Financial Investigations and Analysis for Emerging Money Laundering Risks

Enforcement strategies for drugs: new psychoactive substances (NPS) and synthetic drugs

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COPOLAD

CARICOM IMPACS
Caribbean Community Implementation Agency for Crime and Security

Enforcement strategies for drugs: new psychoactive substances (NPS) and synthetic drugs

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COPOLAD III is a consortium formed by:

We are born for cooperation,
like feet, hands, eyelids,
and teeth in rows above and below.
Acting against one another is
therefore against nature
And it is acting such clashing and detesting.

(Marcus Aurelius - Roman Emperor)

ADHD Attention-Deficit/Hyperactivity Disorder ATS Amphetamine-type stimulants

DCSA Central Directorate for Anti-Drug Services

ECDD Expert Committee on Drug Dependence (of World Health Organization) EUDA European Union Drugs Agency

CELAC Community of Latin American and Caribbean States IILA - International Italo-Latin American Organization MDMA methylenedioxymethamphetamine

NPS New Psychoactive Substance NIR Near-Infrared Spectroscopy

SERS Surface Enhanced Raman Spectroscopy UNODC United Nations Office on Drugs and Crime WHO World Health Organization

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PREFACE

This publication is the result of the collaboration between COPOLAD III and CARICOM IMPACS (Caribbean Community Implementing Agency for Crime and Security), following the training course *"Training on enforcement strategies for drugs: new psychoactive substances (NPS) and synthetic drugs,"* held in Port of Spain (TT) in October 2024, with the participation of experts from CARICOM countries and from the Italian DCSA (Central Directorate for Anti-Drug Services).

The lecture series looked at the threats posed by the increased spread of NPS and synthetic drugs and the diversion of drug precursors, as well as counter-narcotics methodologies through operations conducted by law enforcement agencies in the Deep Web and the use of innovative equipment (portable Raman spectrometers) designed for the rapid detection of dangerous and prohibited substances.

More than 100 representatives from Law Enforcement, Customs, and Strategic *Intelligence* Agencies and units specialized in tackling transnational crime and drug trafficking from CARICOM member countries participated in the course, either in attendance or remotely connected.

INTRODUCTORY NOTE

CARICOM IMPACS

The Caribbean Community (CARICOM) Implementation Agency for Crime and Security (IMPACS) is pleased to contribute to this collaborative initiative under the COPOLAD III Programme, in partnership with the International Italo-Latin American Organisation (IILA) and the Central Directorate for Anti-Drug Services (DCSA). This publication represents a significant advancement in the regional and international response to the challenges posed by synthetic drugs and New Psychoactive Substances (NPS), which continue to evolve in both complexity and prevalence.

As the primary entity responsible for coordinating regional security initiatives within CARICOM, CARICOM IMPACS remains committed to strengthening intelligence-driven and evidence-based approaches to combat transnational crime, with particular emphasis on narcotics control. The increasing availability and sophistication of synthetic drugs, coupled with the proliferation of digital marketplaces and advanced concealment techniques, necessitate a multi-faceted and collaborative strategy. This publication serves as a valuable resource in promoting knowledge exchange and enhancing technical capacities across law enforcement and intelligence agencies.

Within the Caribbean, the illicit trade in synthetic drugs and NPS has presented escalating challenges for law enforcement and public health authorities. The Region's geographical position as a nexus for transshipment routes renders it vulnerable to both the trafficking and local distribution of these substances. Furthermore, the emergence of clandestine production methods and the use of digital platforms for drug transactions have introduced new dimensions to the problem, complicating traditional interdiction and wider law enforcement efforts. The impact of synthetic drugs extends beyond law enforcement concerns, with significant implications for social stability, public health systems, economic prosperity and broader security frameworks.

Recognising these threats, CARICOM IMPACS continues to work closely with its regional and international partners to enhance the collective capacity of CARICOM

Member States in addressing synthetic drug trafficking and NPS proliferation. Through structured engagements such as COPOLAD III, regional stakeholders have benefited from advanced training and knowledge-sharing mechanisms that focus on the detection, interdiction, and forensic analysis of synthetic drugs. Notably, the integration of state-of-the-art technologies, such as Raman spectroscopy, has contributed to improved real-time identification and disruption of illicit drug flows. Additionally, CARICOM IMPACS remains actively engaged in fostering legal and policy frameworks that support a coordinated regional approach, strengthening mechanisms for intelligence sharing, legislative harmonisation, and operational cooperation.

The evolving nature of synthetic drug threats necessitates a sustained commitment to international cooperation and regional security integration. CARICOM IMPACS continues collaborating with key international partners, including the United Nations Office on Drugs and Crime (UNODC), INTERPOL, the European Union (EU) and specialised law enforcement agencies, to advance joint operational responses and policy initiatives. This ongoing collaboration underscores the importance of multilateralism in addressing transnational threats and ensuring that CARICOM Member States are equipped with the requisite capabilities to respond effectively.

CARICOM IMPACS expresses its appreciation to European Union, COPOLAD III and DCSA, for their invaluable contributions to this initiative. Through such strategic partnerships, we can collectively enhance the resilience of our security institutions, mitigate the impact of illicit drug trafficking and safeguard the well-being of communities across the Caribbean.

CARICOM IMPACS

DCSA

The Central Directorate for Anti-Drug Services is an Italian inter-force structure placed under the Chief of Police - Director General of Public Security with the task of fully implementing the directives of the Ministry of the Interior in combating the illicit trafficking of narcotic and psychotropic substances. Its prevailing mission is to coordinate anti-drug operations, on a national and international scale, conducted by the main Italian Police Forces - Polizia di Stato, Carabinieri, and Guardia di Finanza. The DCSA is also a monitoring structure with the function of, on the one hand, collecting, analyzing, and disseminating information on national and international drug production, trafficking, and consumption activities and, on the other hand, preparing periodically updated reports. With its network of anti-drug experts in countries that play a key role in drug production and trafficking, DCSA is a point of reference in the international scenario. Its tasks include others, training in the specific anti-drug field for police officers involved at various levels in counter-narcotics, and, more recently, it has also taken on this role in the international arena.

COPOLAD

COPOLAD III is a cooperation programme funded by the European Union with a *budget* of 15 million euros and an execution time frame of five years starting in February 2021.

As part of the principles underpinning the EU's new counternarcotics strategy, the program accompanies Latin American and Caribbean countries in improving their drug policies. The objective is to support the achievement of improved outcomes concerning the promotion and defense of human rights, gender equity, public health, citizen security, and other dimensions of sustainable development.

The third edition began in 2021, led by the International and Ibero-American Foundation for Administration and Public Policy (FIAP), in consortium with the International Italo-Latin American Organization (IILA) and in coordination with the *German Corporation for International Cooperation GmbH* (GIZ) and the European Union Drugs Agency (EUDA).

Building on the progress made in previous phases, COPOLAD III will continue to promote technical cooperation and policy dialogue between Latin America, the Caribbean, and the EU to support the Region in implementing more effective drug policies with outcomes that substantially improve the lives of people and, in particular, the most vulnerable.

COPOLAD III combines the now traditional bi-regional and multi-country collaboration spaces with direct technical assistance interventions to meet national needs and promote transformative and innovative interventions, mobilizing European, Latin American, and Caribbean public expertise in bilateral, triangular, and South-South cooperation schemes.

1. SYNTHETIC DRUGS AND NEW PSYCHOACTIVE SUBSTANCES (NPS)

Edited by Lt. Col. of the Carabinieri Corps Marco Cavallo - D.C.S.A.

1.1. ORIGIN AND DEFINITION

Synthetic drugs began to be developed in the late 19th century when the rapid advancement of organic chemistry made it possible to isolate psychotropic active ingredients obtained from plants such as opium poppy, ephedra, coca, peyote, and cannabis and modify them to create new chemical compounds. Initially, the purpose was primarily therapeutic: they sought to produce more effective, safe, and specific drugs to treat a variety of medical conditions. For example, morphine, derived from opium, was modified to create diacetylmorphine (heroin), marketed as a non-addictive pain reliever, amphetamine was synthesized ephedrine and marketed as a decongestant and stimulant. These developments marked an era of scientific enthusiasm in which it was believed that many diseases could be treated with new chemicals, without fully considering the implications of side effects or abuse potential. For example, morphine, derived from opium, was modified to create diacetylmorphine (heroin), marketed as a nonaddictive pain reliever, amphetamine was synthesized from ephedrine and marketed as a decongestant and stimulant. These developments marked an era of scientific enthusiasm in which it was believed that many diseases could be treated with new chemicals, without fully considering the implications of side effects or abuse potential.

During the 20th century, many of these substances were initially designed for medical use and eventually spread beyond the therapeutic realm. Growing concern about the social and health harms caused by these substances led to the introduction of increasingly restrictive control measures to reduce their availability and limit their risks. Nevertheless, these substances began to fuel the illicit market. Some of these substances remained "chemical curiosities," unsuitable to gain popularity because of limited or undesirable effects; others, such as MDMA (also known as "ecstasy") or LSD, spread rapidly, eventually becoming major players in the drug market. The uncontrolled spread was encouraged by social and cultural changes, such as the psychedelic movement of the 1960s and 1970s, which encouraged the recreational use of substances both as a means of personal experimentation and as a market product.

The concept of "new psychoactive substances" (NPS) began to be used globally in the early 2000s when the World Health Organization (WHO) and the United Nations Office on Drugs and Crime (UNODC) began to monitor the growing prevalence of the drug market of psychoactive substances that were not yet regulated by international regulations. In many cases, these substances were sold in specialized physical stores (called *smart stores*) or on digital platforms, presented to the consumer in the form of different types of consumer goods such as bath salts, room perfumers, and fertilizers, accompanied by misleading labels that read "not for human consumption". This sales method is still active.

Initially referred to as "legal *highs*" or "drugs", NPS are molecules that can mimic the effects of illegal psychoactive substances, but are a legal alternative to them when they enter the illicit drug market.

The UNODC defined NPS as *"a substance in pure form or in a preparation that is not covered by the 1961 United Nations Single Convention on Narcotic Drugs or by the 1971 United Nations Convention on Psychotropic Substances but may pose health or social risks similar to those posed by the substances covered by those Conventions"*. It is relevant to point out that the definition does not distinguish between synthetic substances or substances of natural origin, although the former is the most represented, and the term "new" includes both substances whose chemical synthesis is new (in the sense of recent) and substances whose synthesis took place in earlier times, but the introduction of the same into the illicit drug market is new. This is the case with substances that were originally synthesized for potential therapeutic use but were never introduced into the market due to their side effects or toxicity and were later recovered for "recreational" use, thus feeding the illicit drug market.

The term 'new psychoactive substance' is a conventional definition, but there is no globally recognized and, therefore, official distinction between synthetic drugs and NPS, and the two terms are often used interchangeably. However, the concept of NPS tends to emphasize the novelty and unregulated aspect of these substances. Also contributing to this interchangeability between the two terms is the current high quantity of synthetic NPS compared to "classic" illicit synthetic drugs (e.g., MDMA, LSD)

1.2. CLASSIFICATION

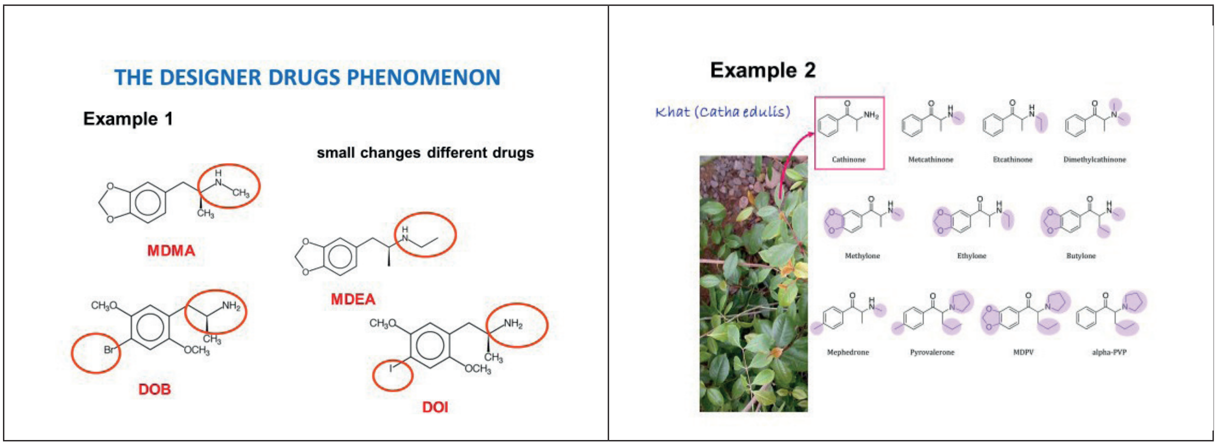
Initially, synthetic drugs and NPS were classified into four categories (stimulants, hallucinogens, depressants, and antipsychotics) based on the characteristics of the pharmacological effects associated with their consumption. However, the rapid evolution of NPS, which is characterized by the constant introduction of new chemical variants, has made it increasingly difficult to establish a consistent and globally recognized classification. The identification of new substances, many with complex or novel chemical structures, has further complicated the use of simple categorization based on traditional pharmacological distinctions.

Again, considering the type of pharmacological effects, the UNODC classified NPS into 6 groups: cannabinoid receptor agonists, opioid receptor agonists, hallucinogens, stimulants, sedatives/hypnotics, and dissociatives [https://www.unodc.org/LSS/Page/NPS/pharmacology]. Probably, the decision to define cannabinoid and opioid receptor agonists as independent groups was caused by their relevance and the receptors on which they act in the nervous system. Similarly, the European *Union Drugs Agency* (EUDA), which monitors the NPS phenomenon in Europe, classifies NPS into 7 groups: anxiolytics or sedatives/hypnotics, hallucinogens, dissociatives, stimulants, cannabinoids, opioids, and unclassified (Table 1).

Classifications based on pharmacological effects may be relevant in the clinical field but lack a chemical approach. Knowledge of the chemical structures of psychoactive substances is essential in analytical toxicology and forensics. Probably for this reason, people have begun to classify NPS not only based on their effects but also considering their chemical structure. The UNODC then classified NPS into 15 groups: aminoindanes, benzodiazepines, fentanyl analogs, lysergamides, nitazenes, phencyclidine-type substances, phenethylamines, phenidates, phenmetrazines, piperazines, plant-derived substances, synthetic cannabinoids, synthetic cathinones, tryptamines and other substances. Similarly, the EUDA classification identifies 13 groups: aminoindanes, arylalkylamines, arylcyclohexylamines, benzodiazepines, cannabinoids, cathinones, plants and extracts, indolalkylamines (tryptamines), opioids, phenethylamines, piperazines, piperidines and pyrrolidines, other substances (Table 1).

The introduction of the chemical structure criterion has made it possible to build the scientific basis for the formulation of regulatory acts that can curb the proliferation of substances belonging to a well-defined chemical class and the development of analytical methods for the identification and characterization of substances belonging to the same class. In addition, this approach aims to provide a more robust framework for monitoring emerging substances and predicting their impact on public health.

However, the classification of NPSs remains a significant challenge: some substances, despite belonging to the same chemical class, show very different effects depending on changes in their molecular structure. Others combine different pharmacological effects (e.g., both stimulant and hallucinogenic effects). Finally, it is important to note that small changes in molecular structure can have a dramatic impact on pharmacological effects, increasing the risk of toxicity and serious side effects. This makes it imperative not only to classify NPSs, but also to study their pharmacological and toxicological effects in depth.



Sources: World Drug Report 2024 - UNODC https://www.unodc.org/unodc/en/data-and-analysis/wdr2024-drug- market-trends.html
European Drug Report 2024: Trends and Developments - EUDA
https://www.euda.europa.eu/publications/european-drug-report/2024_en
EU Drug Markets: In-depth analysis - EUDA https://www.euda.europa.eu/publications/eu-drug- markets_en

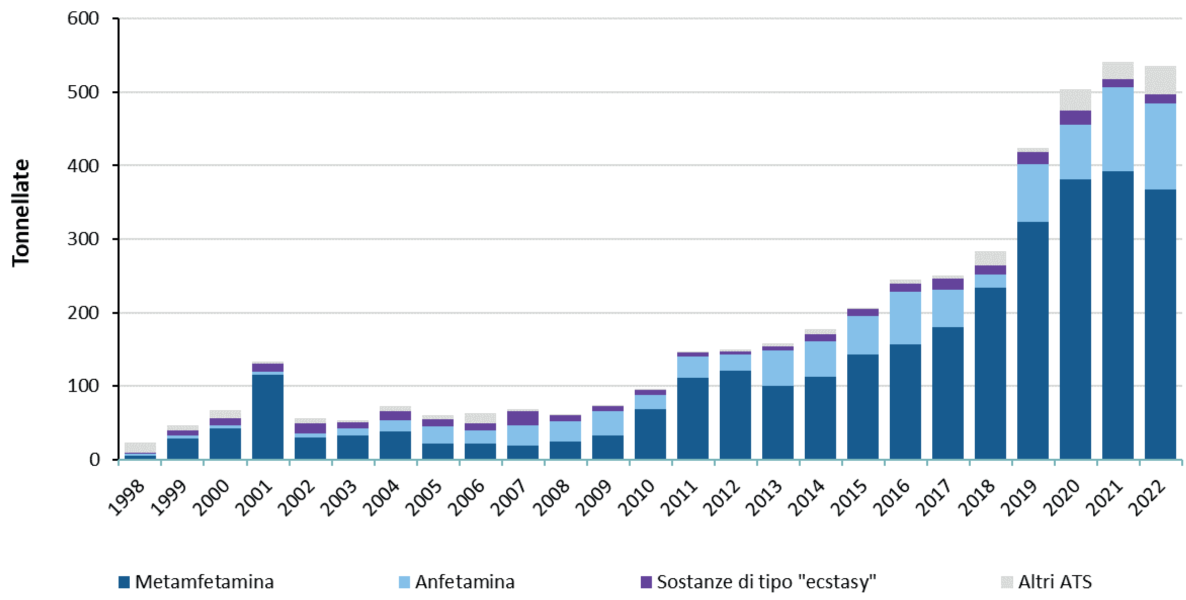
Table 1: Classification of NPS followed by UNODC and EUDA.

UNODC		EUDA
Based on the effects		
	cannabinoid receptor agonists	Cannabinoids
	opioid receptor agonists	Opioids
	hallucinogens	Hallucinogens
	stimulants	Stimulants
	sedatives/hypnotics	Anxiolytics or sedatives/hypnotics
	dissociative	Dissociative
		Unclassified
Based on effects and chemical structure		
	aminoindanes	aminoindanes,
	benzodiazepines	Benzodiazepines
	phenidates	piperidine and pyrrolidine
	fentanyl analogues	Opioids
	Nitazeni	indolalkylamine (tryptamine)
	tryptamine	Arylcyclohexylamine
	phencyclidine-type substances	Phenethylamine
	phenethylamine	Arylalkylamine
	synthetic cathinones	Cathinones
	piperazine	Piperazine
	substances of vegetable origin	plants and extracts
	synthetic cannabinoids	Cannabinoids
	phenmetrazine	other substances
	lysergamides	
	other substances	

As noted above, the phenomenon of new psychoactive substances generates legal problems because, although they are drugs, they are not included in the relevant UN tables and each state decides for itself how to consider them, causing problems in international cooperation. This phenomenon is called *"the designer drugs phenomenon"* (see examples below).

1.3. INTERNATIONAL SITUATION

Over the past decade, among "classic" synthetic drugs, amphetamine-type stimulants (ATS, such as MDMA, amphetamine, and methamphetamine) have been able to carve out their own space in global markets. The latest World Drug Report shows that a total of 536 tons of ATS were seized in 2022, an increase of more than 350 percent over the 2012 figure.



Quantity of ATS seized globally, 1998-2022 (https://www.unodc.org/unodc/en/data-and-analysis/wdr2024-drug- market- trends.html)

Methamphetamine accounts for 69% of all ATS seized globally in 2018-2022. It is probably the most widely used and distributed synthetic drug globally; its production and consumption continue to expand in East and Southeast Asia, North America, South Africa, Australia, and New Zealand; 67 percent of methamphetamine laboratories dismantled globally during 2017-2021 were located in North and South America.

Although historically the use of methamphetamine in Europe has been observed mainly in the Czech Republic and Slovakia, the most recent European Drug Report (the year 2024) indicates that there are growing signs that production and use are increasing in Europe.

From 2012 to 2022, the amount of methamphetamine seized in the EU increased by 293 percent, with long-term trends indicating an expanding market. The main methamphetamine production sites in the EU are located in the Czech Republic, the

Netherlands, Bulgaria, and Belgium. During 2022, 242 methamphetamine production laboratories were dismantled: in the Czech Republic (202), the Netherlands (14), Bulgaria (12), Belgium (6), Poland (4), Greece (1), Spain (1), Slovenia (1) and Sweden (1).

In 2022, EU member states reported about 9,900 methamphetamine seizures, totaling 1.4 tons (up from 1.2 tons in 2021) and an increase over the 2012-2022 period of 180 percent. This increase in the number of seizures can be explained by both an increase in methamphetamine from outside the EU, especially Mexico, and an increase in methamphetamine production laboratories in the Netherlands and, to a lesser extent, Belgium. As of 2019, the production facilities detected in the Netherlands and Belgium, already dedicated to the production of amphetamine and MDMA, have increased: it is believed that because the profitability of methamphetamine is higher than that of amphetamine and MDMA, European synthetic drug producers are collaborating with Mexican producers to develop the relevant processes while taking advantage of the infrastructure already existing in Europe.

Similar trends were also noted in Afghanistan, where methamphetamine production is increasing. Turkey reported 77,700 seizures of methamphetamine in 2022, totaling 15.8 tons and 383 liters (up from 5.5 tons in 2021). The sharp increase in quantities seized in Turkey could indicate an increase in methamphetamine trafficking of Afghan origin along that country's already established routes for heroin trafficking to Europe.

Globally, by the end of 2023, 1,240 NPS had been identified, which is 4 times more than the number of substances (312) that are under international control.

This growth has been strongly influenced by globalization and access to the Internet, as by the systematic use of drug regulatory loopholes in national legislation and the related regulatory approaches. These factors have enabled the industrial-scale production of new psychoactive substances, facilitating their sale, transportation, and distribution.

It is critical to highlight that the impact of different classes of NPS varies significantly across countries, regions, and localities. The threats associated with NPS depend on global supply chains and local drug market dynamics, both of which are subject to change over time. NPS can appear sporadically or spread rapidly while maintaining a temporary presence in the market. In other cases, they may take root more widely, becoming persistent and causing significant problems.

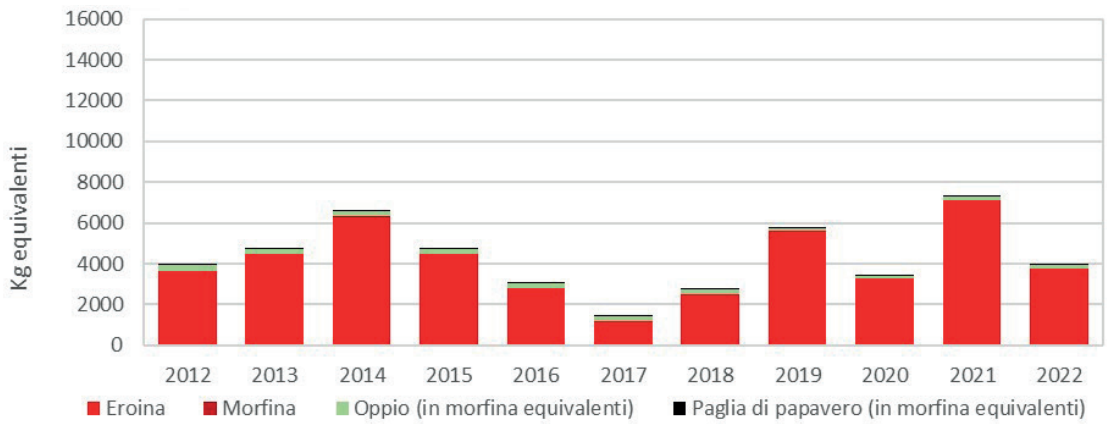
Globally, the trafficking of plant-derived NPS has been steadily declining since 2019 and is dominated mainly by khat and kratom, while synthetic-derived NPS, ketamine, synthetic cannabinoids, and synthetic cathinones have predominantly dominated the market during 2018–W2022.

Global seizures of ketamine (a dissociative anesthetic not subject to international control) reached a record high in 2022, with a 70 percent increase over 2021 in East and Southeast Asia and significant increases in Western and Central Europe, Oceania, and North America, highlighting a geographic spread in the trafficking of the substance. Ketamine also has recently been identified in mixtures with other drugs, particularly MDMA powders or tablets sold as "pink cocaine" or "tucibi."

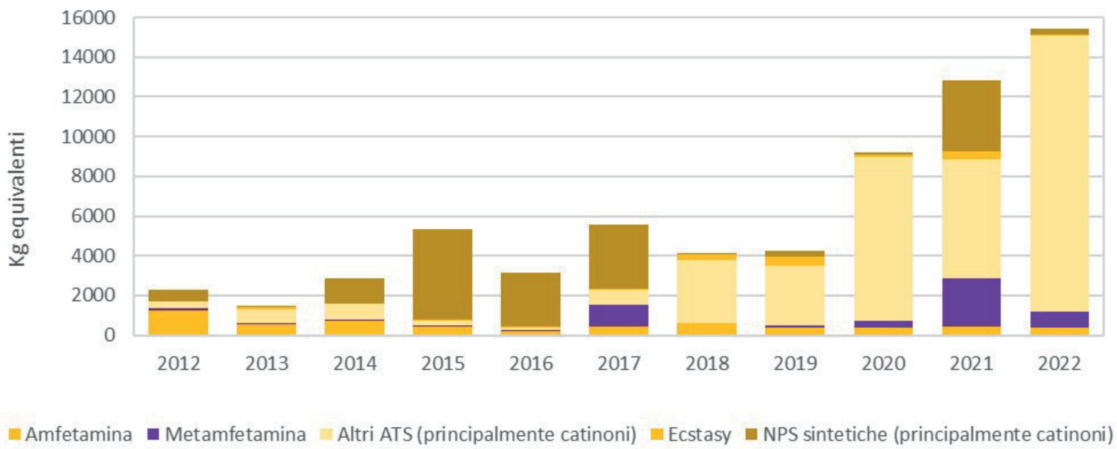
In Europe in 2022, ketamine accounted for 9 percent of NPS seized, rising from just under one ton in 2021 to 2.8 tons in 2022. European production of this substance remains limited, and most ketamine seized in Europe is believed to come from Asian countries.

One of the most significant changes in global drug trafficking and use over the past decade has occurred in Central Asia, Transcaucasia, and Eastern Europe. In these regions, where trafficking was historically dominated by opiates, mainly from Afghanistan, there has been a gradual shift toward the use of synthetic stimulants, particularly synthetic cathinones such as mephedrone, N- methylphedrone, alpha-pyrrolidinopentiophenone (alpha-PVP), cathinone, metcatinone, and 4-CMC (4-chloromethcatinone, also known as clephedrone). 4-CMC (4-chloromethcatinone, also known as clephedrone).

The quantities of NPS and ATS seized tripled between 2019 and 2022, while opioid seizures decreased. Most of the increase in NPS and ATS seizures occurred in Eastern Europe.

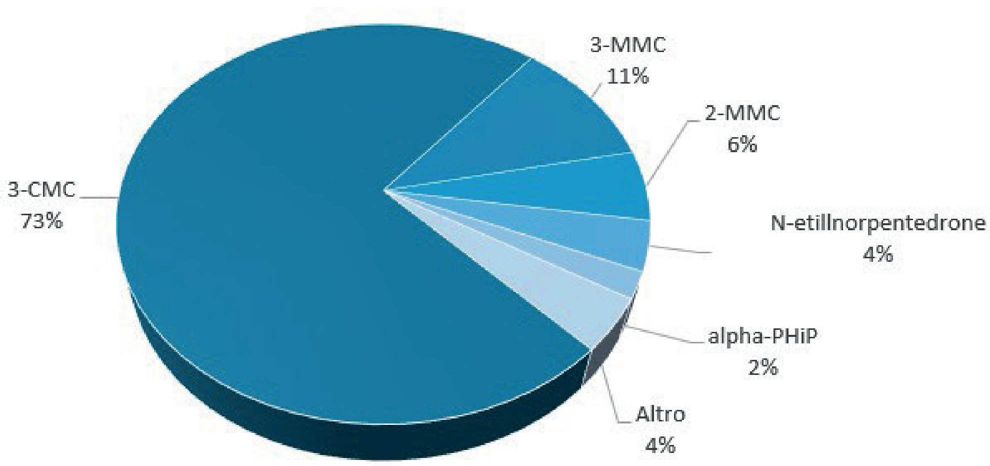


Seizures of opioids broken down by drug, in Asia Central, Transcaucasia and Europe Eastern, 2012- 2022. (https://www.unodc.org/unodc/en/data-and-analysis/wdr2024-drug-market-trends.html)



Seizures of synthetic amphetamine-type stimulants (ATS) and NPS, broken down by drug, in Central Asia, Transcaucasia, and Eastern Europe, 2012-2022 (https://www.unodc.org/unodc/en/data-and-analysis/wdr2024-drug-market-trends.html)

In Europe, synthetic cathinones are the second-largest category of monitored NPS, with 167 substances at the end of 2023, representing 17% of all NPS. The most recent data indicate that synthetic cathinones are being trafficked from India to Europe via large shipments. At the same time, they are also being produced in Europe, particularly in Poland, where 21 laboratories were dismantled in 2022, and to a lesser extent in the Netherlands (4 laboratories dismantled in 2022). Synthetic cathinones accounted for about 87 percent of the total amount of new psychoactive substances seized by EU member states in 2022, amounting to 26.5 tons (4.5 tons in 2021). The main substances were 3-CMC (73%), 3-MMC (11%), 2 - MMC (6 %), and N-ethylnorpentedrone (4%). About 25 tons (94%) were cathinones imported from India.

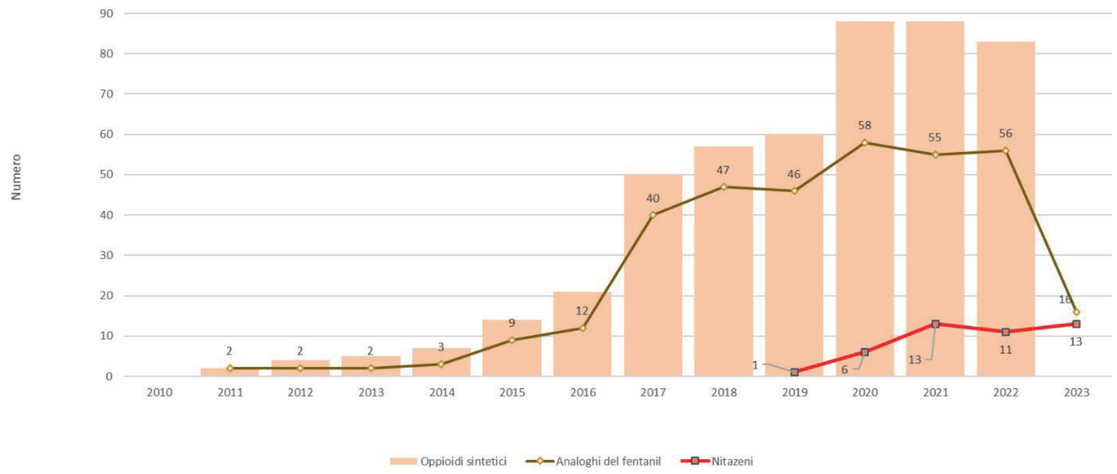


Major synthetic cathinones seized in Europe in 2022, totaling 26.5 tons. (https://www.euda.europa.eu/publications/eu- drug-markets/new-psychoactive-substances/distribution-and-supply/synthetic-cathinones_en)

In 11 European Union states, synthetic cathinones were identified as mixtures along with MDMA (as crystals, powders, and tablets), suggesting the possibility that they are being mis-sold as MDMA or used to adulterate it. The cathinones identified in these mixtures were mainly 4-CMC (klephedrone), 3-MMC, 3-CMC, 4-MMC (mephedrone), and dipentylone.

Synthetic opioids account for 14% of NPS identified globally during 2022. North America is facing a major epidemic of synthetic opioid *overdoses*. In 2022, more than 80,000 *overdose* deaths in the United States were attributed to synthetic opioids, especially fentanyl and its analogs.

The number of fentanyl analogs identified globally continued to grow between 2010 and 2020, only to decline dramatically over the past few years. As of 2019, a new group of synthetic opioids, the nitazenes, appeared on the drug market. Some of these are much more potent than fentanyl and have been linked to deaths in the United States, Canada, the United Kingdom, and Europe.



Number of opioids synthetics identified a level global, 2010-2023 (partial) - (Adapted from https://www.unodc.org/unodc/en/data-and-analysis/wdr2024-drug-market-trends.html)

Deaths associated with opioid use are also a major public health problem in Europe, albeit on a much smaller scale than verified in the United States and Canada. Although an underestimate is likely, in Europe, fentanyl and its derivatives have been linked to 163 deaths in 2022, and nitazenes to 154 deaths during 2023. Despite this difference in scale from the North American context, concerns are growing about the spread of potent synthetic opioids such as nitazenes and the resulting public health implications. From 2019 to 2023, 81 synthetic opioids were identified on European soil, including 38 fentanyl analogs and 16 nitazenes. In 2022, synthetic opioid seizures accounted for about 3 percent (16.6 kg) of all NPS seizures in Europe. Of the seized opioids, 34% nitazene opioids.

1.4. INTERNATIONAL REGULATIONS

Internationally, the classification and control of drugs are governed by the 1961 Single Convention on Narcotic Drugs, the 1971 Convention on Psychotropic Substances, and the 1988 Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances (focused on the suppression of the illicit market and control of chemical drug precursors).

For a substance to be screened under the 1961 or 1971 Conventions, its potential abuse and the associated risks must be assessed by the WHO Committee of Experts on Substance Abuse (ECDD). If the Committee recommends monitoring, the report is forwarded through the WHO Director- General to the UN Secretary-General and then to the Commission on Narcotic Drugs (CND). The latter meets annually, and its states voting members decide whether a substance should be included in the control tables. Although ECDD's scientific decisions are binding, CND may also consider other factors, such as economic factors. Once a substance is included in the tables, each member state is obligated to regulate it at least at the level provided by the Convention or at a more restrictive level.

ECDD first examined NPSs in 2014. By the end of 2023, there were 312 NPS included in the tables of international drug control conventions.

New psychoactive substances, however, continue to pose a challenge to the international control system. Legislative responses, internationally as well as nationally, have continually evolved with the dynamics of the NPS market, particularly the rapid emergence of these substances, attempts by manufacturers to circumvent existing legislation, and the paucity of available scientific evidence that would allow a comprehensive assessment of the harm associated with these substances. National legislative responses are far from unique, with some states using consumer safety laws, others expanding existing drug regulations or creating new ones, and still others introducing temporary measures toquickly control emerging NPS (https://www.unodc.org/LSS/Page/NPS/LegalResponses)./www.unodc.org/LSS/Page/NPS/LegalResponses).

1.5. METHODS OF DRUG DETECTION

The detection of synthetic drugs presents a significant challenge because, unlike traditional drugs such as cocaine or heroin, synthetic drugs are often designed to evade legal regulations and standard detection methods. These chemical compounds, produced artificially in the laboratory, vary widely in chemical structure and effects, making it necessary to develop advanced technologies and flexible methodologies for their detection and identification.

Use of Dispatchable Tests for Synthetic Drugs

"Expedient" tests are an essential tool for the preliminary detection of synthetic drugs, providing rapid indications of the possible presence of these substances. Primarily used in operational settings, such as field seizures, customs inspections, and medical emergencies, these *tests* are designed to be simple, inexpensive, and easy to use, even by unskilled personnel. Although the results are only indicative and require confirmation by more advanced analytical methods, expeditious *testing* is a vital first step.

The most common expeditious *tests* are:

1. **Narcotest**

   Portable kits are used by law enforcement and customs authorities. They are based on specific chemical reagents that react with the suspected substance, causing characteristic color changes.

2. **Immunochemical Testing**

   These *tests* exploit the antigen-antibody reaction to detect specific substances or their metabolites. They are mainly used to *screen* for synthetic drugs in biological samples such as urine and saliva.

3. **Spray colorimetric testing**

   These *tests* use chemical *sprays* that react with the surface of the sample. They are applied to materials such as powders, pills, or residues. For example:

   - Fluorescent synthetic cannabinoid spray reacts with synthetic cannabinoid metabolites and generates fluorescence visible under UV light. and generates fluorescence visible under UV light.

   - Synthetic cathinone spray--changes color on contact with derivatives of stimulants such as mephedrone or methcathinone.

4. **Reactive Napkins**

   Reactive napkins are used to detect traces of synthetic drugs on surfaces, objects, or even on the skin of suspects. They contain pre-impregnated reagents that react with the substances present, highlighting them with a color change.

5. **Specific Chemical Sprays**

   - *Spray* reagents for LSD, sensitive to minute traces of LSD on surfaces or residues.

   - Opioid-based drug *sprays* that detect opioid derivatives, including synthetic analogs such as fentanyl.

Portable Spectroscopes

Although not traditionally considered expeditious *tests*, portable instruments such as Raman or NIR (near-infrared) spectroscopes are increasingly used. These devices enable rapid analysis of the chemical structure of substances without altering them, providing preliminary identification within minutes.

Such instruments offer the possibility of rapid, non-destructive analysis directly in the field, without the need for sample preparation. These techniques allow for obtaining a unique chemical "signature" of the substance, which is useful for identifying known or suspected compounds promptly. In particular, Raman spectroscopy stands out for its portability and ability to analyze solid or liquid samples without prior preparation, making it ideal for field applications (see later discussion on Raman).

Portable spectroscopes, despite their advantages, have some limitations that can affect their effectiveness. One of the main critical issues is the difficulty in identifying substances in complex mixtures, where overlapping spectra or the presence of chemical interferences reduce the accuracy of the analysis. In addition, these instruments can show reduced sensitivity at very low concentrations of the substance of interest, making trace detection difficult. Another significant limitation is the dependence on up-to-date databases: if substances are not included or if insufficient data are available, identification is inaccurate or impossible. Some compounds also do not generate sufficiently distinctive signals, as in the case of molecules that do not produce detectable Raman signals or poorly marked NIR spectra. Environmental conditions, such as bright light or temperature, can also adversely affect the effectiveness of the instrument. Despite these limitations, portable spectroscopes remain valuable instruments, but their use must be complemented with advanced analytical technologies to obtain reliable results. (Instrumentation details are in the NPS section).

1.6. METHODS OF DRUG IDENTIFICATION

High-performance liquid chromatography (HPLC) and gas chromatography (GC) are key tools in synthetic drug analysis because of their ability to separate, identify, and quantify the chemical components of a complex mixture. Both techniques are based on the principle of chemical separation of substances and are complementary, proving highly effective in addressing the complexities associated with them. When used with mass spectrometry (MS), these techniques provide detailed information on the molecular mass and chemical structure of the substances present, proving particularly useful in identifying compounds as synthetic drugs continue to evolve rapidly. HPLC excels in the analysis of polar and thermolabile compounds, adapting better to biological matrices. GC, on the other hand, is indispensable for detecting volatile compounds and synthetic residues, especially when combined with mass spectrometry. However, the effectiveness of both techniques depends on the availability of up-to-date databases, which are needed to compare the chemical profiles of new synthetic drugs constantly emerging on the underground market.

High-Performance Liquid Chromatography (HPLC)

HPLC is a technique based on the separation of chemical compounds in a liquid phase using a column containing a stationary phase. The compounds are carried by a mobile phase (a liquid solvent), and their separation is based on their interaction with the stationary phase.

High-performance liquid chromatography is an extremely versatile and fundamental technique in synthetic drug analysis because of its ability to address a variety of analytical problems with precision and efficiency.

It is particularly useful for the analysis of thermolabile compounds, which tend to degrade or volatilize at high temperatures, making them unsuitable for techniques such as gas chromatography. In addition, HPLC excels at separating complex mixtures, being able to distinguish compounds with similar chemical structures, including synthetic analogs, thus enabling detailed analysis of samples containing numerous substances. Another strength of this technique is its high accuracy in quantifying synthetic drugs and their metabolites, achieved through the use of internal standards that calibrate the instrumental response, ensuring reliable and reproducible results.

Gas Chromatography (GC)

Gas chromatography (GC) uses a mobile gas phase to transport compounds through a column containing a stationary phase, separating them according to their boiling point and their affinity for the stationary phase. This technique is particularly suitable for the analysis of volatile or semivolatile synthetic drugs, such as chemical solvents used in manufacturing or adulterants present in samples. GC offers the possibility of detecting chemical impurities or synthetic residues, which provide valuable information on the origin

and the sample production method. Coupling GC with mass spectrometry (GC-MS) further amplifies its potential, allowing the chemical structure of substances to be accurately identified and confirmed, improving the specificity and sensitivity of the analysis.

1.7. METHODS OF DRUG CONCEALMENT

Synthetic drug concealment methods are represented by all those strategies devised to evade the controls of Law Enforcement and Customs Authorities, exploiting increasingly sophisticated and innovative techniques. These methods are based on a combination of chemical, technological, and logistical ingenuity, often adapting rapidly to advances in detection systems.

One of the most common methods of concealment is to present synthetic drugs as legal or harmless products. For example, these substances may be packaged as dietary supplements, bath salts, fertilizers, incense, or flavorings, accompanied by misleading labels that mask their true nature. In some cases, drugs are dissolved in liquids, such as beverages or perfumes, making them more difficult to identify during routine inspections.

Another widely used technique is concealment in goods. Synthetic drugs can be hidden inside commercial items such as toys, electronic components, medical equipment, or clothing. Crime often exploits secret compartments specially created to transport the substances, such as double walls in suitcases, motor vehicles, containers, or parcels. In the postal sector, small quantities of drugs may be concealed in seemingly innocuous books, envelopes, or gadgets.

In chemistry, molecular modifications are used to make synthetic drugs less detectable to *standard tests*. These compounds can be designed not to respond to reagents commonly used in detection *tests* or to mimic legal chemical structures. Once the drugs reach their destination, they can then be chemically "reconverted" back into their original form.

Criminals are increasingly exploiting digital technologies to coordinate and disguise operations, using tools such as the *darknet* and cryptocurrencies, which facilitate the synthetic drug trade and make it difficult to trace perpetrators and trafficking routes. *Online* sales also allow small quantities of drugs to be shipped in ordinary packages, reducing the risk of interception. More advanced methods include the use of drones for transport over short distances and the exploitation of unwitting couriers, unaware that they are transporting illicit substances. In some cases, synthetic drugs are mixed with other substances or chemicals to mask their odor, thus evading detection by trained dogs.

Finally, the continuous creation of chemical variants makes it difficult for authorities to keep detection *tests* and lists of prohibited substances up to date. In this context, international collaboration, updating of control technologies, and specific training of operators are key tools for combating the concealment and trafficking of synthetic drugs.

Specific Examples of Concealment of Synthetic Drugs

1. **Dissolution in liquids**

    - Perfumes and cosmetics: synthetic drugs are dissolved in products such as perfumes, shampoos, or body lotions, taking advantage of their ability to mix with liquids without arousing suspicion. Subsequently, the substance can be extracted through chemical processes.

    - Drinks: some synthetic drugs are diluted in bottles of alcohol, fruit juice, or energy drinks, confusing control officers.

2. **Changes in food products**

    - Sweets and snacks: synthetic drugs are hidden in candies, chewing gum, or chocolates. In some cases, food products are coated with psychoactive substances.

- Food powders: drugs are disguised as spices, flours, or food additives, taking advantage of the similar appearance of legal substances.

3. **Hiding places in everyday objects**

- Toys: drugs are hidden inside *stuffed* animals, dolls, or toy vehicles. These items are sealed so that they appear intact.
- Electronics: secret compartments are created in items such as *laptops*, cell phones, or audio speakers. In some cases, drugs are built into batteries or circuit boards.
- Books and documents: the pages of books are hollowed out to create hidden compartments, or drugs properly dissolved impregnate the paper, from which they can later be chemically extracted.

4. **Packaging and hidden compartments**

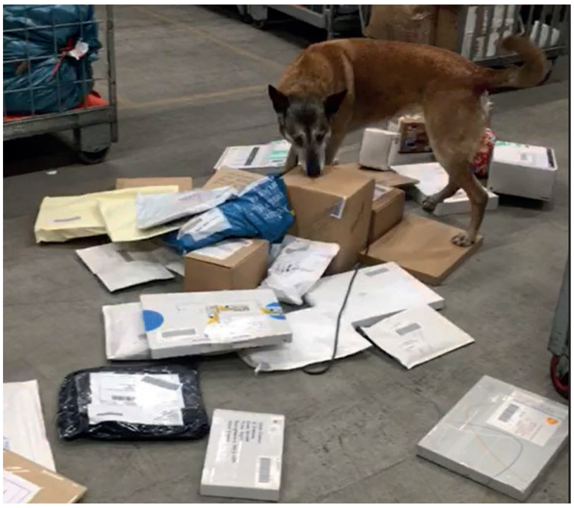
- Double walls: suitcases, *containers,* and automobile tanks are modified to include hidden compartments.
- Modified containers: drugs are placed in plastic or glass bottles with double bottoms or walls, apparently normal on the outside.

5. **Chemical masking**

- Impregnation in textiles: synthetic drugs are absorbed into fabrics such as clothing or blankets. Once they reach their destination, they can be extracted and converted back into their original form.
- Mixing in building materials: drug powders are integrated into cement, plaster, or paint, making them difficult to detect.

6. **Use postal packages and small items**

- Mailing envelopes: small amounts of drugs are mailed in regular envelopes, often in the form of powders or tablets.
- USB devices: drugs are reduced to a fine powder and inserted into electronic devices such as USB flash drives or chargers.



7. **Drones**

    - Drones: smugglers use drones to deliver small quantities of synthetic drugs over short distances, such as in cases of crossing borders or reaching correctional institutions.

8. **Digital masking**

    - Fake packaging: drugs are packaged with fake labels or brands to imitate legal products, such as over-the-counter medicines, sports supplements, or industrial chemicals.

1.8. NPS DETECTION METHODS

The analytical detection of new psychoactive substances (NPS) and synthetic drugs relies on advanced techniques that aim to identify complex and evolving chemical compounds. Despite similarities in the methods used for both categories, NPS analysis presents unique challenges related to the rapid spread of ever-new chemical variants and the lack of comprehensive databases.

Use of Spedition Tests for NPS

Spedition *testing* is also used for the detection of new psychoactive substances (NPS) but with some limitations and considerations. NPSs, by their nature, are designed primarily to circumvent legal regulations. By modifying even part of the molecular structure, manufacturers can create compounds that fall outside the legislative schedules prohibiting their use and distribution. This approach allows them to circumvent laws temporarily, as NPS are not included in lists of controlled substances until they are identified and regulated. This continuous structural variability makes it more difficult to identify them with traditional presumptive *tests*.

For NPS, expeditious *tests*, such as colorimetric *tests*, can be useful for detecting generic classes of substances (e.g., synthetic cannabinoids, cathinones, or phenethylamines), but they always identify individual compounds or new variants.

Limitations in the use of expeditious *tests* for NPS relate primarily to their low specificity, as new psychoactive substances are continually being modified, and the *tests* often fail to identify newer chemical variants. In addition, these methods may generate false positives or negatives, as the structure of the NPS may not react with the reagent used. For these reasons, results obtained through expeditious *tests* always need confirmation by advanced analytical methods, such as high-performance liquid chromatography (HPLC) or gas chromatography coupled with mass spectrometry (GC-MS), to ensure definitive and reliable identification.

Portable Spectroscopes

Non-destructive analytical techniques, such as infrared (IR) spectroscopy, Raman spectroscopy, and near-infrared (NIR) spectroscopy, are taking on an increasingly prominent role in the detection of new psychoactive substances. Their ability to analyze samples compromising their integrity makes them particularly valuable tools in areas where preserving the material is critical. Because of their speed and reliability, these techniques find application both in forensic laboratories and directly in the field. However, they are not without limitations, which can affect the effectiveness of identification in specific contexts.

Infrared (IR) spectroscopy represents one of the most established techniques. It is based on the absorption of infrared radiation by chemical bonds in a molecule, generating a characteristic spectrum that serves as a chemical "fingerprint." This technique makes it possible to identify specific functional groups and distinguish compounds with similar chemical structures, proving particularly useful for NPS.

However, the resolution of IR spectroscopy can be limited in the presence of complex samples or mixtures, as signals from the various components can overlap, making it difficult to identify a single substance. It also requires up-to-date databases to function optimally, which often do not include the latest variants of NPS.

Raman spectroscopy, on the other hand, uses light *scattering* to analyze chemical bonds and provide detailed information about molecular structure. This technique is distinguished by its ability to analyze solid, liquid, or powder samples without prior preparation. In addition, it is less affected by the presence of water than IR spectroscopy, making it particularly suitable for the analysis of wet samples or in solution. However, one of the main limitations of Raman spectroscopy is its reduced sensitivity in the presence of very low concentrations of substances.

In addition, some NPS may not generate sufficiently intense Raman signals, making the technique less effective without proper sample preparation or advanced tools.

Finally, near-infrared (NIR) spectroscopy relies on the interaction of near-infrared electromagnetic radiation with matter, detecting molecular vibrations associated with hydrogen, oxygen, and carbon bonds. This fast and noninvasive technique is often used for the initial screening of NPS. Although advantageous for its rapidity, data interpretation remains more complex and requires more specific knowledge.

1.9. METHODS OF IDENTIFYING NPS

Similarities and differences in the analytical approach of NPS and Synthetic Drugs

Analytical methods for identifying NPS share many techniques with those used for classical synthetic drugs. Technologies such as high-performance liquid chromatography (HPLC) and gas chromatography (GC) are widely applied to separate chemical components in samples. Mass spectrometry (MS), coupled with these chromatographic techniques (GC-MS and LC-MS), is essential to identify molecules by their mass profile and to determine their chemical structure.

New psychoactive substances (NPS) require even more advanced analytical methods than traditional synthetic drugs due to their chemical variability and the continuous creation of new variants, necessitating in-depth exploratory analysis to identify uncatalogued molecules. In this context, high-resolution techniques play a crucial role, providing the sensitivity and precision needed to characterize unknown compounds.

NMR Spectroscopy for NPS

Nuclear magnetic resonance (NMR) spectroscopy is an advanced and highly specific analytical technique used to determine the chemical structure of molecules, including complex compounds such as new psychoactive substances (NPS). Because of its ability to provide precise details of atom arrangement and stereochemical configuration, NMR is an indispensable tool for the identification and characterization of NPS, which often exhibit novel and variable chemical structures.

NMR works by analyzing the interaction of atomic nuclei with a magnetic field and radio frequency radiation. This process generates spectra that provide information about chemical bonds, electronic environment, and interactions between atoms within the molecule. For NPS, this technique is particularly useful for confirming the proposed molecular structure based on data obtained from other analytical techniques, such as mass spectrometry.

One of the main advantages of NMR is its ability to identify the stereochemistry of molecules, a crucial aspect for NPS, where isomers with small structural differences can have completely different pharmacological effects. In addition, NMR is a non-destructive technique, which allows the sample to be preserved for further analysis.

In NPS analysis, NMR is often used in combination with other analytical techniques, such as high-resolution chromatography and mass spectrometry. This integration allows for complete and accurate identification, ensuring that even the most complex chemical variants are analyzed and characterized correctly.

Comparisons with Synthetic Drugs

Although the basic techniques are similar, the context of applying analysis for NPS requires more flexible and innovative approaches. For example:

- classic synthetic drugs can often be detected using presumptive *screening* methods;
- high-resolution chromatography is used in the case of NPS to define the exact mass of compounds precisely, allowing the most likely brute formula to be traced;
- NMR, rarely used for *routine* analysis of synthetic drugs, is becoming indispensable for the structural identification of NPS.

Analytical detection of NPS requires a combination of sophisticated techniques beyond those traditionally used for synthetic drugs. High-resolution chromatography and NMR spectroscopy represent indispensable tools to address the challenges posed by the chemical complexity and continuing evolution of NPS. Although both categories benefit from technologies such as HPLC, GC, and MS, the level of detail and flexibility required for NPS underscores the need for constant technological and methodological development to keep pace with new and emerging threats.

2. THE MAIN SYNTHETIC DRUGS

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2.1. AMPHETAMINE-TYPE STIMULANTS (ATS)

Amphetamine-type stimulants (ATS) are a class of psychoactive drugs that include amphetamine, methamphetamine, MDMA (ecstasy), and other amphetamine-type stimulants, such as Adderall (a combination of amphetamines), Ritalin (methylphenidate), and Concerta (extended-release methylphenidate). These drugs are prescribed to treat ADHD (*Attention Deficit/Hyperactivity Disorder*) and other disorders, but they can also be abused. ATS use can have adverse health effects, including both physical and psychological dependence, cardiovascular problems, increased heart rate and blood pressure, risk of heart attack, stroke, and other heart diseases, and mental health problems with worsening of pre-existing mental disorders such as psychosis, anxiety, and depression. Long-term use of ATS can damage the brain, causing problems with memory, learning, and other cognitive functions. Finally, an *overdose* of ATS can be fatal.

AMPHETAMINE is a synthetic and potent central nervous system stimulant that mimics the action of sympathetic nervous system neurotransmitters such as norepinephrine and dopamine. The molecule is composed of a benzene ring, a side chain, and an amine group. This structure allows it to interact with brain receptors and produce its stimulant effects. Amphetamine has limited therapeutic use, but most of it is produced in clandestine European laboratories. It is under control by the international community and is closely related to methamphetamine.

- **Presentation:** basic amphetamine occurs as a volatile, colorless oil, insoluble in water. The most common salt is sulfate, a white or whitish powder soluble in water. Illicit products are mostly in the form of powders and tablets (e.g., ecstasy tablets).

- **Mode of use:** amphetamine can be ingested, snorted, and, less commonly, injected. Unlike the hydrochloride salt of methamphetamine, amphetamine sulfate is not sufficiently volatile to be smoked. An ingestion dose can range from a few dozen to several hundred milligrams, depending on purity.

- **Psychoactive effects:** taking amphetamine induces a wide range of effects, both physical and psychological.

- **Psychological effects:** euphoria and sense of well-being, increased alertness and concentration, reduced fatigue and appetite, increased self-esteem and talkativeness, irritability, anxiety and paranoia, hallucinations, and psychosis (at high doses or with prolonged use).

- **Physical effects:** increased heart rate and blood pressure, dilation of pupils, sweating and tremors, insomnia, weight loss, tooth damage (with chronic use), and increased risk of heart attack and stroke. use), increased risk of heart attack and stroke.

- **Short-term health consequences:** later, users may experience irritability, restlessness, anxiety, depression, and lethargy. Amphetamine increases the activity of the norepinephrine and dopamine neurotransmitter systems. Severe intoxication causes serious cardiovascular disorders and behavioral problems, including agitation, confusion, paranoia, impulsivity, and violence.

- **Long-term health damage**: chronic amphetamine use produces neurochemical and neuroanatomical changes. Addiction results in deficits in memory and difficulty in decision-making and verbal reasoning. Some of the symptoms resemble those of paranoid schizophrenia. Said effects can extend beyond the duration of use, although they can often regress. Injecting amphetamine carries the same risks of viral infection (e.g., HIV and hepatitis) found in other injectable drugs, such as heroin.

- **Use in medicine:** amphetamine is occasionally used therapeutically for the treatment of narcolepsy and attention-deficit/hyperactivity disorder (ADHD).

- **International control:** the R and S enantiomers (levamphetamine and dexamphetamine respectively) and racemate (a 50:50 mixture of the R and S stereoisomers) are listed in Annex II of the 1971 United Nations Convention on Psychotropic Substances.

METHANFETAMINE is a methyl derivative of amphetamine with a slightly more complex chemical structure. This small difference has a major impact on the potency and duration of effects. Methamphetamine is generally considered more potent than amphetamine because it produces more intense and prolonged effects (up to 24 hours or more), with a more rapid peak. It is more addictive than amphetamine.

MDMA (3,4-methylenedioxymethamphetamine), commonly known as *ecstasy*, is a synthetic substance belonging to the class of phenethylamines and amphetamine derivatives. It is mainly produced in illegal laboratories, with Europe being a major area of manufacture.

- **Presentation:** It occurs as a white or whitish powder or in water-soluble crystals. Illegal products are mainly in the form of colored tablets on which symbols are imprinted and, less commonly, white powders or capsules. Basic MDMA is a colorless oil that is not soluble in water.
- There is so-called "pink cocaine" on the market, a mixture of MDMA and ketamine, generally in the form of a pink-colored powder.
- **Mode of use:** tablet MDMA is taken orally, but the powder presentation can be snorted, inhaled, or injected, although the latter mode is rarely encountered in "recreational" settings.
- **Effects:** MDMA acts as a central nervous system stimulant, producing euphoria, increased empathy, and heightened sensory sensitivity, while hallucinogenic ability is modest.
- **International Legislation:** MDMA is classified in Schedule I of the 1971 United Nations Convention on Psychotropic Substances, which requires strict control because of its high potential for abuse and lack of meaningful therapeutic uses.

2.2. SYNTHETIC CATHINONES

Synthetic cathinones are a class of synthetic psychoactive substances that have a similar chemical structure to cathinone, a stimulant substance found naturally in the khat plant. These substances have become increasingly popular in recent years, particularly among young people, despite their significant health risks. Derivatives include beta-keto analogs, which are very similar to phenethylamines. Since the 2000s, these substances have appeared on the European underground market for recreational use. The synthetic cathinones most commonly used for this purpose are mephedrone and methylone, until 2010 among the most popular on the market. To evade controls, suppliers of synthetic cathinones place them on the market under other names (e.g., Explosion, Blow, Recharge) or as plant fertilizers or bath salts, often accompanied by the words "not suitable for human consumption." The chemical structure of synthetic cathinones is the key to understanding their potent effects and dangerousness. Although they vary greatly depending on the specific substance, all synthetic cathinones share a similar structural basis to the natural cathinone found in the khat plant.

- **The basic structure of cathinone:** cathinone is a phenethylamine with a ketone group in the β- position relative to nitrogen. This basic structure gives it stimulant properties. Chemists synthesize new cathinones by modifying the basic structure of cathinone.

Examples of synthetic cathinones and their structures:

- mephedrone is one of the best-known synthetic cathinones; it has a nitrogen-bonded methyl group and a methylenedioxy group on the aromatic ring;

- MDPV (Methylenedioxypyrovalerone) is similar to mephedrone but with a longer side chain;

- 4-MEC differs from mephedrone in the position of the methyl group on the aromatic ring. Structural changes affect the ability of the substance to bind to dopamine and norepinephrine receptors, causing the stimulant effects. The chemical structure of a synthetic cathinone also determines the duration of the effects and how quickly the substance is metabolized and eliminated from the body. Regarding the potency of the substance, small structural changes can lead to significant changes in the substance. Structure influences the substance's toxicological profile and the likelihood of adverse effects such as tachycardia, hypertension, and psychosis. The continuous evolution of the chemical structures of synthetic cathinones makes it difficult for authorities in the legal and health fields to keep up with these substances. In addition, structural diversity contributes to the unpredictability of effects and increased risks associated with their consumption.

- **Presentation:** generally, they come in white or brown powder form, occasionally in tablet form, and can mimic the effects of cocaine, amphetamine, or MDMA. Tablets are less common but are available on the illicit market as a substitute for MDMA.

- **Mode of use:** synthetic cathinones can be taken orally, intranasally, or by snorting, by insufflation, and, because of their water-solubility, can also be injected. These substances are not easily detectable by normal, expeditious testing.

- **Psychoactive effects:** like phenethylamines, cathinones behave as central nervous system (CNS) stimulants, albeit with lower potency. The lower potency is caused by the β-keto group, which creates a molecule less likely to cross the blood-brain barrier. A typical dose of mephedrone is 100– 250 mg. Depending on the specific substance, the effects are considered similar to those of cocaine, amphetamine, or MDMA. Like cocaine, mephedrone also has a short-lasting peak. As a result, users can consume multiple doses in succession, up to 1g. at a time.

- **Short-term health consequences and long-term damage:** from observation of patients with suspected mephedrone intoxication, it is possible to detect how cathinone derivatives procure sympathomimetic effects similar to amphetamine derivatives. The first toxicologically confirmed fatal case directly related to mephedrone use was recorded in Sweden in 2008.

- **International control:** cathinone and metcathinone are listed in Schedule I of the 1971 United Nations Convention on Psychotropic Substances. Amphepramone and pyrogenerone are in Schedule IV of that Convention, but other derivatives are not under international control. By Council decision of December 2, 2010, 4-methylmethcathinone (mephedrone) was placed under control measures in EU member states.

2.3. SYNTHETIC CANNABINOIDS

Synthetic cannabinoids are laboratory-created chemicals designed to mimic the effects of tetrahydrocannabinol (THC), the main psychoactive component of cannabis. Unlike the natural THC, these compounds are often much more potent and can cause unpredictable and dangerous effects. More correctly referred to as cannabinoid receptor agonists, these substances were initially used for therapeutic purposes in the treatment of chronic pain. However, it proved difficult to separate medical properties from unwanted psychoactive effects. In late 2008, several synthetic cannabinoids were identified in herbal blends for smoking or in so-called incense and room fragrances. Among these, the most popular were Spice Silver, Spice Gold, and Yucatan Fire, but many others have since become part of the products called Spice. These products do not contain tobacco or cannabis but, when smoked, produce effects similar to those of high-THC cannabis. They are sold in specialty stores (*head stores*) and on the *Internet*. There is no single chemical structure that characterizes all synthetic cannabinoids, as their diversity is enormous. This variability is due to the continuous search for new substances with more potent or long-lasting effects, often with the aim of evading legislative controls. variability is due to the continuous search for new substances with more potent or long-lasting effects, often with the aim of evading legislative controls.

The basic structure of synthetic cannabinoids can vary widely.

- **Examples of Synthetic Cannabinoids:** some of the best-known synthetic cannabinoids belong to the following families:
    - JWH series-a large and diverse group of synthetic cannabinoids, often used in so-called "Spice."
    - AM series-another family of synthetic cannabinoids with a similar chemical structure to the JWH series compounds.
    - Cyclohexylphenols (CP)-synthesized initially as potential analgesics, some compounds in this series have been used recreationally.
- The wide variety of chemical structures of synthetic cannabinoids has important implications. **Unpredictable effects:** the chemical structure of a substance largely determines its biological effects. Constantly changing molecular structures make it difficult to accurately predict the effects of a new synthetic cannabinoid.
- **High potency:** many synthetic cannabinoids are significantly more potent than THC, increasing the risk of adverse effects.

- **Toxicity:** chemical structure can influence the toxicity of a substance. Some synthetic cannabinoids can cause serious damage to various organs, including the heart and brain.

- **Addiction:** the ability to induce addiction is closely related to chemical structure. Many synthetic cannabinoids are highly addictive.

  The chemical structure of synthetic cannabinoids is an ever-evolving field, with new substances being continuously developed. The complexity and variability of these molecules make it difficult to accurately predict their effects on human health. It is critical to understand that the use of synthetic cannabinoids carries significant risks and can have serious health consequences.

- **Presentation:** in their pure state, these substances come in liquid (oil) or solid form. Mixtures for smoking are sold in small aluminum packets, usually 3 grams, containing dried plant substance to which one or more cannabinoids are added. Sometimes the plant mixture is sprayed with a solution composed of cannabinoids. Many of the plants are often listed on the package, but many others are omitted. The presence of multiple cannabinoids may be intended to confuse the chemical-forensic identification of psychoactive products.

- **Mode of use:** as is the case with cannabis, plant mixtures containing cannabinoids are most often smoked. However, some consumers report that "Spice" can also be taken as an infusion.

- **Psychoactive effects:** cannabinoid receptor agonists mimic the effects of THC and anandamide by interacting with the CB1 receptor in the brain. In vitro studies have shown that some synthetic compounds bind more strongly to this receptor than THC. All cannabinoids found in smokers' blends have, like THC, a high affinity for the CB1 receptor. Little is known about the detailed pharmacology and toxicology of synthetic cannabinoids, and few formal human studies have been published. It is possible that, apart from high potency, some cannabinoids may have particularly long half-lives that could potentially lead to a prolonged psychoactive effect. The effects of synthetic cannabinoids can vary widely depending on the chemical structure and dose taken and in general, can include euphoria and relaxation (effects similar to THC, but often more intense and prolonged), hallucinations, and psychosis (particularly common with high doses or prolonged use), increased heart rate and blood pressure, nausea and vomiting, anxiety, and paranoia.

- **Use in medicine**: aside from THC (dronabinol), the only synthetic cannabinoid receptor agonist to have found clinical use is nabilone, a THC derivative that finds limited application in the treatment of nausea in cancer chemotherapy.

- **International control:** none of the synthetic cannabinoids are under international control due to UN drug control conventions.

2.4. SYNTHETIC OPIOIDS

Synthetic opioids are a class of drugs that produce effects similar to those of natural opioids, such as morphine and codeine but are produced entirely in the laboratory. Unlike natural opioids, which are derived from the opium poppy plant, and semisynthetic opioids, which are chemical modifications of natural opioids, synthetic opioids are created through processes of complex chemicals. Synthetic opioids act by binding to opioid receptors found in the brain, spinal cord, and other parts of the body. These receptors are involved in pain perception, mood regulation, and other physiological functions. When an opioid binds to these receptors, it can reduce pain perception, induce euphoria, and have other effects on the central nervous system.

There are numerous synthetic opioids, each with specific pharmacological characteristics. These include: fentanyl; tramadol; nitazenes (discussed specifically later); methadone, used in the treatment of heroin and other opioid addiction as it helps reduce withdrawal symptoms; oxycodone, used to treat moderate to severe pain; hydrocodone, a synthetic opioid similar to oxycodone; and U- 47700, 7-8 times more potent than morphine and never approved for pharmaceutical use. Synthetic opioids, like all opioids, can cause several side effects, including dependence, tolerance, and *overdose*.

Synthetic opioids play an important role in the treatment of pain, but their use should be carefully monitored by a physician. Synthetic opioid abuse is a serious public health problem that has led to an increase in opioid-related *overdoses* and deaths.

Opioid addiction and abuse are complex problems that require appropriate treatment. Fentanyl is a synthetic opioid developed for analgesic use, with about 80 times the potency of morphine. Its analogues, known by the generic name fentanyl, are produced by chemical modifications to the basic structure of fentanyl, and their potency can be up to thousands of times that of morphine and fentanyl. Fentanyl and some of its analogues find use as anesthetics and analgesics in both human (Alfentanil, Sufentanil, Remifentanil) and veterinary (Carfentanil) settings. However, most fentanyls have no recognized therapeutic use and are illegally synthesized in clandestine laboratories to be specially placed on the drug market. laboratories to be specially placed on the drug market.

- **How they are presented:** white granular or crystalline powders**.** Pharmaceutical formulations for therapeutic use may appear as tablets, transdermal patches, liquids, or as a solution for injection. In the illicit market, generically they are found in the form of a powder, often used to cut other drugs, such as heroin or cocaine, to increase potency, or again in the form of tablets that mimic legal drugs. Occasionally, they may be used to impregnate thin pieces of paper (“*paper trips*”). Some of the pharmaceutical formulations, such as tablets and transdermal patches, may be taken from the licit market and put into the illicit market.

- **How they are used:** pharmaceutical formulations of fentanyl and its analogs are intended for oral or transdermal administration. Transdermal patches that end up in the illegal market can be smoked or chewed. Tablets, both those that are misappropriated from the licit market and those produced illegally, can be taken orally or pulverized and taken intravenously or snorted. In the illegal market, powders are generically inhaled, injected, or snorted. Many users are unaware that fentanyl and/or fentanyls have been mixed with other drugs, such as heroin or cocaine, and face an increased risk of *overdose*.

- The **Effects** of fentanyl and its analogs are similar to those of other opioids, but much more potent. They act at the level of the central nervous system, causing euphoria, analgesia, relaxation, and deep sedation. Common side effects include nausea, dizziness, vomiting, fatigue, headache, constipation, anemia, and peripheral edema. Tolerance and dependence develop rapidly in repeated use. Characteristic withdrawal symptoms (sweating, anxiety, diarrhea, bone pain, abdominal cramps, chills, or "goose bumps") occur when use is discontinued. Serious interactions can occur when fentanyl and its analogs are mixed with heroin, cocaine, alcohol, and other central nervous system depressants, e.g., benzodiazepines. An overdose causes respiratory depression, which, if not treated with the antidote (naloxone), can lead to respiratory arrest and death. For the more potent fentanyl derivatives, even taking small amounts can cause lethal intoxication due to respiratory depression. Sudden death can also occur due to cardiac arrest or severe anaphylactic reactions.

- **International Control:** Fentanyl is covered by Schedule I of the 1961 Single Convention on Narcotic Drugs (1964). Other Fentanyl derivatives added to Schedule I in 1980 include Sufentanil and Para-fluorofentanil, while Alfentanil was added in 1984 and Remifentanil in 1999. A total of 13 fentanyls are listed under the 1961 Convention.

TRAMADOL is a synthetic opioid analgesic, or pain-relieving drug that acts on the central nervous system. Unlike other more potent opioids, such as morphine, tramadol is considered a "weak" opioid because it has a lower affinity for opioid receptors in the brain. This means it has lower analgesic efficacy but also a lower risk of causing serious side effects, such as respiratory depression.

- **Effects:** tramadol can cause many effects, both desired (pain reduction) and undesired, such as: nausea and vomiting, constipation, drowsiness and dizziness, headache, dry mouth, and sweating. Less common effects include: tremors and agitation, insomnia, allergic reactions, convulsions, and respiratory depression (especially at high doses or in combination with other drugs).

- **Legal use:** tramadol is a prescription drug. Its legal use is limited to the treatment of moderate to severe pain, whether acute (e.g., after surgery or trauma) or chronic (e.g., neuropathic pain). The prescription must be filled by a physician and therapy should be monitored to minimize the risk of side effects and dependence.

- **Illegal use:** tramadol is often abused, both for its analgesic and psychoactive effects (euphoria, relaxation). The illegal use of tramadol carries serious health risks, including addiction, *overdose*, and serotonergic syndrome (concomitant use of tramadol with other drugs that increase serotonin levels such as SSRI antidepressants), a potentially life-threatening condition.

- **NITAZENES** are synthetic opioids that appeared in 2019 in the underground drug market. They were originally developed for pharmacological purposes in the mid-20th century but were never approved for medical use because of their high potency and risk of abuse.

- **How they occur:** nitazenes are commonly found as white or beige powders or as tablets that mimic legal oxycodone or fentanyl-based drugs. The powders are also often used to cut other drugs, such as heroin and fentanyl.

- **How they are used**: tablets can be taken orally or pulverized and taken intravenously or snorted. The powders are generically inhaled, injected, or snorted. Many users are unaware that nitazenes have been mixed with other drugs (such as heroin) or are present in counterfeit drugs and face an increased risk of *overdose*.

- **Effects:** are similar to those of other opioids, such as fentanyl, but are often much more potent, increasing the risk of *overdose*, even with very small doses. They act at the level of the central nervous system, causing euphoria, analgesia, relaxation, and deep sedation.

  The clinical toxicological properties of many nitazenes have not been studied directly. There are a few reports from *online* forums regarding acute and chronic physical and psychological effects. The reported adverse effects are consistent with those commonly associated with other synthetic opioids, such as fentanyl and its analogs. Overdose causes respiratory depression that, if not treated with the antidote (naloxone), can lead to respiratory arrest and death. For the more potent nitazenes, even taking small amounts can cause lethal intoxication due to respiratory depression. Sudden death can also occur due to cardiac arrest or severe anaphylactic reactions.

- **International Control:** Eight specific nitazenes (butonitazene, clonitazene, etazene, etonitazene, etonitazepine, isotonitazene, methonitazene, and protonitazene) have been listed in the 1961 Convention on Narcotic Drugs.

2.5. BENZODIAZEPINES

Benzodiazepines are a class of drugs that have sedative, hypnotic, anxiolytic, anti-convulsant, and muscle relaxant properties. They are used to treat a variety of conditions, including anxiety, insomnia, convulsions, and muscle spasms. They are synthetic substances that act as central nervous system depressants. Chlordiazepoxide was the first to be synthesized in 1957 and was introduced into medicine in 1961. Benzodiazepines are classified according to their duration of action. Short- and intermediate-acting ones are preferred for the treatment of insomnia; long-acting ones are recommended for the treatment of anxiety. Because of their effects, they are under international control.

- **Basic structure of a benzodiazepine:** their chemical structure is composed of the fusion of a benzene ring and a diazepine ring. There are many structural differences between one molecule and another, and these differences are reflected in the receptor affinity characteristics of these drugs. Benzodiazepines potentiate the effects of gamma-aminobutyric acid (GABA), a neurotransmitter that promotes relaxation and sleep. By increasing GABA activity, benzodiazepines can reduce anxiety, improve sleep, and relax muscles.

- **Presentation:** comes in the form of tablets, capsules, vials for injection (e.g., diazepam, lorazepam, midazolam), and finally, suppositories.

- **Mode of use:** in general, benzodiazepines are ingested in tablet form, but they can also be taken by injection for medical and nonmedical purposes; there are also reports of their intranasal abuse (snorting).

- **Psychoactive effects:** benzodiazepines belong to the group of central nervous system depressants, inducing feelings of calmness (anxiolytics), lightheadedness, and sleep. Compared with more recent drugs, such as barbiturates, benzodiazepines are less likely to lead to depression, which is potentially fatal, and, as a result, are widely used in medicine to treat anxiety (anxiolytics) and insomnia (sedatives/hypnotics), as well as other psychological conditions such as seizures and panic disorders. There is no clear distinction between anxiolytics and hypnotics since most anxiolytics induce sleep when taken in the evening, and most hypnotics have a sedative effect when taken during the day.

- **Common benzodiazepine drugs are:** Alprazolam (Xanax), Diazepam (Valium), Lorazepam (Ativan), Clonazepam (Klonopin).

- **Short-term health consequences:** half-life varies among users, and the older among them tend to dispose of these drugs much more slowly, resulting in greater susceptibility to side effects, including lightheadedness, ataxia, mental confusion, impaired judgment, and anterograde amnesia. There is a significantly increased risk of adverse reactions in older individuals, such as falls, decreased cognitive function, and impaired driving (the latter not limited only to this category of people). According to some European studies, apart from alcohol, benzodiazepines, along with cannabis, are the prevalent psychoactive substances among the driving population. Experimental studies show that these drugs impair driving ability and, combined with alcohol, significantly increase the risk of being involved in or causing traffic accidents.

- **Long-term health damage:** benzodiazepine intoxication may be associated with disinhibition in behavior potentially leading to hostile or aggressive behavior. Combined use of alcohol and benzodiazepines also increases the risk of fatal *overdose* because both act as central nervous system depressants. A similar fatal interaction can occur when opioids and benzodiazepines are taken as part of a poly-drug use pattern. A significant number of problem users ingest, "snort," or inject high doses of benzodiazepines to enhance the euphoric effects of opiates and minimize the unpleasant effects of psychostimulants. EUDA's annual report on the state of the drug problem in Europe points out that the concomitant use of benzodiazepines and opiates is one of the greatest risk factors in drug-related deaths. There is also a risk of developing cross-dependence concerning benzodiazepines. The signs and symptoms of withdrawal can be classified as major or minor, in the same way as those of alcohol syndrome. According to said classification, minor symptoms include anxiety, insomnia, and nightmares. Major symptoms include perceptual disturbances, psychosis, hyperpyrexia, and life-threatening seizures.

- **Use in medicine:** medically, benzodiazepines should only be used as a short-term remedy for severe and incapacitating anxiety and insomnia, as tolerance and dependence can occur even within a few weeks of starting to use them.

- **International control:** 33 benzodiazepines were included in Table IV of the 1971 United Nations Convention on Psychotropic Substances (Table 1). Midazolam (1990) and brotizolam (1995) were later added to the schedule. In 1995, flunitrazepam (CAS 1622-62- 4) was transferred from Schedule IV to Schedule III because the International Narcotics Control Board (INCB) stated that it was one of the most misused benzodiazepines and because of its frequent detour into the illicit market. Phenazepam (CAS 51753-57-2), used in medical practice in some countries outside the European Union, was included in the 1971 United Nations Convention on Psychotropic Substances in 2016.

2.6. GHB/GBL

GHB (γ-Hydroxybutyric acid) is a short-chain fatty acid that acts as a neurotransmitter and neuromodulator in the central nervous system. It is classified as a central nervous system (CNS) depressant with sedative, hypnotic, and amnesic properties. It is commonly known as the "date rape drug" because of its sedative effects.

γ-butyrolactone, abbreviated as GBL, is a chemical compound that, when taken up, is rapidly converted in the body to GHB.

- **How it is obtained:** GHB is a natural substance produced in GABAergic neurons from GABA (gamma-aminobutyric acid). At the synthetic level, it is produced in the laboratory through specific chemical processes. γ-butyrolactone (GBL) is a GHB precursor and rapidly converts to GHB once taken. GBL is commonly used in industrial settings but can be converted to GHB by simple chemical processes.

- **How they occur**: GHB occurs in liquid form (colorless, odorless, and virtually tasteless) or as a water-soluble crystalline powder. There are also pharmaceutical formulations in which GHB is present as sodium oxybate (Xyrem or Alcover) in liquid solutions with specific dosages for therapeutic uses. The GBL precursor occurs as an oily, colorless liquid, often used to adulterate GHB or sold as a stand-alone substance.

- **How they are used:** generally, GHB and GBL are taken orally, often mixed with alcoholic beverages and/or other psychoactive substances.

- **Effects:** the effects of GHB occur within 5 to 20 minutes after intake and peak after 30 to 60 minutes. Duration varies from 1 to 7 hours, influenced by dose and combination with other substances. At the lowest doses, disinhibition, euphoria, muscle relaxation, and increased libido are present. As the dose increases, drowsiness, nausea, vomiting, amnesia, convulsions, bradycardia, and respiratory depression appear, leading to cardio-respiratory collapse and death. The effects are amplified in combination with alcohol, benzodiazepines, or opioids, significantly increasing the risk of *overdose* and death.

- **Other substances with similar effects:** benzodiazepines, barbiturates.

- **International control**: GHB is included in Schedule II of the 1971 Single Convention on Psychotropic Substances. GBL is not subject to international control.

2.7. HALLUCINOGENS

Hallucinogenic, or psychedelic, substances are a heterogeneous group of compounds that interact with the central nervous system, causing significant alterations in perception, thinking, and mood. Hallucinogens primarily act on neurotransmitters, particularly serotonin, dopamine, and norepinephrine, altering communication between neurons. This interferes with brain processes that regulate perception, thought, and emotion, leading to unique and often intense psychedelic experiences. These substances can be either natural (such as psilocybin found in some mushrooms) or synthetic (such as LSD) in origin.

Among the best-known hallucinogenic substances are:

- LSD: one of the most potent synthetic substances:

- Psilocybin: contained in hallucinogenic mushrooms;

- Mescaline: contained in the peyote plant;
- MDMA (ecstasy): although it has stimulant effects, it is often classified among hallucinogens;
- DMT: a psychoactive substance found in some plants and infusions.Hallucinogens can also be divided into different classes based on their molecular structure:
    - **Serotonins:** similar to serotonin, a neurotransmitter that regulates mood, sleep, and other brain functions (LSD, psilocybin, DMT). **Mechanism of action: they** interact with serotonin receptors in the brain, altering their function.
    - **Phenylethylamines:** similar to catecholamines, a group of neurotransmitters that include adrenaline and noradrenaline, an example being mescaline, contained in peyote. **Mechanism of action:** They act on several receptors, including dopamine and norepinephrine receptors.
    - **Piperidins:** structure similar to piperidine, a cyclic organic compound such as phencyclidine (PCP). **Mechanism of action:** They block glutamate receptors, a neurotransmitter involved in information transmission in the brain.
- **Mode of use:** the mode of use of hallucinogens varies depending on the specific substance; in particular, they can be taken by ingestion, inhalation, and injection.
- **Psychoactive effects:** hallucinogens are a class of substances that cause profound distortions of perception, leading to highly subjective and often intense sensory and cognitive experiences. The effects of these substances vary greatly from individual to individual and depend on several factors, including the substance itself, dosage, *set* (the individual's mental state), and *setting* (the surrounding environment). Common effects can be summarized as perceptual distortions, time alterations, emotional changes, depersonalization, and derealization.
- **Health consequences:** hallucinogens can cause a wide range of short-term effects, some of which can be very intense and frightening. It is important to note that the experience with these substances is highly subjective and can vary from person to person.

  Some of the most common risks associated with the use of hallucinogens may be as follows:

    - "*Bad trips*": these are extremely negative and distressing experiences characterized by intense fear, paranoia, disorientation, and feelings of losing control. A *bad trip* can last several hours and leave deep psychological scars.
    - Panic and anxiety: the use of hallucinogens can trigger panic attacks and intensify pre-existing anxiety.

- Perceptual distortions: visual, auditory, and tactile hallucinations can be intense and disorienting. Perception of time and space may be altered, creating a feeling of unreality.
- Disorganized thinking: thinking can become confused, illogical, and difficult to follow.
- Impulsive and risky behavior: under the influence of hallucinogens, some people may take impulsive and dangerous actions.
- Psychotic reactions: in some people, hallucinogen use can trigger or aggravate pre-existing psychotic disorders.
- Physical effects: nausea, vomiting, increased heart rate, increased blood pressure, pupil dilation, sweating, and loss of coordination are common physical effects.

- **Use in medicine:** these substances have been exclusively associated with the world of illicit drugs and recreational settings. However, recent scientific studies are reopening a debate about their potential therapeutic utility. Hallucinogens are believed to act primarily on serotonin receptors in the brain, modulating the activity of several brain areas involved in emotion, perception, and cognition.
- **International control**: hallucinogens are generally classified as psychotropic substances and are subject to strict controls. The specific classification varies from country to country, but usually they may be included in different tables or annexes, depending on their perceived dangerousness. They are listed in the tables of the 1971 United Nations Convention on Psychotropic Substances.

2.8. LSD

Lysergic Acid Diethylamide (LSD) is a semisynthetic hallucinogenic substance, one of the most potent known. It is obtained from lysergic acid, itself obtained from ergotamine, a substance derived from the fungus Claviceps purpurea, a parasite of rye and wheat. LSD was first synthesized in the laboratory by Albert Hoffmann for the Sandezo laboratory in Basel in 1938. A few years later, during a re-evaluation of the compound, he accidentally ingested a small amount and described the first "*trip*." In the 1950s and 1960s, Sandoz made an evaluation of it for therapeutic purposes and marketed it under the name Delysid. "Recreational" use began in the 1960s and is associated with the "psychedelic period."

- **Class of membership:** hallucinogen.
- **How it is obtained:** LSD is produced by chemical synthesis in the laboratory, where it is usually prepared as a tartrate salt, soluble in water.
- **How it is presented:** LSD in liquid form is generally used to impregnate paper squares (*blotters*) the size of small postage stamps, often decorated with colorful patterns or designs, each containing a single dose. Less frequently, it may

be in the form of small 2-3 mm diameter tablets (known as "dots"), capsules, sugar cubes, or cubes of isinglass ("stained glass"). In some cases, it is available directly as a liquid solution, in water or alcohol. LSD is photosensitive when in a liquid solution, while it is more stable in doses on paper.

- **How to use:** LSD is mainly taken orally. Squares of blotting paper are placed on the tongue, where the substance is quickly absorbed. The tablets or capsules, on the other hand, are swallowed. The action of LSD usually begins within 30 minutes of intake and can last 8 to 12 hours or even longer, depending on the dose and individual conditions.

- **Effects:** LSD presumably acts on the serotonergic system. It is active in extremely low doses (as low as 20 micrograms) and is generally not addictive. Early physical effects include pupil dilation, mild hypertension, and occasional mild fever. The main effects are perceptual-sensory, including visual distortions, synesthesia (such as colored hearing), and altered temporal perception. Its effects occur about 30 minutes after ingestion and can last between 8 and 12 hours. The duration and intensity of the effects depend on the dose.

- **Short-term health consequences:** panic reactions, known as "negative trips," can be intense to the point of requiring medical intervention. Although symptoms usually resolve within a few hours, some individuals may experience prolonged hallucinations for up to 48 hours and, in rare cases, psychotic states lasting 3 to 4 days. The effect depends largely on the mental state and the environment in which the substance is taken.

- **Long-term health damage:** LSD use may be associated with *flashbacks*, i.e., sensory memories of experiences under the drug that may occur unexpectedly. Extremely rare side effects, such as irrational acts with fatal outcomes, are documented, but cases of deaths directly attributable to LSD are almost nonexistent.

- **Use in medicine:** in the past, LSD has been used in psychotherapy under the trade name Delysid, but it is not currently used medically.

- **International legislation:** LSD is classified as a controlled substance and included in Schedule I of the 1971 United Nations Convention on Psychotropic Substances, being subject to strict international controls.

3. CLANDESTINE LABORATORIES FOR THE PRODUCTION OF DRUGS

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3.1. DEFINITION

A clandestine drug laboratory is an unauthorized facility where the production, processing, or packaging of drugs takes place. These laboratories operate outside the law and are usually located in hidden places, such as isolated houses, disused industrial warehouses, or underground spaces, to escape law enforcement controls. The main objective of these facilities is to produce drugs for sale in the illegal market, generating huge profits at the expense of public health and safety. Clandestine laboratories are dangerous both to those who run them and to the community due to the handling of toxic and often highly flammable or even explosive chemicals.

A clandestine synthetic drug laboratory is a highly specialized, often rudimentary but sometimes sophisticated environment consisting of a range of equipment, chemical materials, and spaces organized to facilitate the synthesis of drugs. Here is how it is generally composed:

Spaces and facilities

Clandestine drug laboratories can be located in various types of environments: apartments, isolated houses, disused industrial warehouses, garages, or even underground buildings. The area is usually hidden or shielded to avoid detection by law enforcement or neighbors. More sophisticated laboratories can be equipped with specially installed electrical, plumbing, and ventilation systems to control the flow of air and prevent the accumulation of toxic or explosive gases. prevent the accumulation of toxic or explosive gases.

Equipment and tools

A clandestine drug lab may contain a variety of equipment needed for the production process, including:

- Chemical reactors and reaction vessels: used to mix or heat chemicals to obtain drugs. These can be simple metal or glass containers, but also more complex distillation and filtration apparatus;
- scales and measuring instruments: tools needed to accurately weigh chemicals and precursor doses needed in chemical synthesis;
- stoves, hot plates, and thermometers: used to control the temperature of chemical reactions, essential to avoid unwanted or dangerous reactions;
- filtration and purification systems: to achieve the required purity of the substances produced, some laboratories may use filters, centrifuges, or chromatographic columns;
- ventilation and safety systems: some laboratories, particularly those for methamphetamine or ecstasy production, are equipped with ventilation systems to reduce exposure to hazardous vapors, while others may have gas detectors or fire extinguishers to prevent fires.

Internationally, the fight against the procurement of equipment necessary for setting up clandestine laboratories is based on Art.13 of the "United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances" adopted by the UN CND (Commission on Narcotic Drug) at its 6th plenary session on December 19, 1988. Each state party to the Convention is required to have national regulations harmonized with the text of the above article to hinder the procurement of the said equipment by clandestine drug producers.

Chemical materials and precursors

Drug laboratories require the use of chemical precursors and highly toxic substances, which are often difficult to obtain legally. Some of the most common compounds used in these laboratories include:

- Strong acids and bases: such as hydrochloric acid, sulfuric acid, and sodium hydroxide, which are used to adjust pH and facilitate chemical reactions;
- organic solvents: such as acetone, ether, toluene, and methanol, which are used to dissolve and separate chemical components during the synthesis process;
- precursors for drug production: for example, safrole MDMA (ecstasy) synthesis, or pseudoephedrine for methamphetamine production. These precursors are often subject to legal regulations, but traffickers still try to source them through illicit routes.

Regarding Drug Precursors-Controlled Chemical Substances**, which are not the specific subject of this discussion**, reference is made to the text Art. 12 of the "United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances" adopted by the CND at its 6th Plenary Session, Dec. 19, 1988, and Tables I and II annexed to that convention, as well as the annual publication published by INCB (*International Narcotics Control Board*) called "*PRECURSORS*" which can be reached at the Internet address: https://www.incb.org/incb/en/precursors/technical_reports/precursors-technical-reports.html.

Final products and packaging

Once the synthetic or semi-synthetic substance is produced, it is purified, crystallized, or dried depending on the type of drug. The substance is then packaged into small quantities, ready to be distributed on the illegal market. The final products can be in powder, crystal, or tablet form, depending on the drug produced (e.g., crystal methamphetamine, tablet ecstasy), but also liquid (e.g., GBL).

Protection and security systems

Because drug production is illegal and dangerous, clandestine laboratories often have security measures in place to protect themselves from raids by law enforcement or rivals in the market. These systems may include security doors, surveillance systems with cameras and alarms, as well as the presence of weapons or armed guards. In the Netherlands, due to the particular morphology of the territory, it is not uncommon to locate clandestine laboratorieson boats or barges moored in the vast network of canals present in the Region. Such vessels are often equipped with booby traps and tripping or remote activation devices, with the ability to quickly sink the boat and, consequently, disperse evidence of the crime.

Therefore, it is safe to say that clandestine drug laboratories are very dangerous environments, both for those who work in them and for their surroundings. The handling of toxic chemicals and the use of complex processes pose enormous risks of explosions, fires, or environmental contamination. In addition, their presence contributes significantly to drug trafficking and the prosperity of organized crime. For this reason, dismantling these laboratories is a priority for the Police Forces and relevant Authorities.

Clandestine drug production has a devastating environmental impact due to the massive use of toxic chemicals and illegal waste disposal. In cocaine and heroin laboratories, solvents such as acetone, sulfuric acid, and ammonia are often poured directly into rivers or soil, contaminating water supplies and poisoning local wildlife. Deforestation for the illegal cultivation of coca and opium poppy plants destroys vast areas of rainforest, accelerating soil erosion and loss of biodiversity. In synthetic drugs laboratories, such as methamphetamine and fentanyl, chemical reactions generate highly toxic byproducts that, if dispersed into the environment, can alter ecosystems and damage the health of nearby communities. In some synthetic drug manufacturing processes, up to 12-13 kilograms of harmful substances, production waste, are produced to obtain one kilogram of drug substance. In addition, using flammable chemical precursors increases the risk of fires and explosions, further contributing to environmental destruction. The absence of regulations and controls makes these damages irreversible, turning entire regions into polluted areas that are dangerous to human and animal life.

3.2. TYPES OF CLANDESTINE LABORATORIES

Clandestine laboratories can be divided into several categories according to the type of drugs produced and the mode of operation. First, we can distinguish between laboratories for the production of synthetic drugs, such as methamphetamine, semisynthetic drugs, such as cocaine and heroin, and natural drugs, such as cannabis, which can be grown and processed in illegal facilities. Another important distinction concerns size: some laboratories are small, run by individuals or small gangs, while others are true clandestine factories, with large-scale operations involving numerous people. In addition, laboratories can be more or less sophisticated: while some use rudimentary methods, others are equipped with advanced and sophisticated machinery capable of producing large quantities of drugs in a relatively short time. Other types involve packaging laboratories and so-called secondary extraction laboratories.

In common fact, three components are theoretically needed to produce drugs:

1. **The equipment**

   A clandestine illicit drug laboratory has specific equipment for drug synthesis, purification, crystallization, and packaging, with levels of complexity varying by substance and production scale. Common tools include laboratory glassware, such as flasks, test tubes, and glass flasks, used to mix and heat chemical precursors, often supported by hot plates and stoves. Filters, sieves, centrifuges, and crystallizers are used for purification and are essential for obtaining drugs in pure form, such as cocaine and methamphetamine. Large-scale laboratories have industrial chemical reactors, dryers, and hydraulic presses to compress drugs into pellets or tablets. Storage takes place in canisters and bins containing toxic solvents such as acetone and ethyl ether, while precision scales and vacuum bags are used to dose and package the final product. Despite the use of gas masks and chemical gloves in some laboratories, safety measures are often rudimentary, increasing the risk of explosions and contamination. In the most sophisticated laboratories, especially those operated by criminal organizations, ventilation, surveillance, and alarm systems can be installed to prevent toxic gas and enforcement intrusion, making these places highly dangerous for both operators and the surrounding environment;

2. **Precursors and other chemicals**

   Clandestine drug laboratories use a wide range of chemicals, such as precursors, pre-precursors, and *designer precursors*, to circumvent regulations and facilitate drug synthesis. Precursors are chemicals directly involved in drug synthesis and regulated internationally, such as ephedrine and pseudoephedrine for methamphetamine, acetic anhydride for the transformation of morphine into heroin, and potassium permanganate for the purification of cocaine. Pre- precursors, which are less controlled, are chemical compounds that can be converted into the actual precursors through simple chemical reactions, such as BMK (benzyl methyl ketone) for amphetamine production or PMK (piperonyl methyl ketone) for MDMA synthesis. *Designer precursors (designer precursors*) are molecules modified specifically to evade regulations and become active precursors after specific chemical transformations, such as some substituted variants of fentanyl that can be easily converted back to the active form. In addition to these, clandestine laboratories use a wide range of solvents and chemical reagents critical to drug extraction, synthesis, and purification, including acetone, ethyl ether, hydrochloric acid, ammonia, toluene, and sodium hypochlorite, and even kerosene, gasoline and alcohol, which are often handled without adequate safety measures, causing environmental contamination and health hazards to operators.

3. **Expertise (know-how)**

   Operating a clandestine laboratory for illicit drug production requires a broad spectrum of technical and chemical skills, ranging from knowledge of synthesis processes to managing security and toxic waste disposal. Operators must have a solid understanding of organic chemistry to conduct substance synthesis, conversion, and purification reactions, such as the transformation of morphine to heroin or the synthesis of methamphetamine from ephedrine. The ability to handle precursors and hazardous chemical solvents, accurately dosing quantities, and controlling temperatures and reaction times to avoid explosions or contamination is essential. In addition, skills in extraction and crystallization are needed, for example, to obtain pure cocaine from coca leaves or to isolate MDMA in crystalline form. Operating machinery such as reactors, centrifuges, distillers, and hydraulic presses requires hands-on experience, as does the ability to make or modify rudimentary equipment in clandestine environments. On the safety side, knowledge of the hazards associated with toxic gases, flammable vapors, and corrosive agents is essential, while discretion and concealment techniques are crucial to avoid detection by authorities. Finally, in more structured laboratories, advanced skills in chemical engineering and pharmacology may be required, especially for the production of complex synthetic drugs such as fentanyl, where small variations in processes can affect the potency and toxicity of the final product. Nonetheless, improvised producers following "recipes" remedied by word of mouth or on the *Internet* are not uncommon in practice, they improvise themselves as "cooks" to "cook" narcotics, with highly variable results ranging from success, to producing toxic or lethal drugs, to causing venomous gas releases or sometimes very violent explosions.

Possession of the aforementioned three components, referred to as the "triangle" drug production, is necessary to set up a clandestine laboratory, although, as we shall see, the degrees of complexity of laboratories are directly proportional to the type of narcotic and the quantity and quality of the same intended to be produced.

Large-scale clandestine laboratories

Large-scale clandestine drug laboratories, often operated by transnational criminal organizations, are highly organized facilities with advanced industrial equipment for large-scale production of illicit substances such as cocaine, heroin, methamphetamine, MDMA, and synthetic opioids. These facilities, located in remote areas to escape control, can be set up in industrial warehouses, underground, or even inside forests and jungles, with sophisticated security systems such as video surveillance, armed personnel, and chemical release concealment methods. Unlike small artisanal laboratories, they use large-capacity chemical reactors, industrial centrifuges, advanced distillers, and filtration systems to ensure product yield and purity. Production is carried out systematically, with specialized personnel, including experienced chemists, technicians, and packaging and logistics workers. Operations involve the use of large volumes of precursors and chemical solvents, generating huge amounts of toxic waste, which is often disposed of illegally, with serious environmental consequences. In addition, these laboratories are often integrated into global distribution networks, using sophisticated logistics infrastructure to transport drugs, such as modified vehicles, homemade submarines, and clandestine air routes, making them hubs of international drug trafficking. Usually, this type of laboratory can rely on solid, well-designed facilities with several differentiated zones, each used for a particular activity:

- Chemical synthesis and purification zone
  - Industrial chemical reactors for large production volumes;
  - filters and crystallization systems for purification;
  - ventilation and security systems (often rudimentary).

- Chemical precursor warehouse
  - Storage of large quantities of solvents, strong acids and bases;
  - chemical precursors (ephedrine, safrole, acetic anhydride, ANPP, NPP, etc.).
- Packaging and distribution area
  - Drying and pressing the drug into pellets or capsules;
  - packaging for international transportation (concealed in legal goods).
- Safety and security
  - presence of armed guards and video surveillance systems;
  - escape routes and *bunkers* in case of Police operations;
  - laboratories often located in hard-to-reach areas (forests, mountains, deserts).

The types of drugs most commonly produced in large-scale laboratories include:

- cocaine (Colombia, Peru, Bolivia). Coca leaves are processed into a basic paste and then purified into cocaine hydrochloride (white powder). This processing involves chemical reactions with toxic solvents (acetone, ethyl ether, sulfuric acid, ammonia, as well as lime, kerosene, and gasoline);
- heroin (Afghanistan, Mexico, Myanmar). Extracted from opium, processed into crude morphine, and finally converted to pure heroin with acetic anhydride. Requires specialized chemical laboratories and precursors that are not easy to obtain because they are highly controlled;
- Methamphetamine is called "*Crystal Meth*" (Mexico, Asia, USA). Synthesized from ephedrine or pseudoephedrine by industrial methods. Mexican labs run by cartels produce tons of pure crystal every month;
- fentanyl and synthetic opioids, synthesized from highly toxic chemical precursors. Highly potent, small amounts are sufficient to produce thousands of lethal doses;
- MDMA (ecstasy) and other synthetic drugs (Europe, Asia), are produced from safrole and PMK, with sophisticated crystallization processes. These laboratories can produce millions of ecstasy tablets in a single batch.

Small-scale clandestine laboratories called "kitchen-labs"

"Kitchen-labs" are clandestine laboratories, often improvised in domestic settings such as kitchens, bathrooms, garages, or basements, used mainly for manufacturing synthetic drugs such as methamphetamine, MDMA, and fentanyl. These laboratories are characterized by the use of rudimentary equipment, such as laboratory glassware, often, pressure cookers, heating plates, and improvised filters, with chemical precursors often found in commonly used products, such as over-the-counter drugs containing ephedrine or industrial solvents and de-icers. Production takes place in confined spaces with poor ventilation, increasing the risk of explosions, fires, and toxic vapor poisoning. Kitchen- labs are generally operated by small criminal groups or individuals with basic chemical knowledge, who follow recipes available on the dark web or learned within illegal circuits. Their main characteristic is their mobility: to evade controls, they can be quickly dismantled and moved to other locations, making them difficult for Authorities to detect. However, their environmental and health impact is significant, as toxic residues are often improperly disposed of, contaminating homes, sewers, and surrounding areas, with consequences for the health of residents and for the Law Enforcement Agencies involved in cleaning up the sites.

A small-scale clandestine laboratory generally consists of:

- Laboratory equipment
  - Erlenmeyer flasks, test tubes and glass flasks for chemical reactions, often salvaged or second-hand materials;
  - filters and sieves, even improvised ones with common materials, to separate compounds;
  - Hot plates and stoves, including “camping” type, for cooking substances.
- Chemicals and precursors
  - solvents such as acetone, diethyl ether, and ammonia, often made from commonly used products found in hardware stores or home improvement stores;

- Strong acids and bases (sulfuric acid, sodium hydroxide), contained in de-gorging agents or other household products;
- pharmaceutical precursors (e.g., pseudoephedrine for methamphetamine) contained in good concentration in over-the-counter pharmaceuticals that can be purchased at pharmacies without a prescription.

- Rudimentary ventilation systems
  - Fans or improvised hoods to reduce toxic vapors;
  - often inadequate, increasing the risk of chemical poisoning or high gas concentration and subsequent explosions.
- Illegal storage and disposal
  - jars, cans, and canisters of solvents and acids, often poorly stored; and acids, often poorly stored;
  - Illegal disposal of chemical waste into sewers, soil, or abandonment along roads.

The types of drugs most produced in the *Kitchen-labs* include:

- methamphetamine known as "*Crystal Meth*", produced with pseudoephedrine, lithium, and ammonia in a highly flammable and explosive process, or with pseudoephedrine, red phosphorus, and iodine;
- MDMA (ecstasy), synthesized from safrole, using improvised chemical reactors, producing tablets full of impurities and other dangerous substances;
- fentanyl and synthetic opioids, produced in liquid or powder form and mixed with other drugs, with a very high risk of *overdose* for those taking the final product due to the extreme potency of the opioid compared to classic heroin;
- Synthetic cathinones, called "*Bath Salts*," made from legal chemical-pharmaceutical precursors, with effects similar to stimulants such as MDMA, but with greater unpredictability.

Clandestine packaging laboratories

A drug packaging laboratory is a clandestine facility dedicated to the preparation, cutting, dosing, and packaging of drugs before distribution on the illegal market. Unlike production, synthesis, or extraction laboratories, these sites do not directly produce the drug but receive the already refined product to transform it into a marketable form, often mixing it with adulterants to increase its volume and profit. Therefore, these factories are not true laboratories, as chemical processes that compound or break down molecules do not take place there, only physical processes of mixing or compacting into tablets. These laboratories are equipped with precision scales, sieves, and mixers for cutting, hydraulic presses for compressing into pellets or tablets, as well as sealing pouches, capsules, and molds for packaging into ready-to-sell doses. More advanced laboratories use pill compression machines, such as are used in clandestine production of fake fentanyl drugs, or vacuum systems for safely transporting large quantities of powders. Packagers must be experienced in accurate dosing to avoid accidental overdosing, especially in potent synthetic drugs such as synthetic opioids (fentanyls and nitazenes), where small variations can be lethal. These laboratories may be small and easily concealed, but those linked to high-level criminal organizations operate in more structured environments with advanced security measures to avoid detection by authorities.

Clandestine laboratories of secondary extraction

A secondary extraction laboratory is a clandestine facility where chemical processes are carried out to refine, purify, or convert an already extracted or partially processed drug substance into a more potent or ready-to-distribute form. Unlike primary laboratories, which are concerned with the direct extraction of alkaloids from natural raw materials (such as cocaine from coca leaves or morphine from opium), secondary extraction laboratories perform purification, crystallization, and chemical conversion steps to improve the quality of the final product or adapt it to the market. For example, in heroin production, a secondary extraction laboratory may be used to convert crude morphine into refined heroin through chemical processes using acetic anhydride. For cocaine, these laboratories are used to convert the base paste into cocaine hydrochloride (the ready-to-eat powder) or to produce crack cocaine by treatment with baking soda or ammonia. For synthetic drugs, they may be used to crystallize methamphetamine or purify MDMA by removing unwanted by-products. These labs are often less conspicuous than primary production labs, but remain highly dangerous due to the use of flammable solvents and corrosive acids. In addition, their mobility and adaptability make them more difficult to detect, facilitating international trafficking and local drug distribution.

More recent trends, supported by seizures and investigative evidence, suggest a willingness on the part of criminal syndicates to have semi-finished drugs travel from production areas to consumption areas to complete the final stage of extraction *locally*. This technique brings with it a variety of positive aspects. In the case of heroin from Asia (Afghanistan and Myanmar), it is easier to procure the acetic anhydride, which is needed to turn morphine into heroin, in Europe, where the chemical industry is flourishing, than in rural poppy-producing areas. As for cocaine, being able to transform it into solid or plastic objects that, while containing the coca alkaloids, imprison them in a molecular mesh that does not allow them to react with the most common narco-tests that provide negative responses, makes it less detectable. Such items, once they reach Europe, can be re-melted, allowing drug traffickers to recover coca paste or cocaine base and complete the process in a secondary extraction laboratory directly at the place where the narcotic is consumed. Here we emphasize the importance of the presence of a suitable chemist, often supplied by South American production cartels themselves, who is the only one to know the correct formula and is capable of recovering the drug.

Clandestine production laboratories

A clandestine drug production laboratory is an illegal facility where drugs destined for the illicit market are synthesized, processed,or refined. These laboratories vary in size, complexity, and type of substance produced and can range from small domestic *kitchen-labs* to industrial facilities operated by criminal organizations. Depending on the drug produced, the laboratory can be divided into three main categories:

- primary extraction laboratories, where active ingredients are obtained from natural sources, such as morphine from opium or cocaine from coca leaves;

- chemical synthesis laboratories, typical for synthetic drugs such as methamphetamine, MDMA, fentanyl, and cathinones, where chemical precursors are used to create new psychoactive compounds without the need to start from natural products (plants or mushrooms);

- secondary extraction laboratories, where already extracted or already synthesized substances are purified, modified, or enhanced, such as the conversion of morphine to heroin or the transformation of basic paste into cocaine hydrochloride, but also the crystallization of "*crystal meth*" and the extraction, purification, and mixing of fentanyl, before sale.

Laboratories are often equipped with chemical reactors, laboratory glassware, solvents, chemical precursors, and purification and packaging equipment. Their handling requires expertise in organic chemistry and pharmacology, and their operation is highly dangerous because of the risk of explosions, fires, toxic contamination, and environmental impacts. To avoid detection by Authorities, they are often hidden in isolated areas, basements, or abandoned buildings and take safety measures such as video surveillance, chemical vapor filtration systems, and concealment of toxic waste.

Before continuing, it is necessary to point out the differences in classification between synthetic and semisynthetic drugs. The former are created from scratch in chemically synthesized laboratories, while semisynthetic drugs are derived from natural substances that have been chemically modified to increase their effectiveness or modify their effects (e.g., cocaine, heroin, oxycodone, and LSD).

Production of Cocaine

Cocaine is a stimulant drug extracted from the leaves of the coca plant (Erythroxylum coca), native to South America. It is one of the most widespread and dangerous drugs, with a high potential for addiction and physical and psychological harm. It is consumed primarily for its euphoric and energizing effects, but its abuse leads to serious health problems, including heart attack, stroke, and mental disorders. Cocaine is produced from coca leaves and chemically refined. The main producing countries are: Colombia (the main world producer), Peru, and Bolivia. Cocaine trafficking is operated by criminal cartels, which distribute it to North America, Europe, and Asia through illegal routes. Cocaine clandestine production has several peculiarities related to its illegality, the chemical processes involved, and the logistical and environmental conditions under which it takes place. Here are the main aspects:

- Raw materials and origins
    - Cocaine is extracted from the leaves of coca, a plant grown mainly in Colombia, Peru and Bolivia;
    - plantations are often located in remote jungle areas to escape government control.
- Chemical processes and illegal environments
    - clandestine production takes place in hidden laboratories (called "*cocinas*"), often set up in forests, abandoned sheds, or underground;
    - clandestine chemists use toxic solvents such as gasoline, acetone, ether, ammonia, and sulfuric acid for extraction and refining;
    - chemical processes include: maceration of coca leaves with solvents; extraction of coca base (base paste); purification into cocaine hydrochloride (powder, ready for consumption);
    - Working in these laboratories is highly dangerous because of toxic fumes and the risk of explosion or fire.
- Logistics and security
    - drug traffickers protect operations with armed guards and surveillance technology;
    - local populations are often involved under threat or out of economic necessity;
    - drug cartels exploit corruption and secret routes to transport cocaine to other countries.
- Environmental impact
    - coca cultivation leads to massive deforestation;
    - clandestine laboratories dump toxic substances into rivers and soils, poisoning ecosystems and local populations.

- Adulteration and product-cutting
  - international markets, cocaine is often cut with other substances (lidocaine, levamisole, talc, bicarbonate, or procaine) to increase its volume and profit.
- Repression and countermeasures
  - governments and law enforcement counter production with military operations, destruction of plantations, and control of chemicals used as precursors;
  - however, drug traffickers are always finding new methods to evade the Authorities, such as mobile laboratories or alternative chemicals (pre-precursors or design precursors).

Production of Heroin

Heroin is an opioid drug derived from morphine, a natural substance extracted from opium, which in turn is extracted from the poppy (*Papaver somniferum*). It is one of the most powerful and dangerous natural opioids, with a high risk of addiction and *overdose*.

It is classified as an illegal drug in almost every country in the world and is responsible for numerous *overdose* deaths, often due to contamination with fentanyl or other synthetic opioids. Heroin comes in several forms: white or brown powder, most prevalent in Europe and Asia, and is snorted or injected; as black "*Black Tar*" heroin, in sticky form, prevalent in the U.S., generally smoked or injected.

Heroin is produced mainly from opium grown illegally in: Afghanistan, the world's largest producer; Mexico, which produces "Black Tar" for the U.S. market; Southeast Asia (Myanmar, Laos, Thailand), an area known as the "Golden Triangle." Heroin is trafficked through drug cartels and criminal networks, often mixed with substances to increase volume and profit.

Clandestine heroin production has specific characteristics related to raw materials, chemical processes, illegal conditions under which it takes place, and environmental and health risks.

Raw materials and production areas:

- heroin is derived from morphine, extracted from opium, a resin produced by *Papaver somniferum*;
- the main areas of illegal opium poppy cultivation are: the "Golden Triangle" (Myanmar, Thailand, Laos), the "Golden Crescent" (Afghanistan, Pakistan, Iran), as well as Mexico and Colombia (for the U.S. market).

Chemical processes and clandestine laboratories:

The processing of opium into heroin takes place in illegal laboratories hidden in forests, mountains, or underground. The process involves:

- morphine extraction: raw opium is boiled with water and filtered; lime (calcium hydroxide) is added to precipitate morphine; the mixture is filtered and treated with sulfuric acid to obtain morphine sulfate;

- conversion to heroin (diacetylmorphine): morphine sulfate is treated with acetic anhydride (acetylation), a chemical agent that converts it to crude heroin; this step takes place at controlled temperatures and lasts several hours;

- purification and refining: ammonia is used to remove impurities; heroin is washed with organic solvents such as ethanol, acetone, or chloroform; eventually, basic heroin (brown) or heroin hydrochloride (white) is obtained.

Characteristics of illegal production:

- laboratories are protected by armed groups and often run by criminal organizations or terrorist groups;

- processing is highly toxic, and clandestine chemists operate under precarious conditions;

- equipment is rudimentary, and errors in the process can reduce quality or create dangerous products as they are toxic or lethal.

Transportation and adulteration:

- heroin is cut with cutting substances such as acetaminophen, quinine, levamisole, or sugar to increase its volume and gain;

- trafficking routes exploit corruption, secret routes, and human transporters (ovulatory couriers or "mules").Environmental impact:

- Poppy cultivation causes deforestation;

- toxic chemical residues are discharged into the environment unchecked, polluting soil and water.

Repression and countermeasures:

Authorities try to counter production by destroying crops and controlling precursor chemicals. However, production continually moves to less controlled areas.

Following the Taliban's rise to power in Afghanistan, they have declared their intention to ban the cultivation of the opium poppy and, consequently, the export of heroin and other poppy derivatives. Pending reliable data from those areas, the threshold of European and global attention to the phenomenon has been raised further, since as heroin production decreases, it is assumed that the heroin market will react with an initial shortage of availability that could result in the raising of the street price for the same quality or, much more dangerous for the health of consumers, the exponential increase of “cut” rates. The latter option could lead traffickers to the reckless use of fentanyl, nitazenes, or other synthetic opioids as cheap and potent cutting agents. The spread of this phenomenon would create unwitting users of synthetic opioids at the risk of their own lives to secure the profits of drug dealers. Another consequence of the Taliban ban is the relocation of production elsewhere, for example to the historic “Golden Triangle” (Myanmar, Thailand, Laos), recently more devoted to methamphetamine production.

Production of Methamphetamine

Methamphetamine is a synthetic stimulant drug that belongs to the amphetamine class. [*For more information on the narcotic, see appropriate section*].

Methamphetamine is produced in clandestine laboratories, mainly: in Mexico, where drug cartels produce the purest and most potent version; in Southeast Asia (Burma, Thailand), where there remains a thriving mass production in the form of tablets called “Yaba”; and in the U.S. and Europe, where small artisanal laboratories produce more impure versions, often mixed with other substances.

Methamphetamine is illegal in almost all countries and classified as a dangerous drug (Schedule II in the US, Schedule I in Italy). Governments and agencies such as DEA, Interpol, and Europol combat production and international trafficking. Strict controls are enforced on the sale of pseudoephedrine drugs to prevent clandestine production, which is characterized by dangerous chemical processes, readily available ingredients, and a high environmental and health risk.

Raw materials and ease of sourcing

Unlike cocaine and heroin, methamphetamine is a synthetic drug, so it does not require cultivation, only chemical precursors. The main ingredients used in clandestine laboratories differ depending on the method and include:

- ephedrine or pseudoephedrine (derived from decongestant drugs normally sold in pharmacies without a prescription);
- industrial chemicals such as ammonia, muriatic acid, acetone, ether, iodine, red phosphorus (obtainable from matches);
- lithium (obtainable from alkaline batteries) and other reactive metals (sodium).

Said substances can be found in over-the-counter drugs, fertilizers, industrial solvents, and cleaning products, making production accessible to small criminal groups.

Illegal production

There are several clandestine methods of synthesizing methamphetamine. The most common are:

- **"Red P"** (Red Phosphorus) method, also called "Nagai" (from the Japanese chemist who discovered it) or "Czech Method" (because it is widely used in the Czech Republic). This procedure uses pseudoephedrine, iodine, and red phosphorus (from matches or Bengal), produces toxic fumes and explosion hazards, and represents a common method in artisan laboratories known as "*Kitchen-labs.*"

- "**Birch**" (or Lithium-Ammonium) method, also called "Nazi" because it echoes the procedure used by the Nazis to produce Pervitin (a methamphetamine in drug form administered to German soldiers during World War II). The method uses lithium (from batteries) and anhydrous ammonia to reduce pseudoephedrine to methamphetamine. The same is extremely unstable and dangerous, often causing fires and explosions. It is widespread in small mobile laboratories, especially in the US, but also in Australia;

- **P2P** (phenyl-2-propanone) or **BMK** (Benzyl Methyl Ketone) method. This method uses phenyl- 2-propanone (P2P) as a precursor, produces methamphetamine of lower purity but in large quantities, and is the preferred method for large-scale production by Mexican cartels, as well as by criminal syndicates in the Netherlands and Europe for mass production. Unlike the previous two methods, which may also use only small equipment that is not professional, this requires space for a reactor (*reactor, vessel*) and a minimum of professional equipment.

Clandestine laboratories and illegal conditions

- clandestine laboratories range from small home-based "*kitchen-labs*" to industrial facilities hidden in remote areas;

- many laboratories are mobile (in cars, RVs, or hotel rooms) to avoid inspections;

- production operations are highly hazardous, with the risk of explosions, fires, and chemical contamination.

Environmental impacts and health risks

- Toxic production: each kilogram of methamphetamine generates 5-6 kilograms of hazardous toxic waste;

- residues: they are often discharged into rivers, soil, or sewers, causing serious environmental damage;

- contamination of environments: houses used as laboratories become uninhabitable due to toxic chemical residues;
- hazardous exposure: those living near a clandestine laboratory may suffer respiratory, neurological, and skin problems.

Transportation and distribution

- methamphetamine is transported in crystal, powder, or pill form, often hidden in vehicles, postal packages, or everyday objects, more rarely in liquid form in jerry cans;
- Mexican cartels are the main large-scale producers and supply it in the U.S. and Europe, where they concentrate in the Netherlands in collaboration with local organized crime;
- home laboratories capable of producing up to 5 kg of drugs per month, called "*Kitchen-labs*," are widespread in the Czech Republic.

Repression and countermeasures

- Governments monitor the sale of pseudoephedrine, BMK, and other precursors to limit production;
- Authorities try to dismantle laboratories with special operations, but manufacturers are always planting new sites;
- the clandestine production of methamphetamine is among the most dangerous to operators, users, and the environment. The low cost and ease of production make it one of the most popular synthetic drugs in the world.

Production of Synthetic Opioids

Synthetic opioids are synthetic drugs or narcotics that mimic the effects of morphine and heroin, but are chemically produced in a laboratory and are often much more potent. [*See appropriate section for more information on the narcotic*].

The clandestine production of synthetic opioids has peculiar characteristics compared to other drugs because of their extreme potency, complex chemical synthesis, and dangerousness to users and producers.

Raw materials and ease of synthesis

Synthetic opioids, such as fentanyl, carfentanil, and U-47700, are not derived from natural opium but are chemically produced from pharmaceutical or industrial precursors.

Precursor chemicals: Aniline and derivatives; NPP (N-phenyl-1-phenyl-1-propanone) and ANPP (4- anilino-N-phenethylpiperidine), used for the synthesis of fentanyl; industrial chemicals readily available in pharmaceutical laboratories or illegal markets.

Production can take place in domestic, illegal industries, or even corrupt pharmaceutical laboratories.

Illegal production

The clandestine synthesis of synthetic opioids varies depending on the complexity of the compound. Fentanyl and its analogs are among the most illegally produced:

- Three-step synthesis method, called "**Gupta et al.**" It involves the use of ANPP and other substances, as the main precursors for the production of fentanyl;
- Four-step synthesis method, called "**Siegfried**." It involves the use of ANPP and other substances, as the main precursors for the production of fentanyl;
- Five-step synthesis method, called "**Janssen**." It does not involve the use of ANPP but norfentanil and other substances as the main precursors for the production of fentanyl;
- Production of fentanyl analogs. Drug traffickers continually modify the chemical structure to create even more potent variants (carfentanil, acetylfentanil, furanylfentanil). Some of these compounds are from 100 times more potent than heroin to up to 10,000 times more potent than the morphine. Carfentanil, for example, is used as a sedative for large animals and is lethal to humans even in microscopic doses.

Clandestine laboratories and chemical hazards

- Hidden laboratories: these can be small (in houses, basements, garages) or large (illegal industrial warehouses). Some Mexican cartels have advanced laboratories with expert chemists capable of producing fentanyl in massive quantities;
- Very high risk of contamination and *overdose*: fentanyl and its derivatives are so potent that even accidental inhalation of dust or transdermal intake can be lethal. Many manufacturers do not use adequate protective equipment and risk their lives during synthesis.

Distribution and adulteration

- Easy transportation and concealment: fentanyl is very potent, so it only takes a few grams to produce thousands of doses. It is often mixed with heroin or other drugs to increase its potency and reduce production costs;
- Counterfeit tablets: clandestine labs produce pills that mimic legal drugs (Oxycontin, Percocet, Xanax) but contain fentanyl. This has caused a boom in accidental *overdoses* in unwitting users.

Environmental and health impacts

- Toxic production: chemical residues are often illegally dumped into soil and rivers;
- High risk for Enforcement: accidental contact with fentanyl alone can be lethal by transdermal intake or inhalation; therefore, Police and DEA use protective suits and Narcan (naloxone) emergency *spray* during operations;
- Mass *overdose*: fentanyl is responsible for thousands of deaths a year, especially in North America.

Repression and countermeasures

- Precursor chemical control: the U.S. and EU have imposed strict restrictions on the import of NPP and ANPP, and new substances are being tabulated all the time. China has put many fentanyl precursors under control, but drug traffickers also continue to find alternatives through the use of artificial intelligence;
- Use of Naloxone (trade names: Narcan - Kloxxado - Evzio - Prenoxad - Nyxoid - Ventizolve): it is a life-saving antidote in cases of synthetic and natural opioid overdose. Health authorities are distributing Naloxone kits in places at risk.

Clandestine production of synthetic opioids is easier and cheaper than heroin and cocaine (which are crop-related), but extremely lethal (getting the dosage wrong is extremely dangerous). Illegal trafficking of fentanyl and its analogs is fueling a global crisis of *overdose*, prompting governments to take drastic measures to counter its spread.

Production of synthetic cathinones

Synthetic cathinones are a class of stimulant drugs chemically similar to amphetamines and natural cathinone, the psychoactive compound found in the leaves of the khat plant (Catha edulis). They are also known as "bath salts," "*legal highs*," or "*research chemicals*" and are often sold as substitutes for drugs such as MDMA, cocaine, and methamphetamine. [*For more information on the narcotic see appropriate section*].

Authorities are constantly working to shut down clandestine laboratories and *online* sales sites on the *dark web*.

The clandestine production of synthetic cathinones has several peculiarities related to ease of synthesis, chemical and health risks, rapid evolution of the molecules, and difficulty of regulation. Synthetic cathinones are often sold as "*bath salts*," "*legal highs*," or "*designer drugs*," always labeled "not for human consumption," and are similar to amphetamines in stimulant and euphoric effects.

Raw materials and ease of synthesis

Synthetic cathinones take their cue from the natural cathinone, found in the khat plant (*Catha edulis*), but are artificially synthesized to achieve similar and more potent effects. The main chemical precursors are: bromopropanone, methylamine, organic acids, solvents (acetone, toluene, ethanol), and reagents for chemical synthesis (oxidants and catalysts). Said precursors are often legally produced for pharmaceutical or industrial use, and then diverted to clandestine laboratories. The synthesis is relatively simple so that it can be performed even by inexperienced chemists. Some manufacturers purchase semi-processed cathinones from foreign suppliers and purify or modify them in secondary extraction laboratories.

Illegal production

Synthetic cathinones are produced by relatively simple chemical synthesis methods, similar to those of amphetamines. Examples of popular synthetic cathinones are: Mephedrone (4-MMC), Methylone (bk-MDMA), α-PVP ("*Flakka*"), 3-MMC and 4-MEC:

- Direct synthesis from precursors. The chemical compounds are treated with organic solvents and catalysts, generating a crystalline product. After the synthesis process, cathinone is purified and crystallized to be sold in powder, capsules, or tablets;

- Modification of existing molecules (*Designer Drugs*). Clandestine labs alter chemical structures to create new variants and circumvent drug laws.

Clandestine laboratories and chemical hazards

- Home-based or semi-industrial laboratories: may be small (in houses, garages, basements) or larger (in hidden warehouses or industrial sheds); manufacturers generally operate under improvised conditions and without safety controls.

- Risk of contamination and impurities: poor quality synthesis can generate toxic by-products, absence of controls makes dosing unpredictable, increasing the risk of overdose;

- Hazardous production: some reagents are flammable or explosive; lack of proper ventilation exposes producers to toxic vapors.

Transportation and distribution

- Easy transportation and *online* sales: synthetic cathinones are odorless and easy to ship, often disguised as legal products; they are sold on the *dark web*, *social media*, and *online* stores under misleading names (e.g., "bath salts," "fertilizer," "chemical research");

- Trafficking routes: raw materials come mainly from China and India; final synthesis often takes place in Eastern Europe, Mexico, and North Africa.

Environmental and health impacts

- Toxic production: chemical residues are often disposed of illegally in rivers or soils;
- Unpredictable effects: alterations in molecular chemistry can generate unknown and even more dangerous compounds; some synthetic cathinones cause psychosis, paranoia, hyperthermia, and fatal heart attacks.

Repression and countermeasures

- Precursor chemical monitoring: many governments regulate precursors such as bromine propanone and methylamine, however, drug traffickers constantly change formulas to evade controls;
- Bans and updated laws: some countries ban entire chemical classes instead of individual substances, to counter synthetic variants and attack the market;
- Closure of *online* markets: authorities shut down *websites* and *dark web* markets selling these substances.

Synthetic cathinones are easy to produce, distribute, and chemically modify, making them difficult to control. Clandestine production takes place in improvised or semi-industrial laboratories, posing serious health and environmental risks. The high hazard of these substances, coupled with their continuing evolution, poses a growing challenge to Authorities worldwide.

Production of Synthetic Cannabinoids

Synthetic cannabinoids are chemicals created in the laboratory to mimic the effects of THC (tetrahydrocannabinol), the main active ingredient in cannabis. [*For more information on the narcotic, see the appropriate section*].

The clandestine production of synthetic cannabinoids has special characteristics related to chemical synthesis, ease of distribution, and serious health risks. These substances, often called "*Spice*," "*K2*," or "*legal highs*," are created to mimic the effects of THC (the active ingredient in cannabis), but are much more potent and dangerous.

Raw materials and chemical synthesis

Unlike natural cannabis, synthetic cannabinoids are not derived from plants but are synthesized in the laboratory and sprayed onto dried plant materials to be smoked or vaporized. The main chemical precursors are: Indoles and Indazoles (basic structure) JWH-018, AM-2201, AB- FUBINACA (examples of synthetic cannabinoids); organic solvents (acetone, ethanol, dimethylformamide); carrier materials (dried herbs, shredded leaves, blotting paper). Precursor chemicals are often marketed through the *Internet* and shipped to clandestine laboratories around the world. The synthesis is relatively simple and can be accomplished by inexperienced chemists. The finished product is easy to transport and distribute, either in liquid form (for vaporizers) or as a treated herb (sprayed with liquid).

Illegal production

Production of synthetic cannabinoids occurs mainly in three stages:

- Synthesis of the synthetic cannabinoid. The chemical is created in the laboratory from basic compounds (Indoles, Indazoles, Pyroles). The synthesis is similar to that of amphetamines and other psychoactive compounds;

- dilution and preparation of the solution. The synthetic cannabinoid is diluted in an organic solvent (acetone, ethanol) to be more easily absorbed by the plant material. This step is highly dangerous, as incorrect dosing can make the drug too potent, toxic, or lethal;

- application to plant material. The chemical solution is sprayed on dried herbs or blotting paper to simulate marijuana or the soaked "stamps" traditionally used to take LSD. After drying, the product is ready to be smoked. In liquid form, it can be directly used in vaporizers and electronic cigarettes.

Clandestine laboratories and chemical hazards

- Makeshift laboratories: often located in garages, basements, or abandoned warehouses. The lack of quality control makes each batch unpredictable;

- uncontrollable dosage: uneven distribution of the active ingredient; some parts of the product can be extremely potent, causing lethal overdoses. Some synthetic cannabinoids are 100 times more potent than natural THC, with unpredictable effects on the brain;

- use of toxic solvents: production uses hazardous chemicals, which can contaminate the finished product. Some solvents are carcinogenic and neurotoxic.

Transportation and distribution

Easy transportation and online sales: synthetic cannabinoids are odorless and difficult to detect in drug screening. They are often sold on the *Internet* and the *dark web*, labeled as "incense," "herbal blend," or "fertilizer." Production and packaging often take place in Eastern Europe, Russia, and Mexico.

Environmental and health impacts

- Toxic production: solvents used to dilute synthetic cannabinoids are often disposed of illegally, contaminating soil and water;

- unpredictable health effects: unlike natural THC, synthetic cannabinoids bind to brain receptors more aggressively, causing devastating effects such as psychosis, paranoia, violent hallucinations; seizures and permanent neurological damage; heart failure, kidney failure, and sudden death. Some variants, such as XLR-11 and AB-CHMINACA have been linked to severe seizures and deaths.

Repression and countermeasures

- Precursor chemical monitoring: many governments have banned individual synthetic cannabinoids, but criminal syndicates continually create new variants to evade laws;

- general bans on entire chemical classes: some countries, such as the U.S., have banned the entire category of synthetic cannabinoids, making illegal production more difficult;

- law enforcement operations: law enforcement agencies are dismantling clandestine laboratories and websites selling these substances. Governments are constantly promoting public information campaigns about the serious dangers of these drugs.

Synthetic cannabinoids are extremely dangerous due to unpredictable potency, toxic solvents, and lack of quality control. Clandestine production is relatively easy, as long as one has access to the specific precursors needed, which has led to a global spread of the phenomenon. Despite the efforts of authorities, drug traffickers continue to modify the chemical structure to circumvent laws and sell new variants of these lethal substances, classified NPS before tabulation as real drugs.

3.3. SPREAD OF CLANDESTINE SYNTHETIC DRUG LABORATORIES

In recent decades, the phenomenon of clandestine synthetic drug laboratories has assumed global proportions, turning into a growing challenge for authorities around the world. The production of substances such as methamphetamine, MDMA, fentanyl, and synthetic cathinones has intensified due to easy access to precursor chemicals and the growing technical skills of illicit producers. The expansion of these laboratories not only fuels the drug black market, but also contributes to health problems, organized crime, and social instability. Several factors have contributed to the proliferation of clandestine laboratories globally, such as the increasing ease of access to precursor chemicals for sale *online*, along with all kinds of chemicals. China's chemical industry has undergone unprecedented expansion, and although that country's control authorities are keen to cooperate and continue to tabulate new substances, the flows of goods are such that they cannot be totally under control, partly because traffickers are industrious in continually seeking new channels that are difficult to trace. In addition, technological developments are continually expanding the possibilities of electronic commerce and maintaining anonymity. Information on drug synthesis is readily available on the *dark web*, allowing even non-professional chemists to produce drugs. Corruption and the lack of stringent regulations in some countries, together with the lack of effective controls, encourage the proliferation of illegal laboratories. Finally, synthetic drug use is on the rise, especially among young people, creating a high demand that stimulates clandestine production.

The global spread of clandestine synthetic drug laboratories poses a growing and complex threat. The increase in the production and consumption of these substances requires a global response that combines repression, regulation, and prevention. Without coordinated and targeted action, the phenomenon will continue to expand, with increasingly serious consequences for public health and international security.

Europe

In Europe, clandestine synthetic drug laboratories are increasingly common, with a high concentration in the Netherlands, Belgium, Germany, and the Czech Republic. The main types include:

- MDMA (Ecstasy) Labs

  Most prevalent in the Netherlands, Belgium, and Spain, they produce MDMA in powder or tablet form (ecstasy). They are often large laboratories with industrial facilities. They use chemical precursors such as PMK (piperonyl methyl ketone), which often comes from outside the European Union. They mainly supply the European and international markets.

- Methamphetamine Laboratories

  Widespread in Germany, the Czech Republic, the Netherlands, and Spain, they produce crystal methamphetamine ("*crystal meth*"). Small and "*kitchen-labs*" are found in the Czech Republic, often using pseudoephedrine (extracted from over-the-counter cold medicines). In the Netherlands and Germany, mega-laboratories have been dismantled, with industrial production destined for export. Methamphetamine is increasingly popular in Eastern Europe and the Nordic countries.

- Amphetamine Laboratories (*Speed*)

  Particular laboratories producing amphetamine sulfate (*speed*), sold in powder or paste form, have been located in the Netherlands, Belgium, and Germany. These are characterized by large-scale production, often in the same laboratories as MDMA, using chemical precursors such as BMK (Benzyl Methyl Ketone) and its pre-precursors (APAAN, MAPA, EAPA …). The product is intended for the European market, particularly Germany and Scandinavia.

- Fentanyl and Synthetic Opioid Laboratories.

  Eastern Europe (Russia, Ukraine, Poland), partly also Spain and Belgium are characterized by laboratories producing synthetic opioids, such as fentanyl, and structural analogs called fentanyl (it is estimated that up to two thousand variants would be possible). These laboratories are very dangerous because the products are highly potent and lethal. Often in these specialized chemical laboratories experienced chemists operate, and the global market appears to be growing, especially online (*dark web*).

- New Psychoactive Substances (NPS) Laboratories.

  In Eastern Europe, the Netherlands, and the United Kingdom in conjunction with Chinese laboratories where new formulas are continually being developed, synthetic cannabinoids, synthetic cathinones ("*bath salts*"), and other new-generation drugs are being produced. Very difficult to track because substances change rapidly to escape laws. Often, precursor chemicals come from chemical-producing countries in the form of pre-precursors or *designer precursors* and are later processed in European laboratories. These substances are sold online and in *underground* circuits (by word of mouth on social media).

Recent trends report the discovery of mega-industrial laboratories in the Netherlands and Belgium, supplying Europe. The use of mobile laboratories, or small, itinerant facilities to avoid law enforcement investigations, is confirmed. The use of alternative precursors to escape controls on regulated chemicals is confirmed. Finally, clandestine laboratories are found to be increasingly sophisticated and connected to organized crime.

Central America and the Caribbean

In Central America and the Caribbean, clandestine synthetic drug laboratories are on the rise, although the Region is traditionally better known for the production and trafficking of cocaine and heroin. However, laboratories producing methamphetamine, fentanyl, and new psychoactive substances (NPS) have increased in recent years.

Currently, the most dangerous synthetic drug produced in clandestine laboratories in the Caribbean area is fentanyl and the even more potent analogs are also on the rise in the Caribbean, often mixed with heroin or other substances to increase their effect and reduce production costs. Another substance of concern is "Tusibi" or "2C-B," also known as "pink cocaine," which is gaining popularity in some areas. 2,5-dimethoxy-4-bromophenethylamine is a synthetic drug belonging to the psychedelic class of phenethylamines. It is known for its hallucinogenic and entactogenic (promotes empathy and a sense of connection) effects. It is a synthetic drug that combines the effects of ketamine and MDMA, creating extremely dangerous hallucinogenic and stimulating sensations.

The expansion of these clandestine laboratories is aided by the ease of chemical synthesis, drug trafficking routes, and the growing demand for synthetic drugs in global markets.

Methamphetamine laboratories

In Mexico (states of Sinaloa, Michoacán, Jalisco, Guerrero, and Baja California), Guatemala, and Honduras, crystal methamphetamine productionios has been reported, destined mainly for the United States, controlled by Mexican cartels, such as the Sinaloa Cartel and the Jalisco Nueva Generación Cartel (CJNG). There are industrial-scale productions, with laboratories well hidden in forests or mountains, using precursor chemicals such as ephedrine and pseudoephedrine, illegally imported from Asia and South America. These laboratories are becoming increasingly sophisticated, with expert chemists constantly improving the purity of the product.

Fentanyl and Synthetic Opioid Laboratories

Mexico (states of Sinaloa, Jalisco, Michoacán, Sonora, Baja California) produces fentanyl and derivatives destined for the United States and Canada, often mixed with heroin or counterfeit medicinal pills. Extremely dangerous, as fentanyls are very potent (up to 50-100 times more potent than heroin). Mexican cartels receive precursor chemicals from abroad and process them within local laboratories. The production of fake fentanyl-based drugs is well underway, and tablets containing fentanyl are sold as oxycodone or Xanax, often to unwitting consumers. Cartels are continually experimenting with new synthetic variants to escape controls and source new, uncontrolled chemicals to use as precursors.

Ecstasy (MDMA) and Amphetamine laboratoriesThe Dominican Republic, Puerto Rico, Costa Rica, and Mexico result in small-scale production of MDMA and amphetamines, mainly for local and tourist markets, often linked to international trafficking from Europe and South America. Production is limited, with precursor chemicals imported from Europe and Asia. Many laboratories are artisanal and located in urban or tourist areas. Recently, expansion into the tourist market has been experienced, with increased consumption in places such as Cancun, Punta Cana, and San Juan.

Laboratories of New Psychoactive Substances and Synthetic Cannabinoids

Production of synthetic cannabinoids, synthetic cathinones ("*bath salts*"), and other new-generation drugs resulted in Mexico, Dominican Republic, Panama, and Guatemala. These substances prove difficult to track because they frequently change composition to evade laws. They are widely trafficked via the *dark web*, paid for with cryptocurrency, but also often sold in nightclubs, festivals, and tourist areas. Local production appears to be on the rise, at the expense of importation from Asian factories.

Drug cutting and repackaging laboratories

In Mexico, the Dominican Republic, Honduras, Guatemala, and Colombia, laboratories the rise are not producing drugs, but cutting, mixing, and packaging them for international trafficking. Commonly used to mix cocaine with adulterants to increase volume, they also operate in fentanyls, mixing them with heroin or creating fake drug tablets. Such factories are often hidden in warehouses, houses, or laboratories in large cities. The increasing use of toxic adulterants appears to be on the rise, increasing the risks to consumers, who are often unaware (in the case of counterfeit drugs).

Recent trends include growth in methamphetamine and fentanyl production. Mexico is the leading producer in the North American market. As the tourist market expands, synthetic drugs are increasing in popular locations. The use of alternative precursor chemicals to evade international controls and the increasing involvement of organized crime in trafficking management make Mexican cartels the main antagonists of local governments on the road to legality.

3.4. ACTIONS TO DISMANTLE CLANDESTINE LABORATORIES

Countering clandestine drug labs is a daunting task for law enforcement and requires a coordinated and complex approach. Dismantling operations begin with the identification of laboratories, which is done through investigative activities, alerts, and surveillance techniques. Once located, operations must be planned with extreme caution to avoid incidents due to the presence of dangerous substances or the possibility that laboratories are protected by armed groups.

Law enforcement, often in collaboration with chemical and environmental experts, must neutralize the dangerous substances and ensure the safety of the officers involved. Once the laboratory is dismantled, the perpetrators are arrested and prosecuted according to the law. In addition, dismantling operations have an important deterrent function, as they reduce the supply of drugs on the illegal market and damage the trafficking network that fuels organized crime.

Preparatory operations

Intervening and dismantling a clandestine synthetic drug laboratory is an extremely dangerous operation that requires several specialized precautions, planning, and expertise. Here are the main precautions to be taken:

- Planning and preparation

  Before any intervention, a thorough planning phase is essential. This includes:

  - Information gathering: the identification of the laboratory should be done through investigations, surveillance techniques, eavesdropping, and reporting. The search for disproportionate electricity consumption in residential or rural areas or at abandoned warehouses, and the search for chemicals, processing wastes, narcotics production processes, waste water from the sewage system, can all be valuable techniques to help locate clandestine laboratories. So the search for specific harmful gaseous emissions in the air, carried out with specific technological aids. It is, in addition, essential to know in advance the structure of the building, access to rooms, and any areas of risk;

- Coordination with experts: the dismantling operation should involve experts in chemistry, law enforcement, and specialized units (such as anti-explosive or biological units), i.e., forensic units (Forensic Police). Involve, if necessary, fire and medical personnel from the emergency services, as well as military NBCR (Nuclear, Biological, Chemical and Radiological) risk specialists. Only the chemical expert can identify hazards related to chemicals in the laboratory;

- Provision of protective equipment: officers should be equipped with appropriate personal protective equipment (PPE), such as protective suits, gloves, gas masks with appropriate filters, chemical-resistant boots, and goggles.

- Safety and management of hazardous substances

  Clandestine laboratories often contain highly toxic, flammable, or explosive chemicals. Precautions to manage these hazards include:

  - Chemical risk assessment: experts should examine the type of chemicals used in the laboratory to assess the hazards and risks of explosion, fire or toxic exposure. Some compounds may be unstable and react violently to changes in temperature or pressure;

  - Area isolation: it is essential to isolate the area surrounding the laboratory to prevent exposure to toxic vapors or possible explosions. A safety zone of at least 300 meters may be necessary, depending on the type of chemicals involved;

  - Ventilation and control systems: if the laboratory is equipped with ventilation systems, it is important to monitor them before entering, as there may be accumulations of dangerous gases. If necessary, ventilation systems should be turned off before any search.

- Explosion hazard prevention

  Many clandestine synthetic drug laboratories operate with highly flammable or explosive materials. It is good practice not to abruptly stop chemical reactions in progress. Precautions to prevent explosions include:

  - Use of specialized equipment: it is essential to use explosion-proof equipment during the operation, particularly if the laboratory may contain volatile gases or liquids. The presence of open flames or heat sources (such as ovens and reactors) is a hazard to be avoided at all costs, as is turning on or off the electric light or abruptly stopping cooling and/or heating activities in progress (refrigerators/heating mantles);

  - Evacuation and securing: officers should enter the laboratory with great caution, avoiding vibrations that could trigger reactions. Any suspected reactor or container should be treated as a potential source of explosion. Any explosive materials must be handled by specialized explosives units.

- Arrest and management of those involved

  Many clandestine laboratories are protected by armed groups or personnel who may resist intervention. Precautions in this case include:

  - Security management: the operation must be supported by specialized police units, such as counter-terrorism departments or Intervention Forces (e.g., SWAT - *Special Weapons and Tactics*), to ensure officer safety. The risk of aggression must always be taken into account;

  - Control and arrest of suspects: officers must be prepared to stop and arrest anyone found inside the laboratory, strictly following legal regulations. It is important to correctly identify those responsible for running the laboratory.

- Dismantling and reclamation of the area

  After arresting the perpetrators and neutralizing the immediate dangers, the laboratory must be safely dismantled:

  - Confiscation of materials and substances: chemicals and equipment must be seized and catalogued so that they can be used as evidence in legal proceedings. It is necessary to document everything thoroughly;

  - Remediation and disposal of hazardous substances: chemicals must be disposed of properly, following environmental and safety regulations, to avoid contamination. In some cases, Environmental Authorities must be involved in the remediation process;

  - Follow-up investigations: after dismantling, law enforcement should conduct in-depth investigations to gather information on other laboratories or distribution networks involved in drug trafficking. Concerning the precursors found, backtracking or backward investigations should be conducted to find out their origin and possible point of diversion.

In conclusion, intervening and dismantling a clandestine synthetic drug laboratory is a high-risk operation that requires preparation, coordination, and the use of specialized techniques. Only through careful planning, the use of appropriate equipment, and the involvement of chemistry and security experts can minimize the risk to the lives of officers and the surrounding community.

Precautions access

Safely accessing a clandestine drug lab is an extremely dangerous operation and requires specialized equipment (PPE-Personal Protective Equipment) to protect operators from toxic exposures, chemical hazards, fires, and explosions. Response teams, such as Law Enforcement, specialized units (SWAT, DEA, Europol), and *Hazardous Materials Team* (*Hazardous* Mat) technicians, use specialized equipment to operate safely. The clandestine laboratories release toxic gases (e.g., phosgene, ammonia, solvent vapors), which can be lethal; they often contain invisible vapors that can be toxic or explosive; they also contain highly toxic and persistent chemical residues. In evidence collection, documentation is essential for investigation and to determine the type of substances produced. In the event of accidental exposure to toxic vapors or chemical spills, it is critical to act quickly. Many laboratories are reused by drug traffickers if they are not completely dismantled.

Personal protection (PPE - Personal Protective Equipment)

Operators need to be protected from inhalation of toxic vapors, contact with hazardous substances, and fire. Required: Haz-Mat Suit (Level A or B), full chemical protection, made of tyvek or similar materials; mask with air-supplied respirator (SCBA - *Self-Contained Breathing Apparatus*), for advanced filtration against toxic vapors (e.g., phosgene, hydrochloric acid); chemical-resistant gloves, made of nitrile or butyl, resistant to acids and solvents; acid-proof safety boots, as protection from chemical spills; fireproof protection, needed in high-risk explosion environments.

Detection and monitoring tools

Hazardous chemicals, toxic gases, and radiation need to be identified. It is required: multi-gas detector (PID *PhotoIonization Detector*), to detect solvent vapors and volatile compounds; methamphetamine detection instruments (*Field Drug Test* Kits), Chemical Kits for rapid tests on contaminated surfaces; explosive *limit meters* (LEL - *Lower Explosive Limit meters*), which measure concentrations of flammable vapors; radioactivity detectors, in case of the presence of radioactive isotopes used for advanced synthesis.

Neutralization and decontamination tools

Toxic substances must be removed to reduce the risk of contamination. The following are required: neutralizing solutions for acids and bases, to stabilize chemical spills; solvent absorbents, in granules or inert materials to contain hazardous spills; portable decontamination showers, to clean operators after the operation; and high-powered fans with *High-Efficiency Particulate Air* (HEPA) filters, to remove toxic vapors and improve air quality.

Documentation and evidence collection tools

Evidence needs to be collected for investigation without contaminating people. It requires: sealed chemical containers, with resistance to toxic and corrosive substances; swabs and kits for collecting biological samples, and for forensic analysis of contaminated surfaces; chemical-resistant cameras to safely document the scene; drones with thermal cameras to explore areas without direct operator exposure.

Tools for emergency management and first aid

It may be necessary to deal with chemical or medical emergencies in the field. Antidote kits are needed for exposure to phosgene, cyanides and other toxic substances, but also Naloxone against opioid *overdoses*; portable oxygen, for workers exposed to toxic gases; chemical burn materials, including eye washes and neutralizing creams; chemical-insulated stretchers, for safe transport contaminated people; AMBU (*Auxiliary Manual Breathing Unit*) apparatus for emergency cardiopulmonary maneuvers.

Tools for decommissioning and remediation

Work must be done to secure the laboratory and destroy illicit equipment. It is necessary to have: remote-controlled *robots* to handle chemical objects without direct operator exposure; neutralization tanks to treat chemical residues before disposal;

tools for destruction of chemical reactors and illegal containers to prevent reuse in the laboratory.

In conclusion, access to clandestine synthetic drug laboratories is a very high-risk operation that requires: advanced protection for operators to avoid exposure to toxic substances; air and chemical monitoring to identify unseen threats; contingency and decontamination plans to deal with any possible incidents; and effective destruction of the laboratory to prevent it from being reused.

3.5. COMBATING THE PHENOMENON OF CLANDESTINE LABORATORIES

The fight against the proliferation of clandestine synthetic drug laboratories requires a comprehensive, coordinated and multidisciplinary approach involving Governments, Law Enforcement Agencies, Health Institutions, and International Organizations. Some insights can be drawn from this paper and inspire a winning strategy in combating the phenomenon.

Strengthening international cooperation

Coordinate actions between countries to counter precursor chemical trafficking and synthetic drug production. Create international *task forces* e.g., between DEA (US), Europol, Interpol, other Organizations, and Local Authorities. Support bilateral agreements to monitor chemical precursors (e.g., collaboration between the U.S., EU, Mexico, and China to monitor fentanyl precursors). Increase information and *intelligence* exchange on criminal groups running production.

Example: the international operation "*Dark HunTor*" (2021) dismantled more than 150 synthetic drug trafficking on the *dark web* in cooperation between the US and Europe.

Stricter control of chemical precursors

Reduce access to key chemicals for synthetic drug production. Create updated lists of banned precursor chemicals. Digitally track precursors legally sold for industrial uses. Strengthen customs and port controls, especially for imports from countries considered at risk. Support research laboratories to develop legal alternatives to high-risk precursor chemicals.

Example: the EU has introduced stricter regulations for the control of BMK and PMK, used in the production of MDMA and amphetamines.

Dismantling clandestine laboratories with targeted operations

Reduce the number of active laboratories through coordinated law enforcement operations. Employ drones and satellites to locate hidden laboratories in forests or isolated areas. Adopt advanced technologies to detect chemical anomalies (e.g., monitoring wastewater to identify production residues). Promote specialized *task forces* for anti-drug operations, with units trained to neutralize laboratories without chemical hazards. Destroy discovered laboratories immediately, preventing equipment from being reused.

Example: in Mexico, the use of drones made it possible to locate and destroy mega-methamphetamine laboratories in the forests of Sinaloa.

Actions against organized crime

Targeting criminal groups that run synthetic drug production. Imposing economic sanctions aimed at blocking the assets of drug cartels and their financiers. Blocking suspicious financial transactions, especially via cryptocurrency. Strengthening anti-money laundering laws to track money flows from drug production. Increasing legal tools to arrest and prosecute expert chemists who collaborate with criminal organizations.

Example: the US imposed direct sanctions on Chinese suppliers of fentanyl precursors, reducing their ability to operate.

Regulation and control of the *dark web*

Restricting the sale of synthetic drugs on the *Internet*. Advanced monitoring of the *dark web* with artificial intelligence to identify sellers. Law enforcement infiltration of illegal *online* marketplaces to dismantle distribution networks. Collaboration with tech companies to shut down *marketplaces* selling synthetic drugs. Increased control over cryptocurrencies and anonymous transactions to curb drug trafficking financing.

Example: operation "*Cyber Dragon*" dismantled one of the largest drug marketplaces in the *dark web* in 2022.

Prevention and demand reduction campaigns

Reduce synthetic drug use to weaken the illegal market. Education in schools and universities about the dangers of synthetic drugs. Creation of youth information apps and platforms with up-to-date data on drugs. Harm reduction programs, such as substance purity *testing* in nightclubs to prevent fentanyl overdoses. Increased access to treatment for methamphetamine and synthetic opioid addiction.

Example: Canada has introduced drug *testing* programs at music festivals to prevent lethal consumption.

Strengthening of laws and punishment

Creating a stricter regulatory framework to deter the production and sale of synthetic drugs. Increased penalties for those who operate clandestine laboratories. Increased protection for whistleblowers who report illegal activities. Creation of an international list of criminals linked to synthetic drug production. Stricter laws against the use of cryptocurrencies to finance drug trafficking. Establishment of a specific crime for the clandestine production of drugs, regardless of the presence of the finished product.

Example: Germany introduced a law in 2023 increasing penalties for those who sell fentanyl on the *dark web*.

Synthetic drugs are a growing global threat, and their production is evolving rapidly. Only a holistic, international, and coordinated response can curb the phenomenon. An effective plan must combine repression, precursor control, prevention, education, and awareness of the threat, and technological interventions.

4. NETWORKED DRUGS, THE NEW CHALLENGE

Edited by Carabinieri Lieutenant Colonel Antonio Lombardi-
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Drug trafficking, once confined primarily to the streets and dark alleys, has adapted to the digital age, moving increasingly *online*. With the advent of the *Dark Web* and cryptocurrencies, drug trafficking has found new ways to operate anonymously and securely. Digital platforms within the *Dark Web,* so-called *Black Markets*[1], have made the drug trade accessible to anyone with an Internet connection. However, the phenomenon is not limited to the *Dark Web. Social networks*, such as Facebook, Instagram, Telegram, and others, also offer spaces for advertising, selling, and buying illicit substances through private groups and direct messages. Online drug trafficking has profound social and economic implications. On the one hand, it facilitates access to drugs for anyone with an internet-connected device, increasing the risk of addiction and health damage. On the other, it generates huge profits for traffickers, who in this particular dimension do not always, or rather, do not necessarily have an established criminal profile, but are "new crime entrepreneurs" enticed by easy profits acting behind the protective shield a monitor, thus flanking traditional organized crime that is also increasingly involved in *cybercrime*, having well understood the potential of technologies and the Internet in facilitating illicit trafficking, and among them drug trafficking, which, because of its inherent transnational dimension, lends itself well to these new prospects for growth and development.

The rapid growth of *cybercrime* recorded worldwide, triggered by the pandemic period, has revolutionized life habits, increasing the time spent *online* (*the average Internet user now spends 6 hours and 40 minutes online every day*[2]) resulting in an increase in digital skills applied in work, relational and business settings, has led,

1. These are computer resources accessible only using browsers that allow users to surf the Web in complete anonymity (TOR browsers with .onion domains). *Dark Web* resources are not indexed by common search engines and are not registered with public domain registries as they are aimed at ensuring the anonymity of users browsing them. To achieve this, the connection is "bounced" between multiple *servers*, located in different states, called nodes, so that its real origin is almost impossible to trace. In addition, the data exchanged is encrypted between nodes. Access is not free but restricted to accredited users.

2. *Global Digital Report* 2024-published by *We Are Social* in collaboration with *Meltwater*.

nationally and internationally, to a series of government initiatives aimed at mitigating potential drifts into illicit behavior.

In its Action Plan on Drugs for 2021-2025[3]4, the European Union lists among its priorities to *"Monitor drug markets on the Internet and darknet through implementation of the preparatory action proposed by the European Parliament on 24/7 darknet monitoring to achieve comprehensive results."* (Action 17)

Monitoring the *Internet*, therefore, remains essential to prevent and suppress *online* drug trafficking, starting from the assumption that only by being constantly present on the web can the Police Forces acquire knowledge, expertise and, consequently, that operational and behavioral naturalness indispensable to plumb the *web*, which has now become a boundless extension of each individual's sphere action, right down to its darkest sides. Being on the *web*, and observing the digital spaces dedicated to the marketing of narcotics, to industry forums, allows Law Enforcement to understand the dynamics and logic of a market that is constantly changing and evolving, a fundamental condition for the identification of drug traffickers and the identification of distribution routes and money flows associated with drug trafficking. Monitoring the network also helps to gather all the information that helps to educate and raise awareness of the risks associated with drug traffickingand drug use. Awareness of the presence of law enforcement on the network represents prevention and deterrence.

4.1. THE WEB AND ITS SUBDIVISION

WEB SURFACE

The Surface Web, or " surface *web*," is the portion of the *Internet* that most users explore daily. It is the most visible and public part of the *Web* and consists of sites that can be easily found through search engines such as Google, Bing, Yahoo, and others. These search engines index[4]and catalog content, making it accessible to anyone with an Internet connection.This means that they can be found easily with a simple search, since they have been included in search engine databases. The Surface Web is accessible to everyone. No special *software* or configurations are needed to navigate. Content is visible, and our every action can be tracked by the servers that host the sites. Each time a user visits a Surface Web site, the server records information such as the user's IP address (a *unique identifier of each device connected to the Internet*), the sites visited, and the duration of the visit. *Website* providers (such as companies, bloggers, and publishers) are responsible for the content they publish and must ensure that the site does not violate the law. Content providers are also responsible for the security of the data they collect from users. Users of the Surface Web are also responsible for their use of the sites.

3. See, in particular, Strategic Priority No. 3 of the European Union Action Plan on Drugs for 2021-2025, which is divided into 4 actions (17 to 20).

4. Through software (called a crawler, spider or robot), with which a search engine usually analyzes the contents of a network (or database) in a methodical and automated way. Specifically, it is a crawler/bot that acquires a textual copy of all documents on one or more web pages, creating an index that subsequently allows them to be searched and displayed.

The Surface Web consists of a wide variety of content, ranging from news, social media, e-commerce (*such as Amazon, eBay, and others*, *where users can purchase products in* direct and secure way) to blogs, entertainment sites and more. In short, users can shop online, read news, watch videos, participate in forum discussions, and interact with other people.

In the Surface Web, security is always at risk. Phishing, malware, and DDoS attacks are common, so users need to be vigilant and take precautions such as using antivirus software and secure connections (such as HTTPS). *Privacy* on the Surface Web is limited. Many websites use cookies to track user behavior and collect personal information such as location, shopping preferences, and browsing patterns. The Surface Web plays a central role in modern society, allowing quick and direct access to information, goods, and services. It is also the place where many social interactions occur, where people meet through *social media*, forums, and *chats*.

It is a platform used by companies, governments, and nongovernmental organizations to communicate with the public, promote their services, and gather *feedback* from consumers.

DEEP WEB

The Deep Web is a fundamental part of the *Internet* (accounting for 96 percent of it) that is not accessible through standard search engines. Although it is often confused with the Dark Web, which is a less regulated section of the *Web* and often associated with illegal activities, most Deep Web content is legitimate and is used for *privacy* and protection purposes. Access to the Deep Web is protected by authentication and accountability systems, with a wide range of content. This means that it cannot be easily found through a common search. Unlike the Surface Web, which is indexed and publicly visible, the Deep Web includes a wide range of content and resources that remain hidden from users who do not have authorized access or do not know the exact URL. The Deep Web includes many sites that use real-time generated content (such as custom search results or information in a database) and private corporate sites that operate internal *Web* portals or private networks (intranets) that are not visible to the public. These sites are accessible only to employees or authorized users. Many *online* services, such as *video-on-demand* platforms, magazines, or paid digital newspapers, require registration and, in some cases, payment for access. *Webmail* services and *social media* profiles that are private or accessible only to certain users are not visible in the search engine indexing process. This data is protected by authentication systems and access is allowed only to those with the appropriate credentials. The Deep Web also includes *online* banking services or other platforms where access is allowed only with secure logins, such as banking portals or electronic payment systems. Access to these areas requires strong authentication, such as *usernames, passwords,* and in some cases the use of two-factor authentication. The Deep Web offers a higher level of *privacy* than the Surface Web. Information is not visible to the public but is protected by advanced security systems. However, this does not mean that the Deep Web is immune to risk. Access to these areas is protected, but it requires constant attention to security to avoid *privacy* breaches. Traditional search engines are unable to gather information from the Deep Web, as many of these sites are not designed to be found through a generic search.

DARK WEB

The Dark Web is a hidden part of the *Internet* that is not accessible through traditional search engines such as Google, Bing or Yahoo, as it is located on closed networks generically called the Dark Net, which are within the *Internet* (which is unique!). Unlike the Deep Web, which includes a variety of legitimate and private content, the Dark Web is primarily known to contain illegal activities, but is not limited to that. Although some of its content is used for criminal activities, there are also legitimate uses, especially for those seeking a high level of anonymity *online*. The Dark Web was designed to ensure user anonymity and *privacy* of communications. Unlike the surface *Web*, where users can be identified by IP address or other tracking technologies, the Dark Web uses special networks such as Tor *(The Onion Router*) and I2P *(Invisible Internet Project*), which encrypt and remove tracking *online* activities. Tor, for example, routes Internet traffic through a network of nodes that mask the user's IP address, making it difficult to trace the origins of communications. Dark Web sites do not use the normal .com, .org, or .net domains, but rather specific domains such as .onion (for Tor) or .i2p (for I2P).

Communications and transactions on the Dark Web are encrypted to ensure that neither governments, enforcement, nor other outside parties can intercept the information. Although this makes the Dark Web a haven for those seeking anonymity, this same protection is often exploited for illicit activities. The Dark Web is decentralized and has no centralized hierarchical structure. In other words, no central Authority manages the Dark Web. This makes it more difficult for control and regulation, but also monitoring by law enforcement agencies. Because of technologies that mask the origins of *Internet* traffic, Dark Websites are not easy to detect and identify without using special tools or *software.* In addition, they often require invitations, registrations, or direct *links* to access them, which further limits visibility and access.

4.2. WHY THE DARK WEB? WHY TOR?

Freedom has a price

It is better the risk of illicit market than the limitation of the circulation of ideas

This simple concept gives the dark web a "license to live"

On the Internet, without adequate safeguards, *privacy* is vulnerable. Every online activity leaves identifiable traces: our actions on the web generate "fingerprints," such as IP addresses, timestamps[5], and other data that can be used to monitor, collect information, or even spy on *Internet* use. Although encryption helps protect the contents of communications (e.g., messages or *e-mails*), it is not sufficient to ensure complete confidentiality.

5. It is the process of generating and affixing a time stamp on a computer, digital or electronic document. The time-stamping process consists of the generation, by a trusted third party (the Accredited Certifier), of a "digital signature of the document" to which is associated the information about a certain date and time. The affixing of the time stamp makes it possible to establish the existence of a computer document as of a certain instant and to guarantee its validity over time.

While the data are protected in their content, the origin, destination, amount, and type of information transmitted can still be detected and analyzed by third parties. TOR (*The Onion Router*) is a network designed precisely to prevent this and to ensure *online privacy* and anonymity. It allows users to surf the *Internet* safely and exchange data without being tracked. TOR protects not only the content of communications but also the identity of users and their geographical location. The TOR system creates a virtual "circuit" that passes data through a series of nodes (*routers*), making it difficult to trace its path. Each node in the TOR network knows only the previous node and the next node, so it does not have access to the entire path. This process creates layers of encryption (*hence the term onion*) that protect the data. Each layer of encryption is removed as it passes from one node to the next, so not only is the content protected, but also the source and destination are hidden. TOR allows access to *websites* and *online* services that might be blocked or censored in certain geographic areas and protects against network traffic analysis by preventing browsing data from being monitored. Because traffic must pass through multiple nodes, browsing speed may slow down compared to a direct connection. Although TOR offers advanced protection, it does not guarantee absolute security. If a user is not careful, he or she may unintentionally reveal personal information.

TOR (*The Onion Router*) is free and *open-source software* that can be used by anyone who wants their *privacy* on the *Internet*. It was initially developed in the 1990s by the U.S. Navy to create a secure, anonymous network for military communications by preventing third parties from monitoring conversations between users and making it difficult to identify the source or destination of the communication. Today, it is used by millions of people around the world to defend against unauthorized data collection and to freely access online information and content. In summary, TOR is one of the most effective solutions for protecting the *privacy of online* users and escaping surveillance and tracking of *Internet* activities. In 2002, the project was released as *open-source software*, thanks to the support of the Electronic Frontier Foundation (EFF), an organization fighting for digital rights and *privacy*. The decision to make TOR accessible to everyone marked a turning point, allowing anyone to protect their *privacy* online.

Over time, TOR has become a tool used by a variety of users: activists, journalists, citizens in countries with censorship, and anyone wishing to protect their *online* identity. Today, TOR is one of the most popular networks for anonymity on the *Internet*, although it has been the subject of discussion regarding its use by users involved in illegal activities. However, the project continues to evolve, focusing on protecting *privacy* and freedom of expression *online*.

4.3. TOR PROJECT - ELECTRONIC FRONTIER FOUNDATION

The *Electronic Frontier Foundation* (EFF) is a nonprofit organization committed to protecting digital rights and freedom of expression online. Founded in 1990, EFF has become a leading voice in defense of *online privacy*, freedom of information and digital human rights, fighting for unrestricted access to information and against *Internet* censorship. EFF is also a leading advocate for *net neutrality*[6], the right to *online privacy*, and the defense of

6. It is a legal principle that, broadly speaking, a neutral network does not give differential priorities to different packets, while a "non- neutral" network does. According to the neutrality principle, *internet providers* cannot purposefully block, slow down or charge differentially for data access.

users against surveillance and abuse of power by governments and corporations. The organization provides legal support in cases of digital rights violations and also works to raise awareness about *privacy* protection, ethical use of technologies, and strengthening civil rights *online*. EFF is known for being very active in lawsuits against privacy violations, and for it constant search for solutions to defend freedom on the Internet.

TOR PROJECT

The Tor Project is a nonprofit organization that develops and maintains the Tor *software.* The project began in 2006 to create a secure network that could allow users to surf without being tracked. The Tor Project is committed to ensuring freedom of expression, privacy, and security for everyone who surfs *the Internet*, particularly for those living in contexts of censorship and repression. Tor Project is funded through donations, sponsorships, and contributions from government and private entities that support its mission to defend *privacy* on the *Internet.* In addition, Tor's *software* is *open source*, which allows independent developers to contribute and constantly improve the system.

Both the EFF and the Tor Project share similar goals regarding the protection of digital rights and *online privacy*. Both are committed to the fight against mass surveillance and censorship and promote technological solutions to preserve users' anonymity and security. EFF has played an important role in supporting Tor in its legal battles and defending the right of users to use it without being penalized or persecuted by government agencies. Together, these two organizations continue to work for a future in which *online* freedom and the right to *privacy* are respected and defended globally.

A recent example of TOR being used for legitimate purposes can be found in the ongoing conflict between Russia and Ukraine. On March 4, 2022, on the same day that Russia issued a decree by it provides "...*heavy prison sentences for anyone who publishes fake news about the military, including calls to impose sanctions on Russia*," the BBC published the following announcement, in Ukrainian, Russian and English, on the "*media center*" section of its official website: " ...*BBC news becomes available on the dark web to counter the blocking of information by the Russian authorities*..." providing directions on how to reach its site on the Dark Web.

4.4. MARKETPLACES IN THE DARK WEB: ORIGINS, EVOLUTIONS AND REVENUES

Legal Market online In the open web

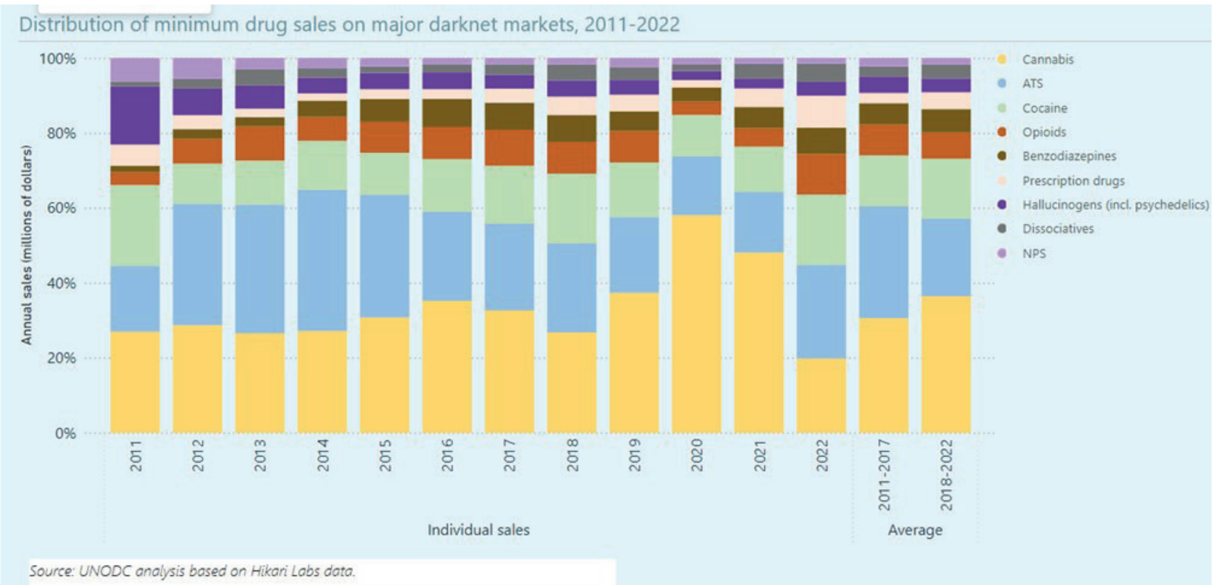
Illegal online market In the Dark Web

Darknet marketplaces are *online* platforms that enable anonymous transactions, often using the Tor network to ensure anonymity for both buyers and sellers. These marketplaces were created to provide a safe and secure channel for activities such as trading in illegal drugs, weapons, and other law-breaking goods, leveraging encryption and anonymity. In addition to advanced cryptography technologies to protect communications, payments are made in cryptocurrencies such as Bitcoin and Monero, which offer an additional layer of anonymity. The first *darknet* marketplaces emerged in the early 2000s, but the real explosion came with the birth of Silk Road in 2011. Silk Road was the first major *darknet* marketplace that popularized anonymous transactions, using Bitcoin as a payment method for anonymity. After the success of Silk Road (2011 - 2013), many other marketplaces emerged, fueled by the growing demand for anonymity and the availability of Bitcoin, which was becoming increasingly popular in the meantime. In 2013, Silk Road was shut down by law enforcement, marking a major blow to the *darknet* market, but not the end of the new criminal ecosystem that had been created. After Silk Road's closure, other markets followed in a crescendo of technological innovation in favor of ever-stronger anonymity. Some of these suffered the same fate as Silk Road and were shut down or "scammed" (*i.e., the founders stole users' funds and fled*). Some examples were Alph a Bay and Hansa, which were shut down by law enforcement in 2017. What followed was a kind of fragmentation: while large *darknet* markets had dominated the scene until then, starting in 2018, there was a proliferation of smaller and smaller *darknet* markets. There has been an increase in *scams* and competition, with new markets springing up frequently but short-lived, moving, time after time, thousands of users and sellers from one *Market* to another. Some more stable Markets have sought to improve security and reliability. Despite fluctuations in sales volumes, related to factors such as scams, voluntary closures, and enforcement actions, the *Black Market* ecosystem is still active. Between 2020 and 2022, the market experienced further frequent changes, with many markets suddenly closing or being dismantled by authorities. For example, the Empire market shut down its operations in 2020, leaving unfilled orders. Other larger markets, such as WhiteHouse, Cannazon, and Torrez, have voluntarily shut down in an orderly fashion way after achieving their profit goals. Currently, although the ecosystem of *darknet* marketplaces is less centralized than in the past, the demand for *online* anonymity continues to sustain the existence of these marketplaces with truly remarkable sales and revenues.

According to UNODC's *World Drug Report* 2024, sales in the last four years (2020 - 2023) have been increasing until 2021, declining in 2021 (*following the dismantling of Hydra Market - April 2022*) and then picking up again in 2023. In more detail, revenue (*in millions of dollars*) from drug sales broken down by years is shown below:

- year 2020= $1,910;
- year 2021= $2,700;
- year 2022= $1,400;
- year 2023= $1,600.

Going even more specific, looking at the 39 largest Markets in the period 2018 - 2022, here are the revenues (*in millions of dollars*) broken down by type of drugs trafficked in the *Dark Web* black market:



- Cannabis = 39,12 $;
- AT = 22,32 $;
- Cocaine = 17,08 $;
- Opioids = 7,54 $;
- Benzodiazepines = 6,69 $;
- Hallucinogens = 3,92 $;
- Dissociatives = 4,06 $;
- NPS = 1,8 $

4.5. SOCIAL MEDIA

The fragmentation of markets in the Dark Web has prompted many traffickers to find more flexible alternatives for their activities. *Social networks*, particularly encrypted ones and messaging platforms, have become increasingly popular tools in *online* drug trafficking. Platforms such as Telegram, Instagram, Signal, Snapchat, Wickr, Kik, and others, although used primarily for legitimate purposes, have now become true digital marketplaces for drug trafficking and other illegal activities. The characteristics of these *social networks* make them particularly attractive and suitable for illicit purposes. Encrypted messaging platforms, such as Telegram and Signal, allow secure communications between buyers and sellers, making it difficult for law enforcement to monitor conversations. Unlike marketplaces on the Dark Web, *social networks* are also accessible through regular *browsers* and do not require special technologies such as Tor. In addition, because they are public platforms, they offer a large potential audience for marketers, making it easy for them to connect with a global customer base. The platforms allow the creation of closed groups or private channels where transactions can take place relatively securely. These groups are not easily detected or monitored by the Authorities, especially when protected by measures such as two-factor authentication, *end-to-end* encryption, and a total lack of cooperation from the Companies. Drug traffickers can use *social networks* to network and promote their products through posts, stories, or thematic channels. Likewise, buyers can easily discover new suppliers and products. The increasing use of *social networks* in drug trafficking presents significant challenges for law enforcement. Not only is access to *social networks* easier than Dark Web markets, but the anonymity provided by encrypted platforms makes it difficult to identify participants in such transactions. Despite the difficulties, law enforcement agencies have begun to adapt and use advanced monitoring tools to detect and prevent illegal activities on these platforms. Some countries have introduced stricter laws against the use of social media platforms for drug trafficking, seeking to increase cooperation between companies and Law Enforcement. However, the decentralized nature of *social media* and advanced cryptography make the monitoring increasingly complicated.

More specifically, the use of *social networks* and instant messaging applications for drug marketing is spreading, especially among young people. These tools guarantee quick purchase and delivery times, as well as a high level of confidentiality. There are countless pages or groups, found on instant messaging applications ("Instagram," Telegram, Snapchat, Wickr, Kik and others), within which all kinds of drugs are advertised and offered for sale, similar to any *e-commerce* store, with instructions for safe purchase and quick and discreet delivery.

From an originally local system, *social network* trafficking is taking on a national and international character. Over the past three years, numerous investigations in this area have outlined an increasingly complex and structured system run by criminal organizations capable of extending sales and fast delivery throughout the country through the creation of a main group to which numerous local subgroups are linked using the *franchise* method. Much important information has emerged from the investigation.

To open a digital trading marketplace in a new city (*New Point*), administrators of the main channel rely on trusted customers who have made very large purchases. Through posts on the main channel, administrators recruit "guys" to run the *Point* in a given location. The channels are very profitable, and "selling" the package of loyal customers to the channel through the transfer of administrator *passwords* has emerged. Each subgroup uses a number of riders paid by the organization for deliveries. When arrested, the riders are easily and quickly replaced so as not to disrupt the business and not to lose trusted customers.

Each group has a section to leave reviews on the drug and service quality. In one of the monitored groups, some of these reviews were viewed by more than 16 thousand users. Having good reviews is one of the secrets of business success.

Group administrators provide instructions for purchasing the drugs, which are usually bought by prepayment in bitcoin. Some channels accept payment in cash: *buyer-rider*. Thus, what is emerging is a drug-trafficking system that, on the one hand, takes advantage of the opportunities and confidentiality provided by technology, while on the other hand, does not give up traditional practices involving roadside delivery and cash payment. Thus, they expand the user base without a particular exposure to risk: riders are usually unaware of the organization's top management. Another aspect that is emerging is the requirement for online buyers to identify themselves by showing documents. This poses some obstacles to *undercover* activities, as we will see better below.

5. OBSTACLES TO NETWORK INVESTIGATIONS

The ability to charge someone with engaging in activity is one of the greatest challenges facing law enforcement. While it is true that *the Internet* does not "forget," it is also true that there has never been a time when anonymity was so easily achieved. One of the main obstacles regarding network investigations is closely related to the speed of the *web* and the *darknet* dynamics. As a result, law enforcement officers (still few!) conducting investigations need constant updating, which is not always feasible quickly to deal with a complex phenomenon characterized by sophisticated technological content (*the managers/devisers of a black market are generally in possession of extensive computer knowledge*), globalization (*the buying and selling of products has no geographic limits, but occurs simultaneously in various parts of the world*) and constant innovation of and in markets (*changes in the organizational methods of a web shop are an order of day; sites dedicated to selling are characterized by a marked volatility and mutability concerning both their namesand access addresses*).

At the national and international levels, there are Police Offices capable of conducting web investigations, but they are few, with few units and usually inserted as specialized articulations in Departments at the central level. There is no network of experts within each Nation, nor among countries globally, consistently engaged in web monitoring, a need moreover emphasized by the European Commission in the Action Plan on Drugs for the period 2021-2025. The cooperation developed so far in the specific field, even with excellent results in dismantling numerous *Markets on* the Dark Web, has been carried out on individual targets that had attracted the attention of some states by organizing and adapting, from time to time, Police Offices and other actors in the specific law enforcement activity. In a drug trafficking system that exploits the boundless environment of the *Web* with the use, moreover, of technologies that guarantee a high degree of anonymity, this represents the first major limitation that, in addition to the absence of common legislation, makes the fight difficult.

5.1. LACK OF SOCIAL ALARM

Online drug trafficking, taking place in the digital world, does not cause immediate social concern. It does not frighten what is not seen! The danger and degradation that, by contrast, the "physicality" of street dealing generates is not perceived. This does not incentivize legislative initiatives or "investments" in complex investigative activities, usually time-consuming and with an uncertain outcome. In reality, the danger is closer than we can imagine, even lurking in a room of our house, from where a relative of ours can quietly organize and run a drug-dealing square from his or her desk computer or purchase substances of all kinds by having them delivered to his or her home. This is what happens in the popular German TV series "*How to Sell Drugs Online,*" which draws inspiration from a real-life story in which a young 17-year-old boy, in 2013, marketed drugs online (*mainly amphetamines and methamphetamines*) from his room under the code name "Shiny Flakes," shipping them all over Europe and generating estimated revenues of more than 4 million euros.

5.2. LIMITED USE OF COMPLEX INVESTIGATIONS AND SPECIAL OPERATIONS

It is unanimously acknowledged internationally that among the law enforcement strategies on the web, *undercover* activity has also proven to be the most effective for dismantling *black markets* on the Dark web through the detection, location and identification of administrators and sellers, as well as infiltrating groups that specialize in selling drugs on *social networks*, through the most varied instant messaging applications. Despite its recognized effectiveness and a national and international legislation that, with more or less limitations, allows the execution of this special operation, the use of this mode of operation is still modest for two main reasons:

- failure to perceive the special operation on the web with the same prudential parameters reserved for those of the traditional type, which are characterized by "close" activities that expose agents to potential risks, including physical ones. On the *web* such exposure is greatly scaled back;
- Still a small number of specially trained personnel.

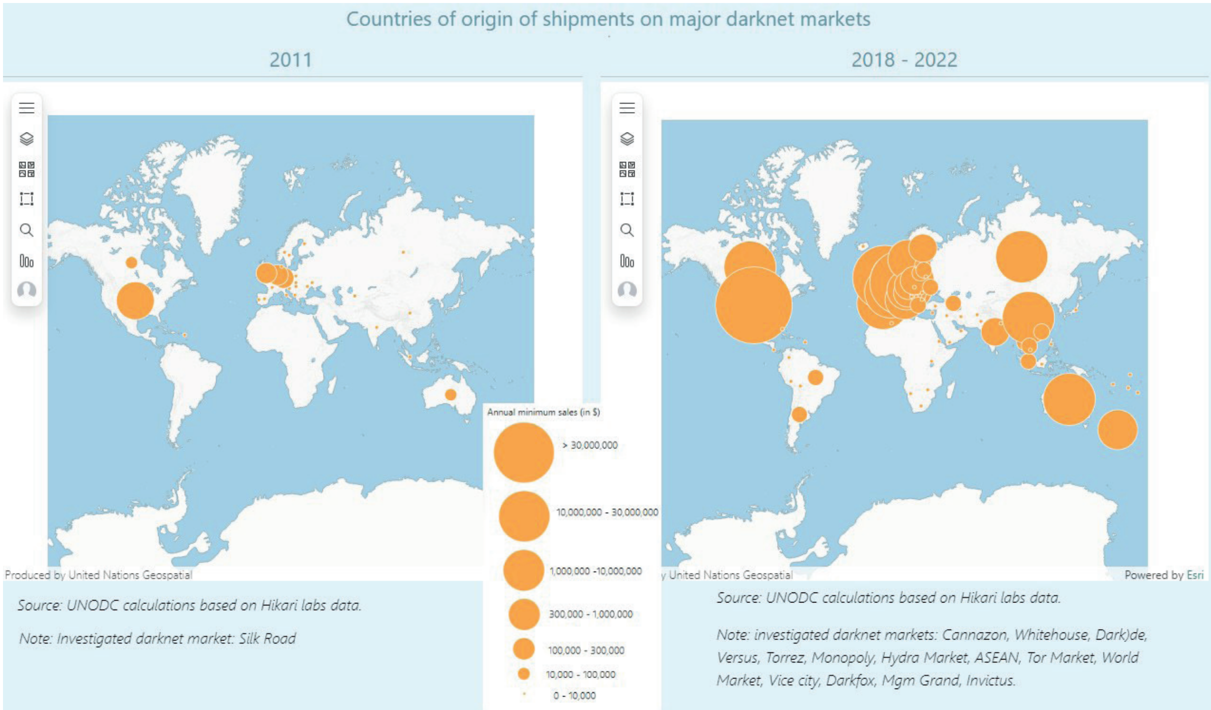
5.3. DRUG TRAFFICKING DEEMED QUANTITATIVELY "UNATTRACTIVE"

When we talk about trafficking on the Web, there is a tendency to downplay its significance by hastily associating it with the purchase of a substance for personal use. This approach, like the perceived lack of social alarm, does not incentivize law enforcement initiatives. It should be immediately clarified that, according to the latest studies and analyses[7]on market trends in *darknet* networks, while transactions below 100$, those in the 100$ - 499$ and above $1000 ranges are increasing, indicating a decrease in small buyers. This trend is to be associated with the growth and proliferation of drug markets on *social networks* and the increase in purchases of larger

7. UNODC World Drug Report 2024 (source: Chain analysis, the Crypto Crime Report - February 2022)

quantities, showing how *black markets* are still current, vital and attractive as valid and secure sources of wholesale supply.

Just to give an idea of the scale of the phenomenon, below is the graph published by UNODC in the *World Drug Report* 2024, regarding the number, with the indication of geographic areas, of shipments related to drug purchases on the Dark Web. In addition to the quantity, it is interesting to note how the online market, which started in 2011 in the United States, has over time expanded to all regions of the globe.



Detail of shipments by country

Year	Country/ territory	Annual minimum sales (in $)
2011	Australia	21110
2011	Austria	700
2011	Belgium	41624
2011	Canada	61728
2011	China	3013
2011	Czechia	810
2011	Denmark	165
2011	Finland	629
2011	France	6236
2011	Germany	101303
2011	Hungary	117
2011	India	1251
2011	Ireland	322
2011	Italy	208
2011	Montenegro	210
2011	nan	882

Year	Country/ territory	Annual minimum sal
2018-2022	Afghanistan	3075,8
2018-2022	Albania	321,4
2018-2022	Algeria	226
2018-2022	Argentina	25066,2
2018-2022	Armenia	1
2018-2022	Australia	8004220
2018-2022	Austria	326996,8
2018-2022	Azerbaijan	35993,8
2018-2022	Bahamas (the)	3
2018-2022	Bangladesh	1
2018-2022	Belarus	709,8
2018-2022	Belgium	286442,2
2018-2022	Bolivia (Plurinational State of)	387
2018-2022	Bosnia and Herzegovina	0,2
2018-2022	Brazil	55342
2018-2022	Bulgaria	4534,6

Year	Country/ territory	Annual minimum sales (in $)
2011	Norway	1590
2011	Poland	263
2011	Portugal	7
2011	Republic of Moldova (the)	86
2011	Russian Federation (the)	11
2011	Saint Kitts and Nevis	652
2011	Singapore	3
2011	Slovakia	33
2011	Slovenia	294
2011	Spain	8249
2011	Sweden	2373
2011	Switzerland	5310
2011	the Kingdom of the Netherlands	135550
2011	Ukraine	410
2011	United Kingdom of Great Britain and Northern Ireland (the	124707
2011	United States of America (the)	638289
2011	Uzbekistan	56

Year	Country/ territory	Annual minimum sal
2018-2022	Cambodia	10186,2
2018-2022	Canada	3562455
2018-2022	China	1349219
2018-2022	China, Hong Kong SAR	85167,2
2018-2022	Colombia	9675
2018-2022	Costa Rica	1505
2018-2022	Croatia	256
2018-2022	Cyprus	567
2018-2022	Czechia	273879
2018-2022	Denmark	65645,6
2018-2022	Dominica	0,2
2018-2022	Eritrea	35,8
2018-2022	Estonia	14964
2018-2022	Fiji	1
2018-2022	Finland	171402,8
2018-2022	France	3110645
2018-2022	Georgia	198,2
2018-2022	Germany	12191713
2018-2022	Gibraltar	368,2
2018-2022	Greece	46809,6
2018-2022	Hungary	1250,6
2018-2022	Iceland	23,2
2018-2022	India	129796,8
2018-2022	Indonesia	544,8
2018-2022	Iran (Islamic Republic of)	32,4
2018-2022	Iraq	9,4
2018-2022	Ireland	99719,2
2018-2022	Italy	352207
2018-2022	Japan	443,4
2018-2022	Latvia	63496,8
2018-2022	Lithuania	10359

5.4. LACK OF COMMON LEGISLATION

The globality of drug trafficking, as well as of all crimes committed online, and the absence of common legislation represent significant obstacles to the effectiveness of investigations in cyberspace. The phenomenon of *online* crime is, in fact, inherently transnational: illicit activities, such as drug trafficking, money laundering, child pornography, terrorism, and financial crimes, know no national boundaries. In this scenario, network investigations cannot be confined to the national sphere, but must necessarily be developed with a multinational approach, requiring coordination and cooperation among different Police Forces, Government Agencies, and International

Organizations. Despite collaborative efforts, both within t h the European Union and globally, the lack of common cybercrime legislation poses serious operational difficulties. Regulations governing surveillance, evidence gathering, interception of communications, and processing of personal data differ widely from country to country and often conflict with each other. For example, within the European Union, Regulation (EU) 2016/679, known as GDPR, sets strict standards for the protection of personal data, but the same regulation does not always allow investigators unrestricted access to data critical to criminal investigations, thus creating a conflict between the right to *privacy* and the need for public safety.

At the European level, police cooperation is regulated by instruments such as the Schengen Information System (SIS II and Europol, which promote the exchange of information on transnational crimes. However, despite the creation of Europol and other cooperation agencies, in many cases, the process of information exchange is hampered by internal bureaucracy within member states, legal, cultural, and political differences, and the lack of a clear definition of competencies at the international level. Added to this is the difficulty in obtaining permission to conduct investigations in other countries, an issue that creates additional delays. In many cases, for example, requests for *Mutual Legal Assistance Treaties* (MLATs) are processed with extremely long delays due to complicated, slow, and often insufficiently uniform procedures. In the absence of legally binding international treaties and universally harmonized legislation, police often find themselves operating in a rapidly changing environment where technology and *online* crime are always one step ahead of currently available regulatory and investigative tools.

6. PREVENTION AND CONTRAST ACTIVITIES ON THE NET: TOOLS AND STRATEGIES

After giving a brief overview of the limitations to network investigations, we will now address the aspects related to the tools and strategies that Governments and Police Forces have at their disposal for effective law enforcement, starting precisely from the last obstacle examined related to the globality of the phenomenon of drug trafficking on the Internet and the lack of a common legislation. From a critical issue, we need to mature an indispensable opportunity. The awareness of the absence of common legislation directs toward a more cohesive global regulatory approach and stimulates a strong push for the harmonization of laws, encouraging the development of global treaties that can facilitate international cooperation. The Budapest Convention (2001) of the Council of Europe, the first international treaty that seeks to harmonize laws against cybercrime, goes in this direction.

This convention aims to close legislative gaps by establishing common principles on how to deal with cybercrimes, particularly the production, distribution and possession of illegal content *online*, as well as improving international cooperation in the collection of digital evidence. Although not all states have yet ratified it, the Budapest Convention is a benchmark that, along with other normative and operational instruments that will be discussed below, guides states and law enforcement agencies.

6.1. INTERNATIONAL COOPERATION

One of the main characteristics of online drug trafficking, as has been repeatedly stressed, is its globality. It is a phenomenon that contextually affects the various parts of the World where the servers of the sellers are allocated or where the buyers reside, to whom the goods could be, moreover, shipped from yet another part. Law enforcement action, therefore, can only be equally globalizing and based, in addition to the specific expertise gained by the Police Forces of each nation, on concrete international cooperation, which, despite the highlighted limits, remains one of the most successful factors in countering the phenomena affecting the network and has led to important results, including the dismantling of major *black markets*.

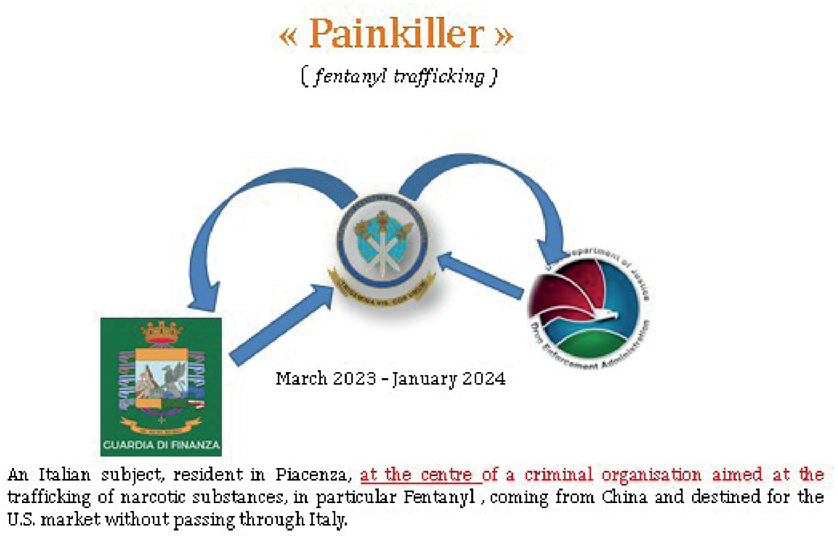
At the international level, strategic and operational measures are being taken to address the security and health implications of drug trafficking and consumption. In Europe, the creation of EMPACT (*European Multidisciplinary Platform to Combat Crime Threats*) for the coordination of counter-narcotics actions, strengthening strategic, operational, and *intelligence* cooperation among National Authorities, Institutions, EU bodies, and international partners, has been crucial. There are several O.A.'s (operational actions) in EMPACT priorities that aim to improve counter-narcotics networking by providing providing training for the acquisition of specific technological skills, including in the use of cryptocurrencies or joint actions such as Cyber Patrol.

The *United Nations Office on Drugs and Crime* (UNODC), internationally, in the fight against drugs, organized crime, corruption, and terrorism, is studying new technologies, such as artificial intelligence and robotics, concerningprevention, criminal justice, and security to meet new challenges. For this very purpose, a specialized center has been established in The Hague to analyze AI and robotics. UNODC is pursuing as an objective to increase internal expertise on the role and impact of these technologies, attempting to create a global network of experts to conduct research and capacity building to support National Authorities in exploiting the opportunities that new technologies offer. Indeed, research has shown how AI can help law enforcement agencies in overcoming critical issues in digital drug supply chain investigations or conducting more effective searches on *dark web* forums.

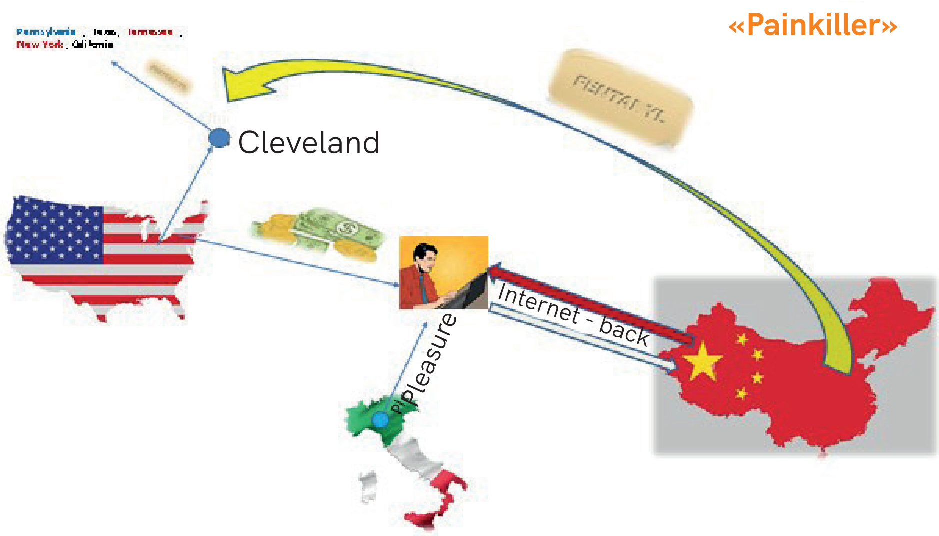
At the European level, again, several information linkage tools have been adopted over time with the aim of ensuring greater effectiveness in combating online criminal phenomena by enhancing the criterion of cooperation and collaboration between states. In particular, in 2013, having noted that in addition to terrorism, international drug trafficking (*carried out through traditional routes and methodologies)* and money laundering, organized fraud and euro counterfeiting, cybercrime also posed a serious threat to the EU's internal security, the "*European Cybercrime Centre*" (EC3) was founded - within Europol - to strengthen the law enforcement response to *cyber*crime.

The EC3 pays special attention to criminal markets found on the *dark web*, where Europol's strategy is to create a coordinated law enforcement approach with the participation of law enforcement agencies from all Member States and other partners, including - for example - Eurojust. To achieve the goal of reducing the size of the illegal economy generated by trafficking in the dark part of the *web*, the "*Dark Web Team*" operates within the EC3, which provides a comprehensive and coordinated approach in terms of information sharing, operational support, and the development of tools, tactics, and techniques for conducting *dark web* investigations. The EC3's work focuses primarily on three areas: 1) cybercrimes committed by organized crime groups; 2) cybercrimes that cause serious harm to their victims (*such as child sexual exploitation*); and 3) cybercrimes (*including cyber attacks)* that affect critical infrastructure and information systems in the Union. The Center serves as a collector of various functions such as: acting as a central *hub* for criminal information and *intelligence*; supporting Member States' operations and investigations through operational analysis, coordination, and expertise; providing a variety of strategic analysis products that enable informed decision- making at the tactical level; performing an awareness-raising function that connects law enforcement agencies on cybercrime; supporting training and capacity building in the specific area; and providing highly specialized digital forensic technical support to investigations and law enforcement operations. The team also aims to enhance joint technical and investigative actions by organizing training and capacity-building initiatives, along with prevention and awareness campaigns within a wide-ranging strategy against cybercrime.

6.2. INTERNATIONAL COOPERATION - CASE STUDY: OPERATION "PAINKILLER"



The investigation was initiated by a report from the *Drug Enforcement Administration* (DEA) liaison officer of the U.S. Embassy in Rome to the Central Directorate for Anti-Drug Services (DCSA), containing a request to identify and locate an Italian individual, who emerged in an investigation on U.S. soil, involved in the trafficking of drugs, including Fentanyl-type drugs, from China destined for the U.S. market. The investigations, carried out by Italian investigators, established the responsibility of a repeat offender, residing in a small town in northern Italy, who, acting as an intermediary, purchased the drugs (*synthetic drugs and fentanyl*), which he distributed to various international buyers abroad through postal shipments made out to untraceable senders and addressed to American recipients, with fictitious master data, traceable to a criminal group, which then marketed it, including to other states, such as Pennsylvania, Texas, Tennessee, New York, and California, and from there resold it to local distributors. In some cases, the same individual had brought Fentanyl into the United States via books with pages impregnated with said substance, even managing to introduce it into a U.S. prison.



The investigation resulted in the tracing of about 100 thousand doses packaged for individual consumption. In addition, it was ascertained that economic transactions - with a total value of more than 250 thousand euros - carried out to pay for the illicit shipments, took place through the use of cryptocurrencies (Bitcoin). The investigative context has, moreover, highlighted how the same individual from Piacenza - already implicated in international drug trafficking activities - was also at the head of a transnational organization dedicated to the production and marketing of accurately counterfeit currency (in particular Swiss Francs and Euros, both in coins and banknotes). Specifically, the individual had set up a workshop in his home equipped with printers, a lathe and other equipment for the production of very high quality coins which, with the help of other Italian and foreign accomplices, were transported to Swiss territory, using concealment methods such as double car bottoms or electric scooter batteries. In Switzerland, counterfeit coins were introduced into the legal circuit via automated sports betting machines and at Bitcoin ATMs. The reproduction of the coin was so perfect in weight, calibration, and size that it evaded the controls of the automatic machines in the Swiss state. The reconversion of bitcoins into euros was then entrusted to other entities in Eastern Europe who, once the laundering operation was completed, provided the restitution to the forger from Piacenza of the "laundered" sum minus the 7%. The investigation ended with the arrest of 7 people in Italy, 11 in the United States, and the seizure of 300 thousand euros in cash, about 26 thousand euros in Bitcoin, 2 kilograms of synthetic drugs, 70 electronic devices, 3 luxury watches, and a house. The activity in question, beyond the operational results, demonstrates the importance of synergies, information sharing, and the spirit of international cooperation between magistrates and law enforcement agencies of different states, which are essential to effectively intercept and counter all forms of illegality that go beyond their respective national borders. The same operation induces, however, the reflection of how easy it is for a single person, possessing the necessary technological skills, to manage, from a small country, a drug supply chain that, in this specific case, involved three Continents.

6.3. NAPLES II" CONVENTION

Some international conventions, in particular the one between the Customs Authorities of some European countries signed in Brussels on December 18, 1997 (*so-called NAPOLI II*), speed up the procedures of information exchange and operational support. Through this Convention, seizures made in airport areas of packages containing narcotics, likely purchased online and sent anonymously to senders given fictitious names, among other information of interest, are also reported spontaneously. The information spontaneously transmitted provides the Police Forces with useful cues for launching investigations into individuals, often incensed, who, operating in the network's guarantee anonymity, organize and manage drug-dealing squares in a halo of perceived impunity. As just pointed out, therefore, the Convention under discussion, although dated, is particularly effective in the actuality of an *online* drug trade that materializes the outcome of confidential network bargains in the complex logistical system of shipments. There is a need, however, for greater speed in information exchange. Often, due to rather long times in communications concerning the date of seizure, it is not possible to adopt the most suitable investigative solutions such as controlled deliveries, an investigative tool that would lead to the identification and arrest of the recipients of the missives, as well as the seizure of electronic equipment from which useful elements could emerge to identify the platforms that propose the sale of drugs and lay the groundwork for the location and identification of administrators and suppliers. The Convention aims at mutual assistance and cooperation between national customs authorities in preventing, detecting and prosecuting certain violations of national and European Union (EU) customs regulations. The key points are:

- cooperation in order to profitably counter transnational trafficking related to national customs laws, drugs, weapons and child pornography, etc;
- mutual assistance between Customs Authorities, provided as a result of a request for information, surveillance, investigation, or notification, or spontaneously, without prior request. Oral requests may be accepted in emergencies, but must be confirmed in writing as soon as possible;
- mutual, necessary assistance of Customs Administrations in cooperation on cross-border issues, such as: the pursuit of suspicious individuals; surveillance; covert operations; joint special investigation teams; and controlled deliveries.

6.4. EUROPEAN INVESTIGATION ORDER

Also from a judicial aspect, some instruments are based on cooperation for gathering evidence in criminal matters, including crimes committed through the use of the network. Specifically, the European Investigation Order is a judicial decision issued or validated by the Judicial Authority of one EU country, to obtain acts of investigation carried out in another EU country, to collect evidence, including electronic evidence, such as information regarding the holder of an e-mail account or date/time and content of messages exchanged through *Facebook messenger* (*all data that can be stored in an EU country other than the one that is conducting the investigation*). The Directive on the European Investigation Order in Criminal Matters was adopted on April 3, 2014, and was transposed in Italy by Legislative Decree No. 108 of June 21, 2017 (Denmark and Ireland are not bound by this instrument). The European Investigation Order is based on mutual recognition, meaning that the executing authority is required to recognize and ensure the execution of the request made by the other country. Furthermore, the execution must be carried out in the same manner as if the investigative act in question had been ordered by an authority of the executing state. Finally, the issuing authority may use a European Investigation Order if the investigative act is necessary, proportionate, and permissible in similar domestic cases. The time limits set are 30 days to decide to recognize the request, and 90 days to execute the request effectively, following adoption of the aforementioned decision. They may include, by way of example, the examination of witnesses, wiretaps, infiltration operations, and information on banking transactions. The European Investigation Order is a particularly effective judicial tool because of its inherent ability to extend the execution of judicial activities and acts abroad, with evidentiary value and in a timely manner.

6.5. JOINT INVESTIGATION TEAMS

"Joint investigation teams" are certainly another law enforcement modality that can provide network trafficking investigations with the comprehensive approach essential to make them more effective. In Italy, Legislative Decree 34/2016 provides for the establishment of a JIT at the initiative of an Italian prosecuting authority or the participation of our country in a JIT at the invitation of the competent authority of another member state, to investigate a specific criminal case of common interest. The EU legal framework contemplates the possibility of establishing Joint Investigative Teams between member states in Article 13 of the Convention on Mutual Assistance in Criminal Matters between the Member States of the European Union and in Council Framework Decision 2002/465/JHA, a decision implemented in Italy by Legislative Decree Feb. 15, 2016, n. 34. There are no limitations on the type of crime prosecuted. In addition, the requirement of "linkage between investigations" of different countries is not necessary. It is possible to set up the team even if there is only one complex investigation, which coordinates investigative action in several member states.

6.6. SPECIAL OPERATIONS: UNDERCOVER ACTIVITIES AND CONTROLLED DELIVERIES

Special network operations, as already pointed out several times, are valuable tools to be alongside traditional investigative techniques, to infiltrate and acquire useful elements on new criminal networks. In Italy, there is no specific legislation in this area. In this regard, however, the national legislature has defined some regulations that equip the Police Forces with particular tools to combat drug trafficking in the network. Law

No. 146 of March 16, 2006 (*Implementation of the United Nations Convention and Protocols against Transnational Organized Crime, adopted by the General Assembly on Nov. 15, 2000 and May 31, 2001*), in Art. 9, allows judicial police officers and agents who are conducting special operations to "*...use cover documents, identities or indications also to activate or make contact with subjects and sites in communication networks...*" as well as "*...the temporary use of movable and immovable property, cover documents, activation of sites in networks, the establishment and operation of communication or exchange areas on computer networks or systems...*" as well as delaying or omitting the adoption of certain measures against persons engaged in drug trafficking, to acquire relevant evidence, or enable the identification and arrest of the main perpetrators of criminal activities.

The delicacy of the issue and the framing of the institutions of *undercover* activities and controlled deliveries, as they are currently envisaged, matured in a transnational vision and need, deserve a brief mention of the process that determined them, also in support of the thesis so far sustained on the effectiveness of instruments that facilitate the penetration of criminal realities with global projections.

The United Nations Convention against Transnational Organized Crime is a multilateral treaty sponsored by the United Nations Organization against Transnational Organized Crime, adopted in Palermo in 2000. The said Convention has been ratified by 188 states of the *World* (*there are 208 states in the World, of which 195 are recognized as sovereign and 193 are part of the UN*). Article 20 of the Convention urged states to employ so-called special operations (*undercover operations and controlled deliveries*) to more effectively combat organized crime, serious crimes such as drug trafficking. Italy ratified the Convention with the aforementioned Law 146/2006. In particular, Art. 9 of the Law regulated in an organic, comprehensive, analytical manner the so-called special operations (*undercover operations and controlled deliveries*). Regarding undercover operations, there has been a shift, through various regulatory interventions, from the original wording of Article 97 of Presidential Decree 309/1990, which provided only the possibility for the Judicial Police to proceed with simulated acquisitions of narcotics, to an organic regulation of the matter that has unified, under a single provision, the multiple so-called *undercover* investigations of all sectoral provisions [*not only in the field of narcotics, but also in the field of crimes against public administration (extortion, bribery, disturbance of public tenders), organized activities for waste trafficking, forgery of money, counterfeiting of trademarks, extortion, money laundering, usury, weapons crimes, etc.*].

It is the case to highlight, now, some technical-operational aspects. "*Online*" undercover operations require new and specific skills and professionalism from the operator, which involves the creation of a new "profile" of "infiltrator." He must, in short, possess the following technical requirements and capabilities:

- be age-appropriate and possess specific information and knowledge about the criminal context being investigated;
- Possess computer skills to navigate within the new platforms and make payments in bitcoin;

- Have a *social* profile corresponding to the coverage that will be shown, taking care to update it periodically in order to make it credible. Must not have personal *social* profiles that could lead the undercover agent to the true identity of the operator employed;

- being able to interact at all hours with the criminal group to prevent activities carried out only during office hours from arousing suspicion in suspects.

When conducting *undercover* activities, to preserve cybersecurity and one's anonymity, it is also essential to use precautions such as:

- Do not use your personal computer or one connected to the internal office network, or shared or public WIFI connections;

- Always disconnect the *webcam* and microphone of the PC being used;

- Use a *wiping* program on the machine being used to periodically "clean" it of any *malware*;

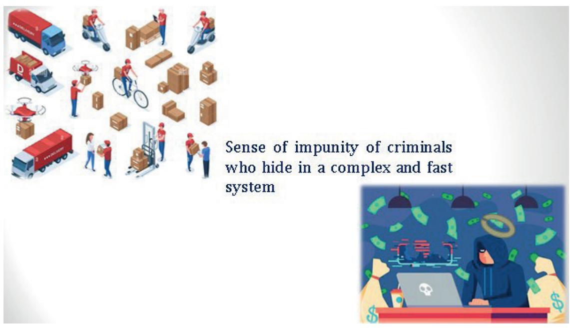
- Always start a VPN (*Virtual Private Network*) to hide your IP;

- Navigate using the Tor browser (to be updated constantly);

- Use an anonymous *e-mail account* (.onion) and a PGP key (for encrypting communications).

6.7. INTENSIFICATION OF CONTROLS ON SHIPMENTS

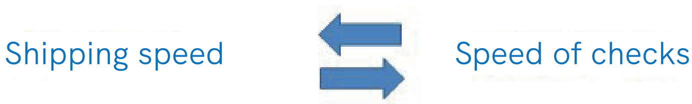
Networked drug trafficking makes use of the shipping systems provided by domestic and international couriers for distribution by nesting itself in the overwhelming number of parcel flows connected to legal *e-commerce*, that continues to grow in every part of the world.



The wide range of customized services in the parcel distribution, in addition to the legitimate advantages for the legal market, offers countless opportunities for further anonymization to traffickers and consumers who, by hiding in an exchange system based on complex and fast logistics, feel secure and perceive a sense of impunity.

Several initiatives, therefore, aimed at tackling the spread of drugs, Especially those of chemical synthesis, through the monitoring and control of postal and parcel shipments operated by major couriers to equip the Police Forces, engaged in combating the illegal narcotics market, with effective state-of-the-art tools and technologies to cope with"the new threat"; increasing the professional preparedness of police officers in the specific area of synthetic drugs. Analyses conducted both in Italy and abroad have shown that the greatest success in detecting drugs within shipments is closely related to the competence of control personnel, who generally use technologies such as X-ray sc*anners* (known as radiogenic scanners). Therefore, practical training courses in the use of such instrumentation have been enhanced.

Another aspect of absolute importance in this particular area is the speed of inspections. The domestic and international trade related to online shopping is characterized by the need for particular speed, which is a fundamental and selective requirement of this specific trading system, so this must be taken into account in inspection operations so as not to harm the shipping companies and obtain their full cooperation. Therefore, the following are necessary: agreement and cooperation between law enforcement and private shipping companies; coordination with the local judicial authority before proceeding; professional training courses; and the purchase of innovative technology.



- ✓ Agreement and collaboration between police forces and private shipping companies
- ✓ Coordination with the local Judicial Authority before taking action
- ✓ Professional training course
- ✓ Purchase of technical equipment

At the international level, there are various initiatives to establish forms of cooperation and information exchange, as this is a growing problem that knows no geographical boundaries.Therefore, controls in the specific sector havebeen intensified, increasing the awareness ofthe Police Forces to focus their attention on the phenomenon and, as part of a necessary public-private collaboration, to plan targeted searches at the collection and sorting *hubs* falling within their territory. Increased awareness of the issue, and intensified information exchange with foreign collaterals, in addition to increased expertise, also in the recognition of new synthetic drugs and methods of concealment, is yielding relevant results.

To get an idea of the scale of the problem, in the year 2023, an analysis of data held by DCSA shows that about 5,000 kilograms of drugs of various types that had been concealed in postal shipments were seizedIn particular, the following were seized:

- nationwide, 3,800 kg;
- abroad, with the final destination Italy, 1,360 kg.

Countries of origin turn out to be, for marijuana, mainly the United States and Canada (where it has been legalized) and Spain; for synthetic drugs, the Netherlands; and for cocaine, those of South America.

6.8. CONCLUSIONS

Organized and common crime have demonstrated to identify enormous opportunities on the *web*, exploiting the most advanced technologies not only to disguise their actions, but also to increase their revenues. For example, consider the use of the *dark web* environment, where illicit parallel markets have been created for more than a decade; the use of cryptocurrencies not only as a currency of exchange, but also as a means of money laundering; and the use of cryptophones to evade any kind of wiretapping and, at the same time, to plan and manage deals, and operational actions without the need physical meetings. In a time, therefore, in which crime has learned to exploit technological innovations by adapting them to its needs, it is absolutely necessary and urgent that the Police Forces increase the skills already possessed in the specific field and, above all, increase the number of Offices and specialized personnel. Only in this way itwill be possible to create a large network of experts capable of dealing with the challenges both domestically and internationally. Personnel, in short, can navigate *the web* by "patrolling" it safely; know the mechanism of operation of cryptocurrencies and flow analysis *software* in *blockchains* to intercept money laundering systems; and carry out *undercover* activities on the web.

Combating drug trafficking, in addition to the expertise of law enforcement officers, requires an integrated approach that goes beyond simple cooperation between police and judicial authorities. In a prospective vision of transnational cooperation, it is crucial to harmonize national laws, not only to facilitate intergovernmental operations but also to actively involve other actors, such as industry experts and online service providers. Digital technologies and *online* platforms have become a preferred channel for drug trafficking, necessitating collaboration between police forces, cybersecurity agencies, and private companies. *Internet* service providers, electronic payment platforms, and logistics companies must be integrated into a monitoring and prevention system that can prevent the use of their infrastructures by criminal organizations. In addition, cooperation with specialists in the field, such as cryptography specialists, artificial intelligence experts for tracking illicit financial transactions, and logistics and transportation consultants, is crucial to developing innovative and targeted solutions to counter increasingly chameleonic drug trafficking.

"If you want something you've never had,
you have to do something you've never done."
Thomas Jefferson

7. APPLICATION OF RAMAN SPECTROSCOPY IN THE FIELD OF NARCOTICS AND POLICE INVESTIGATION

Edited by State Police Deputy Superintendent Sandro Silvestre - D.C.S.A.

7.1. INTRODUCTION

Raman spectroscopy is an analytical technique that uses inelastic scattering of light to obtain detailed molecular information about a substance. Because of its ability to provide a unique chemical fingerprint, this methodology has found increasing application in forensic settings, particularly in the rapid and non-destructive identification of drugs. The use of Raman spectroscopy by law enforcement agencies represents a significant step forward in the identification, classification, and analysis of narcotics in operational scenarios.

7.2. PRINCIPLES OF RAMAN SPECTROSCOPY

Raman spectroscopy is based on the phenomenon of Raman scattering, discovered by C.V. Raman in 1928. When a beam of monochromatic light, usually a laser, interacts with a molecule, most of the light is elastically scattered (*Rayleigh* scattering). However, a small fraction of the light is scattered inelastically (approx. 1 photon per million), acquiring an energy slightly different from its original energy. This energy shift corresponds to the molecular vibrations of the sample. This shift is specific to each different molecule and is represented by a graph called the "Raman spectrum." The main features of Raman spectroscopy include:

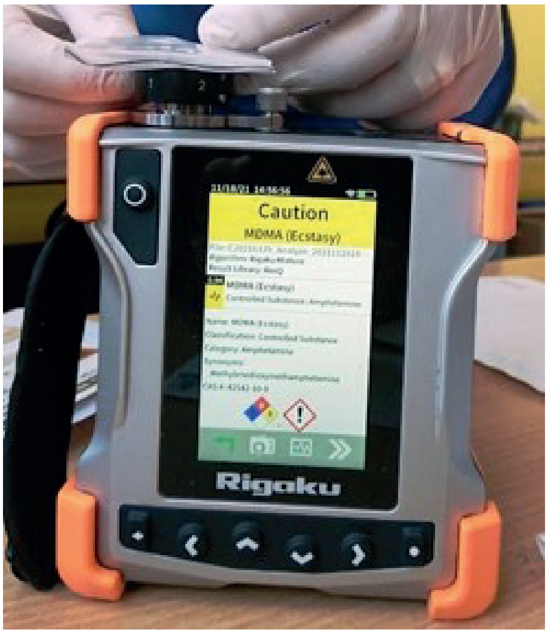
- non-invasiveness: analysis can be performed directly on the sample without the need for complex preparations;
- molecular specificity: each substance produces a unique Raman spectrum, comparable to a chemical fingerprint;

- versatility: applicable to solids, liquids, and gases;
- compatibility with portable instruments, making it ideal for a variety of field applications.

7.3. APPLICATION TO NARCOTICS AND ANALYSIS OF MIXTURES AND MATERIALS

Narcotic drugs, such as cocaine, heroin, methamphetamine, cannabis, and fentanyl, pose a serious social and health problem. The ability to detect these substances quickly, accurately, and safely is essential and of strategic importance in both the operational context of law enforcement and forensic analysis. Raman spectroscopy offers precise multiple advantages in the field of illegal substance identification, allowing a wide range of narcotics to be recognized by comparing the spectrum of the sample with a predefined database, constantly being updated. Among the most relevant features of spectroscopy, which make this technology particularly attractive, are:

- speed (analysis takes only a few seconds);
- non-destructiveness (which allows the sample to be preserved for further analysis);
- versatility (allows for analysis of powders, tablets, liquids).



A major challenge in the identification of narcotics is the presence of adulterants and diluents, such as sugar, paracetamol, or caffeine, which can mask the spectrum of the main substance. However, Raman spectroscopy, due to its sensitivity, can distinguish between different components, providing qualitative and quantitative analysis of mixtures.

Cocaine and its derivatives, for example, exhibit characteristic Raman peaks that can be easily recognized even in complex mixtures. The same is true for other narcotics, such as amphetamines and cannabinoids.

One of the most innovative applications of this technology, which is increasingly popular and used by various government agencies, is detection through *Surface Enhanced Raman Spect*roscopy (SERS) techniques. These methodologies use nanostructured metal substrates to amplify the Raman signal, enabling the elimination of fluorescence phenomena in the sample and the identification of traces of narcotics on different surfaces such as skin, fabrics, or luggage.

7.4. USE IN THE CONTEXT OF LAW ENFORCEMENT

The use of Raman spectroscopy offers numerous operational advantages for law enforcement agencies. First and foremost,portability: different models of portable, lightweight, and rugged Raman equipment have long been available, enabling analysis to be carried out directly in the field, without the need to transport samples to the laboratory.

The safety aspect is also significant: the analysis of the substance can be carried out without direct contact with it (the laser beam, which varies in intensity, can pass through containers of different materials), reducing the risks of exposure to hazardous substances, as in the case of fentanyl, for drugs, or heat-sensitive or explosive compounds.

The use of such tools "in the field" results, in other things, in undoubted time savings, as it enables operators to obtain immediate results, thus facilitating possible seizure operations and the subsequent classification of evidence.

In addition, Raman spectrometers have industry-specific "proprietary" libraries, which are updated periodically by connecting the equipment to the *Internet*.

Interesting, again, is the ability for the user to upload "*home-made*" libraries to the tool, which can then be shared with tools of the same type.

Finally, in many countries, the data provided by Raman instruments can be used as legal evidence and thus admitted in the courts because of their high reliability and reproducibility.

Despite the many advantages, there are, of course, also limiting factors to the use of Raman spectroscopy. The fluorescence, for example, emitted by some samples subjected to laser illumination may mask the Raman spectrum.

Trace sensitivity, again, is another limitation because, although SERS technologies, as mentioned above, have improved instrument sensitivity, identification of extremely low amounts of drug substance can be difficult without proper sample preparation. In addition, dark-colored and potentially thermoreactive materials, being able to absorb energy from the photons, with which they are irradiated, are inappropriate for Raman spectroscopic investigation, since raising the temperature of the sample would lead to sample degeneration and, in some cases, to fire and explosion hazards. For this reason, some Raman spectrometers, such as Rigaku's ResQ CQL *Analyzer* (supplied to DCSA and the Italian Police Corps) include the possibility of a timed scan of the sample, to allow the operator to reach a safe distance before the sample analysis begins. Finally, the costs related to purchase: Raman devices, especially portable ones, can be very expensive, which is a major limitation to their widespread use by Police Forces in some countries.

However, the fields of application of this technology are numerous. Just think of drug seizures, where the use of the apparatus allows rapid identification of the substances analyzed. Also, in the context of controls carried out by Customs Agencies, the use of Raman techniques would facilitate the detection of narcotics hidden in luggage or *containers*, as well as the control of goods sold *online*, in synergy with the actions of monitoring the buying and selling activities of illegal substances on the *Dark Web*.

Further scope may be "environmental detection," through the identification of drug traces in suspicious environments, as in clandestine laboratories.

7.5. EXAMPLES OF THE APPLICATION OF RAMAN SPECTROSCOPY

TO NARCOTICS

As mentioned above, Raman spectroscopy is widely used for the rapid and non-destructive identification of drugs. For example, the MIRA DS portable spectrometer has been successfully used to identify illegal drugs in Mexico and Los Angeles. In anti-drug operations, MIRA DS has detected the presence of fentanyl and methamphetamine in counterfeit tablets sold as Percocet, as well as high concentrations of Diazepam in illegally sold pills.

Another example involves the use of the Agilent Resolve portable system, which uses spatial *offset* Raman spectroscopy (SORS) to identify narcotics hidden behind barriers such as colored plastic or nontransparent containers. This technology enables law enforcement agencies to detect dangerous substances without having to open containers, thereby ensuring safety and efficiency in anti-drug operations.

7.6. USE OF RAMAN SPECTROSCOPY IN CARIBBEAN COUNTRIES AND ITS IMPACT ON THE OPERATION OF LOCAL AGENCIES

In Caribbean countries, combating drug trafficking is a priority, given the region's strategic geographic location along drug trafficking routes. The implementation of advanced technologies such as Raman spectroscopy can offer significant operational advantages. However, further and more detailed information would need to be found for the adoption of this technology by law enforcement agencies operating in the Caribbean, since many Caribbean nations reportedly do not yet have technologically advanced tools for rapid drug analysis. It is to be hoped that in the near future, local Police Forces and Drug Agencies will consider an increasing and progressive adoption of portable Raman devices during their operations, to improve effectiveness in drug detection and identification. In addition, international police cooperation and sharing of *best practices* between Caribbean countries and other nations already using Raman spectroscopy in anti- drug operations could facilitate the deployment of this technology in the Region, helping to strengthen counternarcotics efforts on a national and international scale, as well as generating a marked improvement in security throughout the Region.

Among other things, the standardized adoption of Raman spectroscopy in the area, in addition to bringing the already mentiones benefits, would serve as a driving force in strengthening regional cooperation:

- the introduction of a common technology, such as Raman spectroscopy, could facilitate collaboration among the many Caribbean countries and with international partners, making the exchange, even in real time, of information and data more effective.

A future development of Raman spectroscopy in the Caribbean area should necessarily include:

- dedicated training for police forces: implementation of this technology would require an investment in training to ensure that operators can properly use the tools provided;
- the creation of Local Databases: the development of customized "spectral libraries" for drugs commonly trafficked in the region could increase the accuracy, speed, and effectiveness of analysis;
- integration with Monitoring Systems: Raman spectroscopy could be integrated with drones and robots for remote monitoring of suspicious areas, such as in the case of clandestine laboratories or transit points;
- the expansion of SERS Technology: the adoption of surface-amplified Raman spectroscopy (SERS) could improve the sensitivity of the analysis, enabling the detection of trace drugs in extremely dilute samples.

7.7. PERSPECTIVES ON COUNTERING THE SPREAD OF SYNTHETIC DRUGS IN THE CARIBBEAN AREA

Raman spectroscopy is certainly a powerful tool, but not sufficient on its own to counter the spread of synthetic drugs.

The main reasons for this lie in the adaptability of the illicit trade: traffickers quickly adopt countermeasures to the new technologies brought into play, developing the most diverse methods to circumvent the relevant controls (they might use, for example, more complex packaging or chemical mixtures that mask the active substances).

The affordability of the technology poses an additional problem: the large-scale implementation of Raman spectroscopy does require a significant upfront investment, which could pose a challenge, as mentioned above, for some countries with limited *budgets*, compared to the needs of the Agencies in the field of counter-narcotics.

A further issue to consider is that of the "scale" of the problem: drug trafficking in the Caribbean is a systemic phenomenon, fueled among other things by critical issues found in the economic, social, and political spheres. Technology can obviously help mitigate its effects, but it does not can solve the root causes, such as poverty in certain social contexts, corruption, and international demand for drugs.

The Governments of Caribbean countries have undoubtedly shown increasing awareness and commitment to combating the spread of synthetic drugs in the Region, fostering synergies and collaborations in the international arena in the shared effort to combat drug trafficking.

In March 2019, for example, the United Nations Office on Drugs and Crime (UNODC) provided Jamaica with portable equipment to carry out drug testing, highlighting increased commitment in the context of international cooperation to strengthening local counter-narcotics capacity.

Furthermore, in March 2023, the Attorney General's Office of the Dominican Republic, in collaboration with the Cooperation Program between Latin America, the Caribbean and the European Union on Drugs Policies (COPOLAD III), organized a seminar on new ways to fight drug trafficking and money laundering. This event undoubtedly underscored the importance of international cooperation and the adoption of innovative and shared strategies to effectively address the challenges posed in the Region by the aforementioned issues.

7.8. CONCLUSIONS

Raman spectroscopy represents one of the most promising techniques for countering drug trafficking. Its ability to provide rapid, accurate, and safe results makes it an indispensable tool for law enforcement agencies. Although there are still technical challenges to be addressed, increasingly rapid technological advances are significantly improving the performance and accessibility of this technology.

The future will most likely bring even more widespread adoption of these investigative tools, with a significant impact on the fight against drug trafficking and abuse.

While Raman spectroscopy is, without a doubt, a significant *opportunity*, an undoubted *chance* to improve law enforcement action against drug trafficking in the Caribbean, especially in the case of synthetic drugs, it cannot, however, be considered *tout* court as a definitive solution.

Effectively addressing the problem requires an integrated approach that combines advanced technologies, such as Raman, with strategies in the socioeconomic, educational, and legal fields.

Reducing the production and consumption of synthetic drugs inevitably requires a global effort in which the Caribbean, due to its strategic location, can certainly play a key role, duly supported with state-of-the-art technological tools and programs of cooperation, for example, in the specific and targeted training of Anti-Drug Agencies and Customs personnel, as well as in the sharing of best practices.

This is the future I see for COPOLAD and for the increasingly effective and incisive role DCSA is taking on in the international arena.

BIBLIOGRAPHY

1. *Real World Raman*: identification of illegal, counterfeit, and fentanyl-related drugs: This paper describes the use of the MIRA DS portable Raman spectrometer to identify illegal drugs in Mexico and Los Angeles, highlighting the effectiveness of Raman spectroscopy in identifying drugs.

2. Characterization of materials by Raman spectroscopy (University of Siena).

3. Annual Report 2023 - Central Directorate for Anti-Drug Services: This official document provides an overview of law enforcement activities against drug trafficking in Italy, including information on analytical techniques used by law enforcement, including Raman spectroscopy.

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