor methods and Toolkit for the Security and protection of CROWDs in mass gatherings

Contractual Delivery Date:	Actual Delivery Date:	Deliverable Type*-Security*:
M8 (December 2017)	M8 (December 2017)	R-PU

*Type: P: Prototype; R: Report; D: Demonstrator; O: Other.

**Security Class: PU: Public; PP: Restricted to other programme participants (including the Commission); RE: Restricted to a group defined by the consortium (including the Commission); CO: Confidential, only for members of the consortium (including the Commission).

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Abstract:

The purpose of D3.1 is to identify and define patterns of suspicious & abnormal behaviour, which may indicate possible security threat, of individuals, groups and crowds to large public events.

The task will aim to identify list of suspicious patterns (suspicious signs in body language, appearance, behaviour, location and activity) based on LEA's inputs, case studies, various EC founded projects and the experience gained by the security practitioners partners in LETS-CROWD.

Keywords:

Suspicious behaviour, Abnormal behaviour, Terrorism, Attack

Revision History

Revision	Date	Description	Author (Organization)
0.1	17/09/2017	New document	Yuval Alon (RailSec Ltd)
0.2	25/09/2017	Style fixes	Alejandro Ruiz (ETRA)
0.3	26/10/2017	Suspicious behaviour examples	Alberto Pasquini (DBLUE)
0.3	26/10/2017	Suspicious behaviour examples	Ilse Jacobs (LPV)
0.3	26/10/2017	Suspicious behaviour examples	Allertseder Sebastian(BayFHVR)
0.4	29/11/2017	Review by UC	Arturo Cuesta (UC)
0.5	11/12/2017	Review by ETRA	Santiago Cáceres (ETRA)
0.6	12/12/2017	Review by UNICA	Giorgio Fumera (UNICA)
0.7	17/12/2017	Final version	Yuval Alon, Chanan Graf (RailSec)
0.8	25/08/2018	Revision according to EC comments	Yuval Alon, Chanan Graf (RailSec)



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement № 740466.

More information available at <https://LETSCROWD.eu>

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1 INTRODUCTION

1.1 Purpose of the document

In the past few years Europe has suffered many criminal actions and terrorist attacks during mass gatherings, which have great impact on the citizens and the society. Novel methodologies and tools must be investigated for strategic and operational activities, involving strong cross-border cooperation and intelligence sharing. The aim of LETSCROWD project is to find solutions for all these issues where the human and sociological factor will be the key driver.

LETSCROWD will overcome challenges preventing the effective implementation of the European Security Model (ESM) with regards to mass gatherings. This will be achieved by providing the following to security policy practitioners and in particular Law Enforcement Agencies (LEAs):

- (1) A dynamic risk assessment methodology for the protection of crowds during mass gatherings centred on human factors in order to effectively produce policies and deploy adequate solutions.
- (2) A policy making toolkit for the long-term and strategic decision making of security policy makers, including a database of empirical data, statistics and an analytical tool for security policies modelling, and
- (3) A set of human centred tools for LEAs, including real time crowd behaviour forecasting, innovative communication procedures, and semantic intelligence applied to social networks and the internet, and novel computer vision techniques.

Past experience has shown that terror and criminal attacks can be detected and thwarted by observing and identifying indicators of abnormal & suspicious behaviours.

The purpose of D3.1 is to identify and define patterns of suspicious & abnormal behaviour, which may indicate possible security threat, of individuals, groups and crowds to large public events.

The task is aimed to identify list of suspicious patterns (suspicious signs in body language, appearance, behaviour, location and activity) based on LEA's inputs, case studies, various European Commission funded projects and the experience gained by the security experts partners in LETSCROWD consortium.

Distinct and visible behaviour, such as whole-body behaviours including movement about a space or excessive body gestures were identified as well as behaviours that are less obvious such as signs of stress, eye movements, mumbling and sweating.

The main goal of the document is to establish a list of identified suspicious/abnormal behaviour that may indicate threats to crowds participating in large public events in order to support LETSCROWD project activities of WP3 (Dynamic risk assessment) and WP5 (Human-centred support toolkit), T5.4 (Human-centred computer vision for crowd protection) among others.

1.2 SCOPE OF THE DOCUMENT

This deliverable is part of WP3, Dynamic Risk Assessment. The scope of the document is to list and catalogue a set of suspicious signs / abnormal behaviour that may indicate threats to mass gathering events originating from terror activity.

The suspicious signs / abnormal behaviour threat indicators were collected from open sources available to the public from various law enforcement publications, academic studies, industry state of the art, European Commission research projects and contribution of consortium members.

1.3 STRUCTURE OF THE DOCUMENT

The document consists of the following several main chapters:

- Methodology – description of the manner information was collected and analysed.
- Literature review – overview of main sources of information.

- Past incidents – description of various past terror incidents and threat indicators that were associated with them following incidents debriefing.
- The Israeli approach – review of best practices in Israel; where much of the practical experience was gathered and tested.
- The European state of the art – overview of best practices in various European countries.
- LETSCROWD – patterns of suspicious behaviors.



2 METHODOLOGY

2.1 Source of information

The research involves wide range of sources and methods in order to accurately understand threat indicators (signs of hostile activity) expressed in suspicious and abnormal behaviour. Information for developing the abnormal behaviour indicators obtained from the followings sources of information:

- Literature review (scientific publications, European Community research projects, publications of law enforcement agencies).
- Analysis of past incidents.
- Analysis of questionnaires distributed to LEA's which are members of the LETSCROWD project.

2.2 Approach

The approach adopted for the purpose of this task is based on classification of abnormal behaviour indicators to the various phases of terror attacks to enable identification of methods and technologies capable to detect the threat indicators preferably before they materialized.

Terror attacks or any other hostile activity can be typically divided into phases based on the various activities done by the perpetrators to mount the attack successfully:

Phase	Activities
Pre - attack	Developing intent
	Recruitment or joining
	Target identification
	Acquiring materials (weapons, communication, transportation, etc.)
	Selection of tactic
	Preparation of logistics (hide houses, documents, etc.)
	Information gathering including reconnaissance
	"dry run" (to check effectiveness of counter measures)
Execution	Arrival to immediate area of attack
	Main attack

Post - attack	Escape / gateway
	Communication
	After action reports

Table 1 Attack Phases & Corresponding Terror Activities

The phased model presented above is based on analysis of information gained from past terror attacks. It should be noted that the phased model is employed purely for the purpose of having structured understanding of activities that may be carried out by perpetrators in the course of planning and executing major attacks and to associate threat indicators to specific phase. The various phases detailed above typically occurred during the planning and execution of major terror attack but there are many terror attacks that don't include most of the phases, particularly attacks carried out by "lone wolves" and individuals who are not part of organized terror network.

Moreover, throughout the cycle of the attack a given phase or activity may never occur; two phases may be carried out at the same time; the order of phases may vary; and events in the execution or post-attack phase of one attack may affect motivation, planning, etc., for a next cycle of attacks.

3 LITERATURE REVIEW

3.1 General overview

The review of the literature about abnormal or suspicious human behaviour included various publications on the subject from security professionals, law enforcement agencies and studies done at the academy. Such publications included guidelines, policies, framework programs and research published by the United States Coast Guard, American Transportation Public Association, RAND institute, British police and French ministry of interior. Additional inputs, very practical, were obtained from review of commercial state of the art in the field of video analytics.

Abnormal behaviours of individuals, groups and crowds can be classified into different types: behaviour, body language, movement, and appearance indicators. It is imperative to note that circumstance and context are critical to the interpretation of abnormal behaviour. Elements such as the cultural background, location, time, etc. plays crucial role in the classification of any behaviour as abnormal or suspicious. For example, an individual wearing rain coat walking in the street will not arouse suspicions in the winter time but the same person wearing a rain coat in sunny summer day approaching big concert will raise suspicions.

Additional important factor to note is that in many cases a single indicator is likely to be considered insufficient to trigger response from security personnel. Usually, stronger suspicions arise when several abnormal behaviours indicators are observed, either together or successively. For example when a group of 2 -3 persons carrying back packs and appearing nervous are observed boarding a train, it may not lead to strong suspicion, but if the persons are later on observed splitting and each one of them sits in a different car, this will make suspicion much stronger.

An important source of information is provided by various publications of law enforcement agencies particularly from awareness programs initiated in the United States.

A typical example can be found in a publication by American Transportation Public Association (APTA - Identifying Suspicious Behaviour in Mass Transit, 2009 (1). In that publication ATPA is dividing suspicious behaviour into 3 sections:

- Out-of-the-ordinary situations: activities carried out by the perpetrators during the planning stage of the attack

Taking photos of critical infrastructure	Working in groups
Avoiding eye contact	Taking notes/drawing diagrams
Inquiring about security/operations	Revisiting the same location
Not actually using the transit system	Immediately fleeing the area when noticed
Boundary probing	Weak cover story if questioned

Table 2 – Potential Preparatory Actions for Terrorism or Criminal Activity

- Nervous tendencies: during the preparation and execution phase of terrorist or criminal activity. Such tendencies may increase in close proximity to uniformed security personnel, K9 units (police dogs) and security checkpoints.

Trembling	Continuously scanning the area
Unusual perspiration	Heavy breathing
Fidgeting (fiddling)	Rubbing hands
Clock watching	Repetitively touching face
Avoiding uniformed officers	Exaggerated emotions such as crying or laughing to self

Table 3 – Nervous Tendencies

- Signs of execution: indicators during the actual execution of the attack.

Inappropriate clothing for the season	Repeatedly patting upper body
Exposed wires	Rigid posture with minimal body movement, arms close to sides
Excessive fidgeting, clock watching and area scanning	Appearing to be in disguise
Appearing in a trance	Drastic and sudden change of appearance (shaved body hair, shaved head, increased mass from explosive vest)
Unresponsive, distant, and/or inattentive	

Table 4– Signs of Terrorist or Criminal Activity Execution

Another publication from the Metropolitan Transportation Authority of New York is listing eight signs of terrorism (2). Such publications are typical of security awareness programs in the US. The indicators are:

- Surveillance: the target area will most likely be observed during the planning phase of the operation. Routes to and from the target are usually established during the surveillance phase. It is therefore important to take note of such things as someone recording or monitoring activities, drawing diagrams on or annotating maps, using vision-enhancing devices and/or having in one's possession floor plans or blue prints of places such as high-tech firms, financial institutions or government/military facilities. Any of these surveillance-type acts may be an indicator that something just is not right.

- **Elicitation:** an attempt to gain information about a place, person or operation. An example is someone attempting to gain knowledge about a critical infrastructure like a power plant, water reservoir or maritime port.
- **Tests of Security:** Tests of security is another area in which terrorists would attempt to gather data. This is usually conducted by driving by the target, moving into sensitive areas and observing security or law enforcement response. Terrorists would be interested in the time in which it takes to respond to an incident and/or the routes taken to a specific location. They may also try to penetrate physical security barriers or procedures in order to assess strengths and weaknesses. They often gain legitimate employment at key locations in order to monitor day-to-day activities. In any event, they may try to gain this knowledge in order to make their mission or scheme more effective.
- **Funding:** Suspicious transactions involving large cash payments, deposits, or withdrawals are common signs of terrorist funding. Collections for donations, the solicitation for money and criminal activity are also warning signs.
- **Acquiring Supplies:** Another area to be cognizant of is anyone acquiring supplies. This may be a case where someone is purchasing or stealing explosives, weapons or ammunition. It could also be someone storing harmful chemicals or chemical equipment. Terrorists would also find it useful to have in their possession law enforcement equipment and identification, military uniforms and decals, flight passes, badges or even flight manuals. If they can't find the opportunity to steal these types of things, they may try to photocopy IDs or attempt to make passports or other forms of identification by counterfeiting. Possessing any of these would make it easier for one to gain entrance into secured or usually prohibited areas.
- **Suspicious People Who Don't Belong:** Observing suspicious people who just "don't belong". This does not mean we should profile individuals; rather, it means we should profile behaviours. These include suspicious border crossings, stowaways aboard a ship or people jumping ship in a port. It may mean having someone in a workplace, building, neighbourhood or business establishment that does not fit in because of their language usage or unusual questions they are asking.
- **Dry Runs:** Before execution of the final operation or plan, a practice session will be run to work out the flaws and unanticipated problems. A dry run may very well be the heart of a planning stage of a terrorist act. Another element of this activity could include mapping out routes and determining the timing of traffic lights and flow. This stage is actually our best chance to intercept and stop an attack. Multiple dry runs are normally conducted at or near the target area.
- **Deploying Assets/Getting into Position:** someone deploying assets or getting into position. It is also important to remember that pre-incident indicators may come months or even years apart.

One of the recent publications in the field issued by the Australian government "A Guide to Development and Implementing Suspicious Activity Identification Programs in Ports" (3). The general definition of suspicious activity presented in this document is: **"What makes a person suspicious is not their skin color, gender, ethnicity or position in society. It's what they are doing, where they are or how they are behaving."**

The document provides a comprehensive list of indicators for suspicious activity which include, among other, the following:

- Putting down a bag or item and then walking away from it.
- Taking photographs of infrastructure or filming security measures or procedures.
- Not wearing an ID card in an area where one is required.
- Acting nervously agitated or scared.
- Repeatedly being at a location, for no apparent reason.

- Asking unusual or unnecessary questions.
- Unusual chemical smells or fumes.
- Avoiding security personnel or systems.

Another important publication was issued by the United States Coast Guard within the framework of Americas Water Way Watch program (4). Suspicious activity indicators listed in this publication includes:

- Surveillance: Surveillance involves photography, videotaping, drawing and/or mapping, or other means of monitoring a potential target.
- Elicitation: Elicitation involves asking detailed questions in an attempt to gain knowledge of hidden or proprietary information.
- Tests of security: A test of security is a tool used to develop timelines of authoritative response to a particular incident or occurrence. Staging an incident can be done to determine access vulnerability and/or establish a timeline for later use.
- Suspicious behaviour: Suspicious behaviour is displayed behaviour that is out of place or out of character with the environment. Remember people are not suspicious. Behaviour is!

A more comprehensive approach to the suspicious/abnormal behaviour indicators is presented in recent works such as the one published by RAND Institute (5). This study also adopts the phased model to associate threat indicators with the various stages of attack cycle. The various phases are summarized in the following table:

Phase	Activities
Developing intent	Motivational development Psychological convergence Recruitment or joining
Planning and laying groundwork	Development of strategic priorities Target identification and intelligence, surveillance, and reconnaissance (ISR) Materiel acquisition, testing, and development Concept of Operations (CONOPs) development Training and mission rehearsal Other long-lead-time preparations
Immediate pre-execution	Psychological and physiological preparations Changed social patterns

	Ritual practices Deception and concealment
Execution	Intelligence, surveillance, and reconnaissance Deployment and positioning Coordination and communication Target shaping and feints Main attacks
Aftermath	Post-attack reporting Strategic communication Protective measures Adaptation

Table 5 – Attack Phases Vs activities

The various indicators for each phase are contained in the following tables:

Developing Intent
Reveal hatred, prejudice, trauma, or shame
Exhibit motivation for prestige, glory, status
Approach life and decisions through ideological framework
Explore different organizations and strategies
Proselytize and adhere strictly to organizational standards
Impose or reinforce practices and beliefs in others
Show signs of reinforced commitment
Form new connections in social network to known terrorist elements
Seek out, read, or post radical content
Attend radical mosques or events

Change behaviour at school or home

Table 6 – Behavioural Indicators for Developing Intent

Planning
Seek information on construction of weaponry and explosives
Visit training camps and seek aviation or marksmanship training
Acquire dual-use electronics, explosives, ignition devices
Conduct surveillance of target
Use dry runs to simulate and practice attack
Try to provoke or test security responses near target
release information or discuss how to harm or influence target population
Experiment with chemical or explosive weapons
Purchase explosive precursors or fire arms
Maneuver clandestinely or with camouflage near potential target

Table 7 – Behavioural Indicators for Planning

Pre-Execution Activities
Separate from nonterrorist elements of social network
Increase communication with terrorist elements
Take specialized actions to motivate self and co-attackers
Give inconsistent responses to questioning
Give nonverbal signals of deception and lying
Hesitate near target
Show accelerated heart rate, sweaty palms, thermal indicators
Show micro-expressions of fear, hostility, deception, detachment
Show indicators of instrumental aggression

Exhibit body-movement patterns indicating hostile intent, clandestine movement, or weapon carrying

Table 8 – Behavioural Indicators for Pre-Execution Activities

Execution
Take action portending next stage
Indicate intent by nature of initial targets or give clues about future attacks
Drive car packed with fighting-aged males
Run checkpoints or security barriers
Split into groups (signalling multiple points of attack)
Run into buildings with cover or line-of-sight, indicating intent to engage targets
Shape population composition of target area
Collect intelligence
interact with security personnel
Prepare attack or feints
Conduct main attack
Communicate post-attack “spin” to media

Table 9 – Behavioural Indicators for Execution Activities

After classifying suspicious/abnormal behaviours indicators according to the various attack phases, RAND institute presented technology and methods for detecting such behaviours, grouping them in three cross-cutting categories of information:

- Communication patterns: tracking online communication and activities through monitoring online communication and activities, Text analysis and natural language processing, Speech analysis.
- “Pattern-of-life” data: Mobile device tracking, Pattern-of-life data, Machine learning and big-data analysis.
- Indicators relating to body movement or physiological changes: Kinetics and gross motor movement, Physiological state and reactions.

3.2 The Realm of Video Analytics

Video analytic or computer vision algorithms are one of the most acceptable ways to detects and identify suspicious behaviours in crowds. Many computer vision algorithms exist in literature for tracking, detecting and analysing behaviour in crowded scenes but most of them provide acceptable results in a low to medium density crowd and have challenge to operate properly in dense crowds. (6)

In the video scene analysis and understanding, the focus is on object detection, tracking and behaviour recognition. Most research on crowd analysis can be divided into three parts:

- People counting/density estimation.
- People tracking.
- Behaviour understanding or anomaly detection.

People counting are mainly focused on overcrowded for both security and safety purposes. People counting can be applied on static images and video sequences in both indoor and outdoor scenarios.

People counting focus on the localization of an individual in successive frames. Tracking of people usually involve the location of individual in the frames as a function of time. (7)

Behavior understanding or abnormality detection defined in many types of research in terms of frequency; the events which occur infrequently is called as abnormal. Behavior understanding mainly focuses on velocities, directions of flow and abnormal events such as fighting, running, etc.

Developers of video analytics software are a useful source of practical information about abnormal behaviour indicators. They developed a list of abnormal behaviours that are mostly based on behaviour & movement. Indicators of leading companies typically include at least some of the following indicators:

- Penetration of unauthorized people / vehicles into restricted areas.
- Tailgating of people / vehicles through secure checkpoints.
- Traffic obstacles.
- Unattended objects.
- Vehicles stopped in no-parking zones, highways or roads.
- Removal of assets.
- Crowding or grouping.
- Loitering.

Video analytics solutions are much more efficient in closed venues than in open areas and level accuracy and number of false and nuisance alarms are much lower when applied in closed areas.

The ADABTS (Automatic Detection of Abnormal Behaviour and Threats) in crowded Spaces (8) project refined a list of indicators which were classified into five distinct categories:

- Behaviour/body language.
- Movement.
- Appearance.
- Audio.
- Crowd behaviour/movement.

One of the conclusions of the project is that in many cases individual, group and crowd abnormal behaviour as well as the appearance of an individual or group considered as being suspicious are specific to a particular context whereas other behaviour indicators are more universal.

3.3 Crowds Categorization

Many of the behaviours identified with the use of video analytic and other means of detection (such as human sensors) are based on observation and analysis of different types of crowds. Crowds at special

events, for example can be thought as of comprising numerous smaller groups, each of which can be considered to have its own personality or its own shared social identity. (9)

Accurate identification of some suspicious signs depends on the ability to distinguish between crowd types and their differing personalities and social identities. (10)

One definition of crowd's types is provided by Mombouise who distinguish four types of crowd (11):

Type of Crowd	Characteristic of Crowd
Casual crowds	i.e., ones which are not organized or unified, but comprise individuals who are simply in the same place at the same time
Conventional crowds	i.e., ones which are gathered for specific purpose or to observe a specific event, with crowd members who share common interest
Expressive crowd	i.e., ones with members who are involved in some form of expressive behaviour, although not in a destructive way, for instance, dancing or singing
Aggressive crowd	i.e., ones which are unorganised and lacking in unity, but with members who are willing to be enticed into disorder and unlawful behaviour

Table 10. Type of Crowd and Characteristic of Crowd by Mombouise

A more detailed approach is presented by Berlonghi (12) which categorized crowds into eleven different types summarized in the following table:

Type of Crowd	Characteristic of Crowd
Ambulatory crowd	A crowd entering or exiting a venue, walking to or from car parks, or around the venue to use the facilities
Disability or limited movement crowd	A crowd in which people are limited or restricted in their mobility to some extent, for example, limited by their inability to walk, see, hear, or speak fully
Cohesive or spectator crowd	A crowd watching an event that they have come to the location to see, or that they happen to discover once there
Expressive or revellous crowd	A crowd engaged in some form of emotional release, for example, singing, cheering, chanting, celebrating or moving together

Participatory crowd	A crowd participating in the actual activities at an event, for instance, professional performers, athletes, or members of an audience invited to perform on stage
Aggressive or hostile crowd	A crowd which become abusive, threatening, boisterous, potentially unlawful and disregards instructions from officials
Demonstrator crowd	A crowd, often with a recognized leader, organised for a specific reason or event, to picket, demonstrate, march or chant
Escaping or trampling crowd	A crowd attempting to escape from real or perceived danger or life threatening situations, including people involved in organized evacuations, or chaotic pushing and shoving by panicking mob
Dense or suffocating crowd	A crowd in which people's physical movement rapidly decrease – to the point of impossibility – due to high crowd density, with people being swept along and compressed, resulting in serious injuries and fatalities from suffocation
Rushing or looting crowd	A crowd whose main aim is to obtain, acquire, or steal something – for example, rushing to get the best seats, autographs, or even commit theft – which often causes damage to property, serious injuries, or fatalities
Violent crowd	A crowd attacking, terrorising, or rioting with no consideration for the law or the rights of other people

Table 11 Type of Crowd and Characteristic of Crowd by Berlonghi

Within each type there is a whole range of crowd member types (13). For instance, a demonstration crowd may be comprised of:

- Totally compliant protestors – i.e., passionate but do not cause trouble.
- Slightly more difficult protesters – i.e., no disorder but may commit civil disobedience.
- Protesters who are willing to commit disorder if they become caught up with the emotion of the crowd and are pushed by other fellow members.
- Professional/subversive protesters – i.e., intent on causing and provoking disorder.
- Individuals who are not genuine protestors, but will use a protest as a cover to commit disorder.

In addition to crowd types Berlonghi identifies specific observable characteristics which may assist in the evaluation how a particular crowd is likely to behave:

Characteristic	Behavioral Indicators
Organization How organized is the group?	<ul style="list-style-type: none"> • A demonstrator crowd is likely to be highly organized. • An ambulatory crowd is likely to be unorganized. • A revellous or cohesive may organize themselves spontaneously.
Leadership How established is the leadership?	<ul style="list-style-type: none"> • A spectator crowd will have no leadership. • A demonstrator crowd will have a pre-specified leader. • An escaping crowd being evacuated will have clear leadership whereas an escaping crowd being panic mobbed will not. • Leadership roles for groups of rival fans at sporting events may develop spontaneously.
Cohesiveness Have members of the crowd bonded with each other?	<ul style="list-style-type: none"> • Members of an expressive crowd are likely to form close bonds and may turn on rival crowds, either playfully or with harmful intent.
Unity of purpose Is the crowd united for a common purpose?	<ul style="list-style-type: none"> • A participatory crowd often has a clear purpose e.g. running a marathon.
Common motive for action Are crowd members united in their motives for action?	<ul style="list-style-type: none"> • An expressive crowd chanting at a key moment in a football match have a common motive, of encouraging their team and distracting the opposition.
Psychological unity Is the crowd psychologically united?	<ul style="list-style-type: none"> • A participatory crowd has a strong sense of psychological unity because members are all performing or working together. • A demonstrator crowd is likely to be psychologically united.

	<ul style="list-style-type: none"> A spectator crowd at a chanty concert or event to raise social awareness are likely to be psychologically united.
Emotional intensity Is the crowd emotionally intense?	<ul style="list-style-type: none"> Depends on the nature and purpose of the event, e.g., emotional intensity is likely to be high at sporting event finals or play-offs.
Volatility Has the crowd reached an explosive point?	<ul style="list-style-type: none"> Are people acting as responsible or as reckless members of a crowd, indicating the potential for disorder?
Individual behavior How much individual control and responsibility do people express?	<ul style="list-style-type: none"> A crowd is characterized by individual behavior when crowd members exercise responsibility for their own actions and for the actions of other crowd members.
Group behavior To what extent are individuals dominated by the group?	<ul style="list-style-type: none"> Individuals highly dominated by the group act with little self-awareness, self-consciousness and little sense of responsibility.
Degree of lawlessness How much criminal activity is taking place?	<ul style="list-style-type: none"> Throwing objects, damaging property, fighting, and pushing and shoving are all indicative of a lawless crowd.
Level of violence How violent is the crowd?	<ul style="list-style-type: none"> This can be based on both historical assessment of previous incidents and on current observations of crowd behavior.
Level of property damage How much damage to property is likely to occur?	<ul style="list-style-type: none"> The extent of likely damage can be anticipated by reviewing damage at previous events of similar nature, with a similar crowd or at the same location.
Likelihood of injuries and deaths	<ul style="list-style-type: none"> This depends on the event type and location. For instance, the age, condition and design of certain venues influence

How likely are injuries and deaths?	<p>the likelihood of accidents.</p> <ul style="list-style-type: none"> Escaping, rushing, dense or violent crowds are also more likely to suffer injuries or even deaths.
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Table 12. Characteristic and Behavioural Indicators

Additional factors which can influence crowd behaviours include:

- Size of the crowd.
- Demographics of the crowd, e.g., age, gender.
- Mobility of the crowd.
- Location of the event.
- Geometry of the location.
- Time of event.
- Type of event.
- Density of crowds in different areas of the event.
- Time table of event activities.
- Weather conditions. (13)

4 PAST INCIDENTS

4.1 General

Knowledge gained from the analysis of past incidents and terror attacks is a key for the identification and development of suspicious/abnormal behaviour indicators. Law enforcement agencies rely on analysis of past terror attacks and security incidents to refine and modify suspicious/abnormal behaviour indicators. One of the most important conclusions from analysis of past attacks is that trained security personnel or civilians who are living in societies targeted by frequent terror attacks are able in many cases to identify suspicious behaviour indicators. Sometimes the indicators are very obvious to the conscious eye and sometimes suspicions arise based on general feeling of threat that cannot be explained specifically. In such cases the suspicion is based on accumulation of weak indicators that translate the general feeling that something is wrong with the behaviour or appearance of individual or group and that they may pose security threat.

The following paragraphs (from 4.2 to 4.5) describe in detail a number of terrorist attacks occurred and identify some of the suspicious signs detected during the attacks or in the investigation that follows.

4.2 The attack on Mike's place

One of the incidents that represent the ability of trained and aware security personnel to identify threat indicators and to respond accordingly is the terror attack carried out at a popular pub in Tel – Aviv, Israel.

On April 30, 2003, a suicide terrorist blew himself up at the entrance to Mike's Place pub in Tel-Aviv after being challenged and denied entry by a private security guard securing the place. Three civilians were murdered, and over 50 were wounded in the attack. The attack was perpetrated by Asif Muhammad Hanif, 22, a British citizen. A second British citizen, Omar Khan Sharif who was also due to have perpetrated a suicide attack, fled the scene after his attempt to detonate the bomb in his possession failed. His body was positively identified on May 19, 2003, after having washed ashore on the Tel Aviv beachfront on May 12. The two terrorists reached the scene of the attack from a nearby hotel, in which they had rented a room several hours earlier. Few days earlier, they had spent one night in the same hotel, and during the stay they carried out a reconnaissance activity and selected the target. An examination of the unexploded bomb discarded by Omar Khan Sharif showed that it had been hidden in a book and contained standard explosives. (14)

In a recent interview with the security guard who stopped the suicide bomber from entering the place, he describes the chain of events just before the terrorist detonated the bomb: "I was standing at the entrance to the pub, screening people trying to enter. Suddenly I spotted a person approaching very fast, trying to reach the entrance door. **Something in his behaviour seemed strange. The way he walked was different from other people. In addition, he seemed to be fixated on the entrance door, not noticing anything else. I didn't observe anything suspicious that might hints that he is hiding weapons or explosives. I had an unexplained "stomach feeling" that this person is dangerous.**

4.3 2016 Brussels airport bombing

On the morning of 22 March 2016, three coordinated suicide bombings occurred in Belgium: two at Brussels Airport in Zaventem, and one at Maalbeek metro station in central Brussels. Thirty-two civilians and three perpetrators were killed, and more than 300 people were injured. Another bomb was found during a search of the airport. The perpetrators belonged to a terrorist cell which had been involved in the November 2015 Paris attacks. (15)

The two suicide bombers, carrying explosives in large suitcases, attacked a departure hall at Brussels Airport in Zaventem. The first explosion occurred at 07:58 in check-in row 11; the second explosion occurred about nine seconds later in check-in row 2.

The suicide bombers were visible in CCTV footage which clearly shows that both of them were wearing a single black glove on their right hand. This was maybe to hide detonation trigger mechanism.

Another threat indicator that might have raise suspicion is the report of the taxi driver who drove the suicide bombers to the airport. He reported that the terrorists refused to let him put their bags in the trunk of the taxi; a behaviour which is very uncommon.

4.4 2013 Volgograd Suicide bombing

On 29 December 2013, a suicide bombing attack took place at the Volgograd-1 station in the city of Volgograd, Russia. 18 people were killed and at least 44 were injured. The attack occurred around 12:45 Moscow Time close to metal detectors near the entrance of the station. The bomb contained the equivalent of 10 kilograms (22 lb) of TNT. (16) The approach of the bomber to the station and moments of the explosion was captured by two CCTV cameras inside the station and one outside. From review of the video it can be clearly that on his approach to the target the suicide bomber displayed many indicators for abnormal behaviour including: **not moving to the target in direct way, avoiding eye contact with security guards, looking around nervously.**

4.5 2003 Kefar–Sava train station suicide bombing

On the 24.04.2003 around 07:20 a powerful explosion rocked the Nordau railway station located at the quiet suburban town of Kefar–Sava, centre of Israel. As emergency services rushed to the area it was apparent that the station was the target of a terror attack, the latest one in a chain of attacks targeting mass transit & rail services in Israel.

The investigation of the attack revealed that the terrorist, eighteen years old Ahmed Haled Hativ from the Balata refugee's camp near Nablus in the western bank has arrived to the station on board a bus from Jerusalem. Hativ was wearing a heavy coat to conceal the explosive belt he was wearing under his clothes. The stations security agents that were alerted by his **unusual appearance – wearing heavy coat in the mid of the hot Israeli summer** – and his confused behaviour challenged him before the station entrance and asked him to present I.D. In a response the suicide bombers opened his coat and ignite the explosive device causing horrific carnage. (14)

4.6 Reference case and corresponding abnormal behaviour indicators

The following reference cases are presented according to the various phases of the attack cycle and corresponding suspicious/abnormal behaviour indicators.

Phase	Reference case	Indicators	Link to source
Pre attack	Fort Hood Shooting	Emails between the shooter and a Yemen-based cleric showed religious concerns, questions about martyrdom, and, anger toward the American government.	http://www.telegraph.co.uk/news/worldnews/northamerica/usa/6521578/Fort-Hood-shooting-inside-story-of-how-massacre-on-military-base-happened.html
	Camp Chapman attack	The terrorist wrote posts on the internet with references to literature and the Koran to describe his support for violent opposition to the United	https://www.theguardian.com/world/2009/dec/31/taliban-cia-agents-killed-afghanistan

Phase	Reference case	Indicators	Link to source
		States.	
	Northwest Airlines Flight 253 attack	The attacker informed his father of his radicalization and separation clearly enough so that the father reported his concerns to American intelligence.	http://www.telegraph.co.uk/news/worldnews/northamerica/usa/6891345/Detroit-terror-attack-how-the-bomber-tried-to-blow-Flight-253-from-of-the-sky.html
	Zachary Chesser case	In a series of online posts entitled “Counter Counter Terrorism,” Chesser outlined ways the violent Islamist extremist movement could win an ideological struggle—the so-called “war of ideas”—against the West.	https://www.hsdl.org/c/a-case-study-in-online-islamist-radicalization-and-its-meaning-for-the-threat-of-homegrown-terrorism/
	The Millennium Conspiracy	The attacker became friends with known al Qaeda member. He began regularly attending the mosque.	http://abcnews.go.com/US/story?id=93870&page=1
	Fort Hood Shooting	Online registration, payment, and attendance at training camps. Traveling to known terrorist training locations.	http://www.telegraph.co.uk/news/worldnews/northamerica/usa/6521578/Fort-Hood-shooting-inside-story-of-how-massacre-on-military-base-happened.html
	Oklahoma City Bombing	Acquire dual-use electronics, explosives, and ignition devices.	https://www.fbi.gov/history/famous-cases/oklahoma-city-bombing
	Dallas Skyscraper Bombing	Suspicious behaviour near targets (lingering, observing, photography, rapid departure if approached).	https://www.nbcdfw.com/news/local/FBI-Arrests-Man-Accused-in-Skyscraper-Bomb-Plot--61272512.html
	Camp Chapman attack	Actions that test security responses near target, Dry runs.	https://www.theguardian.com/world/2009/dec/31/taliban-cia-agents-killed-afghanistan
	The Millennium	Increased communication with terror	http://abcnews.go.com/US/story?id=93870&page=1

Phase	Reference case	Indicators	Link to source
	Conspiracy	activists.	
	Barcelona 2017	Intelligence services reveal supposed conversation with Barcelona terrorist.	http://www.elnacional.cat/en/news/intelligence-group-reveals-supposed-conversation-with-barcelona-terrorist_185673_102.html
	Dortmund Bombing 2016	Surveillance of the target.	http://www.stern.de/panorama/stern-crime/anschlag-auf-bus-des-bvb---die-raetselhafte-geschichte-des-sergej-w-7431272.html
Execution	Mumbai attacks, London subway attack	Splitting into groups or individuals.	https://www.britannica.com/event/Mumbai-terrorist-attacks-of-2008
	Madrid train attack	Leaving unattended items/bags.	http://www.bbc.com/news/uk-33253598
	Brussels airport attack	Wearing gloves or holding hand in pocket.	https://www.theguardian.com/world/2016/mar/22/brussels-airport-explosions-heard
	Kibbutzim junction attack	"Pipe" vision, looking disconnected from environment.	https://en.wikipedia.org/wiki/Mehola_Junction_bombing
	Mehola bus attack	Electrical wires or electrical components from the IED inside bag.	https://en.wikipedia.org/wiki/Mehola_Junction_bombing
	Mhala edumim attack	Wearing clothes that are out of character with the environment or neighbourhood.	http://vitalperspective.typepad.com/vital_perspective_clarity/files/Fatal_Hamas_Attacks_Since_9-00.pdf
	Haifa bus attack	Not acting as expected from the situation.	http://vitalperspective.typepad.com/vital_perspective_clarity/files/Fatal_Hamas_Attacks_Since_9-00.pdf
	Jerusalem bus	General intuition accumulated from	http://vitalperspective.typepad.com/vital_perspective_clarity/files/Fatal_Hamas_Attacks_Since_9-00.pdf

Phase	Reference case	Indicators	Link to source
	attack, mikes place attack	weak un specific indicators.	perspective_clarity/files/Fatal_Hamas_Attacks_Since_9-00.pdf
	Beer Shebaa terror attack	Breathing heavily, looked to be under pressure, and appeared anxious. Appearing nervous, tense or agitated.	http://vitalperspective.typepad.com/vital_perspective_clarity/files/Fatal_Hamas_Attacks_Since_9-00.pdf
	Beer Shebaa terror attack	Avoiding security personnel.	http://vitalperspective.typepad.com/vital_perspective_clarity/files/Fatal_Hamas_Attacks_Since_9-00.pdf
	Megiddo Junction Attack	Heavily loaded vehicle parked in strategic location.	http://vitalperspective.typepad.com/vital_perspective_clarity/files/Fatal_Hamas_Attacks_Since_9-00.pdf
	Bataclan attack in Paris	"Weird faces" in a car outside the concert hall.	http://www.telegraph.co.uk/news/worldnews/europe/belgium/12013230/Brussels-Paris-attack-terror-alert-suspects-Salah-Abdeslam-manhunt-Monday-live.html
	Brussels airport attack	The cab driver who took the three terrorists to the Brussels airport thought the way they handled their baggage was weird. There were too many suitcases and they were very heavy. The terrorists didn't seem to let the driver to touch the bags.	http://www.thedailybeast.com/brussels-taxi-hero-shows-how-we-stop-terror-attacks
	Cologne 2004 Bombing	Loitering in the area of the target.	http://www.taz.de/!5064684/

Table 13 – Reference Cases for Threat Indicators in Actual Attacks

From the table above it is clear that in many terror attacks threat indicators can be identified giving proper training and providing tools to law enforcement agencies and even to ordinary civilians.

5 THE ISRAELI APPROACH

5.1 The backdrop

Israel is a country coping for many years with terror threats originated mainly from the Israeli – Palestinian conflict. Many terror attacks have been carried out in the country not only by domestic terrorists but also from external factors such as state sponsoring terror, international terror organizations and "lone wolves". The nature of the threats is ever changing and forced LEA's to revise their security policy repeatedly to meet different tactics and *modus operandi* used by the terrorists in the various stages of the conflict.

The Israeli security concept traditionally emphasizes the critical role of the human factor as key success element in the prevention of terror attacks. The main notion is that security cannot rely on technology alone and that well-trained, highly competent security personnel are essential for coping with security threats. The method of identifying suspicious/abnormal indicators based on behaviour and appearance is one of the most imperative tools used by Israeli security personnel and it proved its efficiency repeatedly in the fight against terror in Israel. (17)

Methodologies for identification of threat indicators are important part of basic and advanced training programs provided for Israeli security agencies personnel, police officers and private security guards. The training is regularly enhanced by refresher trainings and drills designed to test and refine capabilities. Due to the prolonged duration and relative high numbers of attacks the general public in Israel is also aware and constantly educated about ways to identify suspicious behaviour. It is very common in Israel that civilians are reporting to the police about suspicious activity or even take action, isolating areas around suspicious objects for example, until the arrival of the police.

5.2 The concept

Israeli approach is based on the classification of threat indicators into 3 main groups: behaviour, appearance luggage and travel documents (e.g. passports flights tickets etc. in airports). The accepted definition to threat indicator is: **"A sign, finding or item that indicates that the perpetrator or person has an intention to carry out an attack or a criminal act. That indication shall point out an exception from the norm and will supposedly suspect the person with the intent of terror or criminal attack."** It is important to note that all instructions to security personnel emphasize that beside the list of identified suspicious signs indicators a person could be considered as suspicious based on "gut feeling". Experience shows that in some cases a civilians or security personnel can spot terrorists based on accumulation of weak signals that are not obvious.

A **partial list** of suspicious signs adopted by Israeli law enforcement agencies is inserted in the tables below:

Behaviour (including body language)
Avoiding security personnel
Refuse to cooperate with security personnel
Walking without purpose near target
Shows interest in the target
Stalling around target
Unauthorized access

Location of hand palms
Constant patting hands on body parts
Nervous behaviour: looking around, sweating, shaking, etc.
Apathy
"Pipe/tunnel vision"
Walking very focus to the target / Disconnection from environment
Talking to himself

Table 14. – Suspicious Signs in Behaviour

Appearance
Bumps under clothes
Long sleeves covering the palms
Oil stains
Wires leading to clothing
Clothing that are inappropriate to environment or the person
Freshly shave

Table 15 – Suspicious Signs in Appearance

Luggage & Vehicle	
Luggage	Vehicle
Mismatching to the environment	Different front & back license plates
Disproportionate weight	Heavy Wight on rear axle
Identical luggage carried by several persons	Large containers or gas containers inside
Left baggage	Car abounded by person
Oil stains	Additional improvised electrical wires
Wires	Stolen vehicle
Noises	

Table 16– Suspicious Signs in Luggage & Vehicle



6 THE EUROPEAN STATE OF THE ART

6.1 General

European countries vary greatly in their experience with terror attack. While some countries: UK, France and Spain for example sustained prolong periods of attacks carried out by domestic and foreign terrorists' other countries experienced relatively limited periods of attacks (Italy, Germany) or sporadic attacks if any (Scandinavian countries).

There is limited amount of publications and information regarding the subject of suspicious signs in European countries. In preparation of this report LEA's participating in the LETSCROWD were consulted:

- Municipal police of Madrid, Spain.
- The university of applied science – police affairs, Germany.
- Local police voorkempen, Belgium.
- Ministry of interior, Italy.
- Public security police, Portugal.
- Ministry of internal affairs, Romania.
- Basque Country police, Spain.

The following paragraphs describe suspicious/abnormal indicators developed in some European countries.

6.2 Suspicious/abnormal indicators in Europe

6.2.1 United Kingdom

In a publication issued by the British police in the framework of the ACT program (17) the public following examples of suspicious activity and behaviour which could potentially be terrorist related reported:

- Anyone hiring or acquiring large vehicles or similar for no obvious reason.
- Anyone buying or storing a large amount of chemicals, fertilizers or gas cylinders for no obvious reasons.
- Anyone taking notes or photos of security arrangements, or inspecting CCTV in an unusual way.
- Anyone visiting the dark web, ordering unusual items online or carrying out unusual bank transactions.
- Anyone who has illegal firearms or other weapons or has shown an interest in obtaining them.
- Anyone holding passports or other documents in different names, for no obvious reasons.
- Anyone who goes away traveling for long periods of time but is vague about where they're going.

This list of suspicious signs – sometimes with small variations – is also available in websites of organizations such as the British Transport Police, etc.

6.2.2 France

In the VIGIPIRATE plan (18) of the General Secretary for the National Safety and Security (SGDSN) of the French Government different suspicious behaviours are listed according to the different phases of the terroristic action:

- Preparation of the action
 - Observation and/or surveillance of the threatened site, by an individual, a couple or a group of persons (with possible communication by gestures, time keeping, loitering - prolonged presence of the same person on site in various moment of the day without a specific reason, presence of a parked vehicle with persons on board for a long period of time).
 - Elicitation of information on the threatened site by means of:

- Use of internal associates in crime.
- Collection of details on the security measures by means on innocent questions.
- Observation of security controls, testing them using false alarms.
- Collection of pictures of the critical parts of the threatened site.
- Internet searches for information on the threatened site.
- Use of dissimulation or camouflage techniques (use of pseudonyms or identity cards with different names, use of pre-paid SIM cards or different cellular phones, etc.)
- Phase just before the attack
 - The individuals could try to hide the weapon(s) to be used for the attack and therefore they could:
 - Carry a bag either suspiciously heavy or malformed by the weapon(s).
 - Wear personal protections (kneepads, bulletproof jackets, etc.).
 - Wear clothes either inappropriate for the season or large enough to hide a weapon.
 - Hide a weapon on his body, to go through a check point that is checking individuals without pat-down.
 - Show signs of edginess or distrust not in line with the environment.
 - An explosive attack could also be possible and in this case suspicious signs are:
 - An abandoned object, especially in a significant passage.
 - A vehicle parked for a long period of time close to either a crowded place (market, shopping mall, church, etc.) or a sensitive site (embassy, town all, etc.), especially without licence plate.

VIGIPIRATE proposes also the list of signs of radicalisation. These are:

- Signs of breaking-off
 - Physical and garments changes.
 - Anti-social proposals.
 - Sudden adhesion to hyper-ritual religious proposals.
 - Refusal of authorities, institutions (e.g. school) and of social life.
 - Sudden refusal of daily habits.
 - Separation from the family and relatives.
 - Sudden modification of personal interests.
- Personal environment
 - Lack of a father figure and more in general family support, fragile environment.
 - Personal relationships with influencing people or groups and followers of specific internet sites.
 - Immersion in a radicalised family.
- Theories
 - Conspiratorial and victimised theories.
 - Admiration of terrorists.
 - Violent speeches against religions or communities.

- Participation to sectarian religious groups or radical circles.
- Participation to conferences of religious extremists.
- Binary behaviours, distinguishing between “pure” and “impure”.
- Tools
 - Use of virtual and/or human networks.
 - Dissimulation and double-dealing strategies.
 - Planning of travel in war zones.



7 LETSCROWD - PATTERNS OF SUSPICIOUS/ABNORMAL BEHAVIOURS

7.1 General

From the findings of Section 4 it is clear that in many cases threat indicators during the planning and execution phases of terror attacks can be detected and identified.

Identification of threat indicators originating from suspicious/abnormal behaviour requires implementation of various tools and technologies such as public awareness raising programs, training programs for law enforcement personnel, software applications and security hardware (mainly CCTV).

Such tools that may enhance the capabilities of LEA's to detect and identify threat indicators – and by that enabling them to prevent or minimize the threat – are developed within the framework of LETSCROWD project.

7.2 Threat Indicators Relevancy for LETSCROWD Project

The following table provides a comprehensive list of threat indicators relevant to the tools that will be developed by LETSCROWD project. The threat indicators list is presented through cross reference matrix of attack phase; corresponding threat indicators – based on suspicious/abnormal behaviours' and signs – and relevance to the tools developed by LETSCROWD project.

Some of the suspicious/abnormal behaviours' and signs can be attributed to more than single attack phase, for example the suspicious sign "left luggage" may be identified both at the pre-attack stage (terrorists testing the security array) and also at the attack stage (actual IED inside the luggage).

Attack phase	Suspicious / abnormal behaviour	Relevance to LETSCROWD tool
<i>Pre - attack</i>	Reveal hatred in social network	Semantic Intelligent Engine, Dynamic Risk Assessment
	Reveal admiration to terror causes in social network	Semantic Intelligent Engine, Dynamic Risk Assessment
	Posting pictures or information in social network regarding traveling to known terror training and recruiting locations	Semantic Intelligent Engine, Dynamic Risk Assessment
	Explore different terror or radical organizations, strategies and tactics	Semantic Intelligent Engine, Dynamic Risk Assessment
	Explore acquisition or construction of weapons or dual use materials	Semantic Intelligent Engine, Dynamic Risk Assessment

	Form new connections in social network to known terrorist elements	Semantic Intelligent Engine Dynamic Risk Assessment
	Seek out, read, or post radical content	Semantic Intelligent Engine, Dynamic Risk Assessment
	Release information or discuss in social network how to harm or influence target	Semantic Intelligent Engine, Dynamic Risk Assessment
	Putting down a bag or item and then walking away from it	LEA Training Package, Dynamic Risk Assessment, Human-centered Computer Vision
	Probing security	LEA Training Package, Dynamic Risk Assessment
	Taking notes or photos of security arrangements	LEA's Training Package, Dynamic Risk Assessment
	Nervous tendencies (avoiding eye contact, sweating, heavy breathing, Rubbing hands, etc.)	LEA Training Package, Dynamic Risk Assessment
<i>Attack</i>	Placing a bag or a parcel and then walking away from it	LEA Training Package, Dynamic Risk Assessment, Human-centered Computer Vision
	Wearing clothes either inappropriate for the season or large enough to hide a weapon	LEA Training Package, Dynamic Risk Assessment
	Repeatedly patting upper body parts	LEA's Training Package, Dynamic Risk Assessment

	Avoiding security personnel or systems	LEA Training Package, Dynamic Risk Assessment
	Acting nervously agitated or scared	LEA Training Package, Dynamic Risk Assessment
	Splitting into groups (signalling multiple points of attack)	LEA Training Package, Dynamic Risk Assessment, Human-centered Computer Vision
	Walking without purpose near target	LEA Training Package, Dynamic Risk Assessment
	Location of hand palms	LEA Training Package, Dynamic Risk Assessment
	Nervous behaviour: looking around, sweating, shaking, etc.	LEA's Training Package, Dynamic Risk Assessment
	Apathy	LEA Training Package, Dynamic Risk Assessment
	"pipe/tunnel vision"	LEA Training Package, Dynamic Risk Assessment
	Walking very focused to the target / Disconnection from environment	LEA Training Package, Dynamic Risk Assessment
	Disproportionate weight of luggage (considering its size)	LEA Training Package, Dynamic Risk Assessment
	Identical luggage carried by several persons	LEA Training Package, Dynamic Risk Assessment, Human-centered Computer Vision

	Vehicle with different front & back license plates	LEA Training Package, Dynamic Risk Assessment
	Vehicle with apparent heavy weight on rear axle	LEA Training Package, Dynamic Risk Assessment
	Vehicle with large containers or gas containers inside	LEA Training Package, Dynamic Risk Assessment
	Vehicle abounded by person near target	LEA Training Package, Dynamic Risk Assessment
	Vehicle with additional visible improvised electrical wires	LEA Training Package, Dynamic Risk Assessment
	Stolen vehicle parked near target	LEA Training Package, Dynamic Risk Assessment

Table 17 – Threat Indicators Relevancy to LETSCROWD

8 FUTURE WORK FOR FINAL REPORT (D3.5)

Future work on models of patterns of human behaviours triggering threats and the detection technologies and methods will be focused in three main areas:

- Cultural differences that may be manifested in form of behaviour that may arouses suspicion and might be interpreted wrongly as threat indicators.
- Further evaluation of technologies, tools and methods developed within the framework of LETSCROWD (and in particular tools developed in WP 5) or available in the security industry and their usability in detection of weak signals produced by suspicious and abnormal behaviour. Special emphasis will be put on inputs of LEA's with regard to legal and practicality aspects.
- Further analysis and refinement in the area of detection patterns of suspicious & abnormal behaviour unique to crowded environment with particular emphasis on mass gathering events.

The results of the work will be integrated into this progress report to produce the final deliverable D3.5



9 REFERENCES AND ACRONYMS

9.1 REFERENCES

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9.2 ACRONYMS

Acronyms List	
IED	Improvised Explosive Device
VBIED	Vehicle Born Improvised Explosive Device
VA	Video Analytics