Forensic Science International: Genetics 41 (2019) 50–57

Contents lists available at ScienceDirect

Forensic Science International: Genetics

journal homepage: www.elsevier.com/locate/fsigen

Research paper

The Prüm Decisions as an Aspirational regime: Reviewing a Decade of Cross-Border Exchange and Comparison of Forensic DNA Data

Victor Toom[a,*], Rafaela Granja[b], Anika Ludwig[c]

[a] Independent Scholar, Amsterdam,the Netherlands
[b] Communication and Society Research Centre, University of Minho, Portugal
[c] College of Policing, Coventry, United Kingdom

ARTICLE INFO

Keywords:
Prüm Decisions
Forensic DNA data
DNA databases
Performance
European Union
Cross-border exchange of DNA data

ABSTRACT

The automatic exchange and comparison of DNA data between national databases to combat terrorism and cross-border crime in the EU area has been facilitated by the 2008 Prüm Decisions. While it was anticipated that all EU Member States would have fulfilled the requirements by August 2011, this has not yet occurred. Once each Member State has implemented the Prüm Decisions, which is expected to occur by spring or summer 2019, the EU Commission is planning on submitting a legislative proposal to amend the Prüm Decisions, possibly broadening its scope both in terms of types of data exchanged and the number of countries involved. Therefore, it is a timely place to review the available literature on the existing data on the cross-border exchange and comparison of DNA. However, due to the limited amount of available data regarding the Prüm regime's contribution to combating crime and terrorism, this article reviews national DNA databases' contribution to national criminal justice systems before it turns to the Prüm regime. Outlining how Prüm represents an "aspirational regime" focused on a secure and safe future, we draft recommendations directed towards rendering cross-border exchange of DNA data more transparent and accountable.

1. Introduction

On 22 March 2016, a bomb was detonated at Maalbeek station in Brussels, killing twenty people.[1] In connection with the criminal investigation, automatic rifles were found in a house near Paris two days later. After re-examining the rifles in early 2018, biological traces were collected and DNA profiles were obtained. The profiles were uploaded to the French national DNA database and, on account of the Prüm Decisions, compared with DNA profiles held on national DNA databases connected to the Prüm regime. The cross-border comparison led to matches with three individuals whose DNA profiles were held on the Dutch DNA database. The suspects were arrested in the Netherlands on 18 June 2018.

This brief description highlights several significant issues regarding the cross-border exchange of DNA data. First, it provides a framework for understanding the emergence and current operation of the Prüm regime[2] —a network concerned with the exchange of data on fingerprints, DNA profiles and motor vehicle information[3] between EU Member States that made the arrest mentioned in the example possible. In brief, against the backdrop of the Schengen Agreement and the Hague Program, officials from Belgium, Germany, the Netherlands, Spain, France, Luxembourg and Austria signed the Prüm Convention on

* Corresponding author.
E-mail addresses: toomvictor@gmail.com (V. Toom), r.granja@ics.uminho.pt (R. Granja), anika.ludwig@college.pnn.police.uk (A. Ludwig).

[1] Two other bombs exploded at Brussels Airport killing twelve people; in addition, three individuals involved in the attack committed suicide when they detonated the bombs. More information is available at: http://www.standaard.be/cnt/dmf20180618_03568358; https://www.nrc.nl/nieuws/2018/06/19/drie-nederlanders-opgepakt-voor-leveren-wapens-aan-terroristen-a1607122; https://www.dw.com/en/dutch-police-use-dna-evidence-to-arrest-3-men-with-suspected-links-to-islamic-state/a-44295035 (accessed 4 October 2018).

[2] In this article we use the following terms: **Prüm Convention** refers to the 2005 Convention between 7 countries; **Prüm Decisions** refers to Council Decision 2008/615/JHA and Council Decision 2008/616/JHA that establish transnational data exchange among all EU Member States; **Prüm system** is used to refer to the actual network of EU Member States exchanging DNA data; and **Prüm regime** refers to the cross-border exchange and comparison of DNA data as well as personal information and intelligence once a match is reported, or Step 1 and Step 2.

[3] In the present article, the focus is solely restricted to the cross-border DNA exchange and comparison. Such focus allows to critically reflect upon the implications of the widespread cultural belief that forensic DNA technologies have the capacity to provide irrefutable "truth" in identifying the authors of crimes ([10]) to the Prüm regime.

https://doi.org/10.1016/j.fsigen.2019.03.023
Received 4 February 2019; Received in revised form 22 March 2019; Accepted 30 March 2019
Available online 01 April 2019

27 May 2005. The Convention intended to strengthen the cooperation between those seven countries by exchanging information to combat terrorism, cross-border crime and illegal migration. It also included a clause, leaving participation in such cooperation open to all other Member States in the European Union [1]. In 2008, the Prüm Convention was subsumed into the police and judicial cooperation provisions of the European Union Law by a Council Decision, referred to as the Prüm Decisions [2,3].[4] By means of this Decision, all EU Member States were obliged to join this network, exchanging fingerprints, DNA and vehicle registration data.

All EU Member States were expected to have fulfilled the Prüm Decisions by August 2011, but according to the latest report on the progress of the implementation of Prüm regarding DNA data exchange, there are currently only 24 EU Member States that are fully operational, and Member States have established different levels of connection for exchange [4]. Writing in March 2019, Greece, Ireland, Italy and the United Kingdom are still not operational in the Prüm regime. Reasons for not implementing the Prüm Decisions are diverse (see [5–7]), and include that countries such as Greece, Italy and Ireland did not have DNA databases or dedicated legislation when the Prüm Decisions were adopted and/or were severely hit by the economic and financial crises in 2008 and thereafter. The UK was part of Prüm when the Decision to implement it was taken in 2008, it then withdrew from Prüm in December 2014 and presently is—despite Brexit—seeking to rejoin the Prüm system and its regime ([8]; EU Council 2017, [9]). In addition, available data also shows that the level of connection is very different among countries: in 2018, the Netherlands exchanged forensic DNA data with 23 countries, whereas Denmark exchanged with only five countries [4].

The criminal case presented also outlines a second dimension of the cross-border exchange of DNA data: the arrest of the three suspects—together with numerous other "success" stories attributed to the Prüm regime[5] —further triggers the collective imagination regarding the power of forensic DNA typing in general [10,11], and the use of DNA databases and cross-border exchange and comparison in particular [12,13,6]. Such notion is underscored by a recent speech by the EU Commissioner for the Security Union, Julian King, at the Security Dialogue with the EU's Committee on Civil Liberties, Justice and Home Affairs (or LIBE Committee) where he stated that: "Over the ten years of its existence, Prüm has proven to be a very useful tool in European law enforcement cooperation that has helped to solve many serious crimes in the EU."[6] This fosters a relatively straightforward image of the success of Prüm, rendering invisible all the complexities, problems and ambiguities inherent to the implementation and operation of this extensive regime, such as issues of transparency and trust (or lack thereof), challenges related to data protection, and potential threats to civil rights such as privacy, liberty and the presumption of innocence ([14–17,12,13,5,18,6]). One of the aims of this article is to demonstrate that, while it is true that the Prüm Decisions and its regime have been regarded as useful by law enforcement agencies and helped to solve crimes in the EU, the claim of the EU Commissioner for the Security Union is problematic as quantitative and publicly accessible information to verify his claims are limited, disjointed and largely unavailable.

Third, the brief description above of the criminal case, provides some insight into the mechanisms of the Prüm Decisions and its regime, commonly referred to as Step 1 and Step 2. Step 1 focuses on the cross-border exchange and comparison of DNA data, based on a hit/no hit principle (i.e. the actual exchange of DNA data, its comparison and the result of that comparison). The matches between the traces from the rifles and the DNA reference profiles of the three individuals in the Dutch database were found and reported early 2018 due to the automated cross-border exchange and comparison in the scope of the aforementioned criminal investigation. Step 2—which goes beyond the actual automated data exchange and is governed by national law, nonetheless being a key element in the Prüm regime—regards the actions taken by the searching Member State to request personal data and other information from other countries relating to the DNA hit. Thus, in the abovementioned case, it is likely that French authorities contacted the Dutch National Contact Point requesting the personal data of the individuals linked to the matching reference profiles. Approximately six months after the initial report of the match, and following further investigation by the authorities, the three suspects assumed to be involved in the Brussels terrorist attacks were arrested; underscoring the many contingencies of cross-border exchange and cooperation in criminal investigation.

In this article we engage in a critical review of the literature on national DNA databases' contribution to the criminal justice system and on the cross-border exchange and comparison of DNA data in the context of the Prüm regime. Following Wienroth's [19] proposal, we conceptualize the Prüm Regime—both its initial implementation process and current aims to develop it further—as an "aspirational regime." According to the author: "these regimes provide context to the development and application of forensic genetic innovations by materially and discursively rationalizing and operationalizing research and technology uses at the transnational level. They are 'aspirational' since their rationales and objectives are future-orientated: to develop technologies and techno-legal systems that can solve or prevent crimes, produce state security and public safety" ([19]: 12).

Ten years after the Prüm Decisions were incorporated into EU law, we review how such an aspirational regime has, so far, developed and materialized and articulated its future-orientated objectives. Notwithstanding that the Prüm Decisions are not yet fully implemented, we outline amendments that may be introduced, such as exchanging DNA data with other, non-EU countries; a harmonization of Step 2; a modernization of Prüm's infrastructure and technology; and the exchange of additional forensic modalities. As such, the "next generation Prüm" is one defined by expansion directed towards future-oriented goals, aimed at developing technologies and exchange regimes that can help to solve cross-border crime and terrorism, thus enforcing state and public security and safety.

In this article we demonstrate that there is an overall scarcity of information about how the Prüm regime contributes to the EU's criminal justice systems. Whether or not the expansion of the Prüm regime is desirable, required or necessary is therefore hard to assess and is currently not backed-up by any accurate and publicly available information. Thus, before amendments to the Prüm regime are proposed regarding modernization, harmonization and expansion of countries and modalities, we argue that making available relevant, accurate and comparable data that renders the regime transparent and accountable should be a primary goal. While such latter issues are typically policy-driven topics, this article also speaks to scientists and caseworkers, as well as policy makers in the EU area and beyond. We regard our contribution as an introduction to the many issues and complexities that are of significance to those making decisions on strategic and operational levels regarding the future of the next generation Prüm. In lieu of publicly available, accurate and meaningful data and information regarding exchange and comparison of DNA data in the context of the Prüm regime and how it contributes to combating crimes and terrorism in the EU-area, we first review existing analyses of DNA databases' contribution to solving crime in national jurisdictions. The significance of the reviewed examples is that it is very hard to determine or measure how national DNA databases contribute to fighting crime. Such contingencies of determining added value increase when a cross-border

[4] Note that the aim of fighting illegal migration was not adopted in the Decisions.

[5] http://data.consilium.europa.eu/doc/document/ST-9823-2016-INIT/en/pdf (accessed 25 May 2018); see also [55]: 1-2.

[6] https://ec.europa.eu/commission/commissioners/2014-2019/king/announcements/commissioner-kings-speech-security-dialogue-libe-committee_en (accessed 1 October 2018).

system of connected national DNA databases is considered, as is discussed in the second section, when we review existing studies on the Prüm regime. In the third section of the article, we provide a brief insight into the past, present and future of the Prüm regime to further contextualize previously reported shortcomings of the Prüm Convention, Decisions, system and regime as well as the anticipated changes. Finally, we finish the paper by drawing conclusions and formulating some recommendations.

2. DNA databases' contribution to national criminal justice systems

The performance of forensic DNA databases is often captured in concepts such as cost-effectiveness, cost-benefit and utility analysis [20–26]. Cost-effectiveness analysis focuses on input-costs and compares for example, how much it costs to identify one suspect through DNA when compared to fingerprint analysis. Cost-benefit monetizes all inputs, outputs and outcomes and subsequently "compares competing options for spending money to identify the highest achievable net benefit" ([22]: 34). Forensic utility was first considered an important concept by the 2009 [21] report into the utility of the DNA database of England and Wales (NDNAD); defining it as "the extent to which a database produces measurable improvements in the police's performance in correctly identifying and distinguishing offenders in relation to particular reported crimes" (2009: 64). While the HGC underscored desirability of measuring utility, it highlighted the challenges faced with articulating a working definition, let alone how to measure forensic utility. Using the example of the rate of convictions of suspects found through DNA matches, they argued that while the conviction rate certainly is measurable, it does not take into account the possibility of someone being identified through other, possibly more traditional means than DNA ([21]: 65). Neither does it take into consideration cases which have not progressed to trial, or that an individual's inclusion in a database may (possibly) deter them from committing a crime. In other words, determining utility as well as the cost-effectiveness and cost-benefit of forensic DNA databases are very hard to establish and/or measure.

A number of researchers have attempted to address exactly this challenge. A study from the United States of America (USA) investigated cases involving property offences, where the analysis of DNA was randomly allocated, to measure cost-effectiveness [20]. The results of this field study provided support for the use of DNA evidence in high volume cases. More specifically, when compared with traditional investigation, the researchers found that the availability of DNA evidence led to twice as many suspects identified and arrested, and twice as many cases accepted for prosecution. They also found that DNA evidence was five times more likely to result in the identification of a suspect compared with fingerprint evidence [20]. Therefore, in the investigation of property offences, the authors concluded that DNA evidence "increases the rate at which suspects are identified, arrested and prosecuted" ([20]: 153).

Another USA study, looked at the contribution of DNA profiles uploaded to DNA databases in six USA states,[7] distinguishing between profiles derived from crime scene traces and profiles originating from reference samples provided by arrestees [27]. The authors found that, when compared with profiles obtained from arrestees, more matches were generated if profiles were uploaded of convicted offenders and more matches were found if more crime scene traces were collected and uploaded ([27]: 20). They stated that "the marginal value of adding more suspects or arrestees to the database is lower than the value of adding more crime scenes, under existing legislation" ([27]: 18). Based on these findings, the authors suggested that focusing on processing crime scene traces instead of arrestee samples is more cost-effective ([27]; see also [28]). Both studies thus support the claim that DNA evidence in criminal cases positively adds to the criminal justice system in the US, yet they also demonstrate the challenges and complexity of determining its contribution to combatting crime and its costs.

Researchers have also tried to evaluate the effect of DNA evidence on criminal justice processes. For example, work conducted in Australia which analyzed a sample of 750 completed cases (in four categories of offences: sexual crimes, serious assaults, homicides and property crimes). Half of the cases involved DNA evidence and the other half did not. In that research design, Briody [29–32]) was able to assess the effects of DNA evidence on court decision and defendant confessions. For the first three categories, he found, among other things, that DNA evidence: "emerged as a positive predictor that prosecutors would pursue cases in court, and it demonstrated a powerful influence on jury decisions to convict" ([31]: 1; see also [33]).

Attrition models[8] are often used to measure and quantify a number of stages in forensic investigation which can be expressed in terms of "matches" so that routine forensic activities and achievements can be positioned within the "overall investigative and prosecutorial 'chain' of events" ([34]: 378; see also [35]). Using data from the UK, Briody and Prenzler [31] analyzed the impact of DNA and property crimes by analyzing the ratio of convictions to reported volume crime from figures published in 2000 and 2003. By formulating a series of attrition points, the authors aimed to identify a series of stages or target points where key changes could be directed in order to improve outcomes ([31]: 76). Combining the successive attrition rates from different stages, provided a cumulative result arguing that the NDNAD was "instrumental in achieving convictions in less than 2% (0.01683) of reported burglary cases in a 'best case' scenario. If the average attendance figures of 75% attendance rate and 3% yield are used in the calculation, the result drops to 0.0089, or a ratio of convictions through DNA to reported burglaries of less than 1%" ([31]: 78). The authors concluded that the incapacitation effect of imprisonment from being identified through DNA would apply in less than 0.5 percent of reported offences and the any deterrent effect arising from imprisonments was correspondingly low.

Another mode of assessing DNA databases' value has been to estimate the so-called deterrence effect.[9] Although structural deterrence has been a major theory in criminology for decades, established results have been equivocal. For example, in one review, results are summarized as follows: "whereas some research has found support for structural, […] other work has found either no support for the theory […] or that increases in sanction threats have been associated with *increases* in crime" ([36]: 187). The deterrence effect has also been tested for individuals included in national DNA databases, with unclear results. While one study found small deterrent effects (2–3%) for robbery and burglary, it also recorded a 20–30% recidivism increase for, among others, violent crimes [37]. However, another USA study found that DNA databases do deter convicted (violent as well as property) offenders from committing new crimes ([25], 2017). More specifically, the researcher found that each (subject) profile added to the Combined DNA Index System (CODIS) "resulted in between 0.07 and 0.68 fewer serious offences" ([25]: 25). Combining information on the costs of crimes, the estimated number of prevented crimes, and the costs of maintaining a DNA database and its wider infrastructure (i.e. laboratory, software), Doleac puts forward that DNA profiling is cost-effective when considered that the social costs of crime are estimated to be $1566 per crime, while adding one DNA profile to CODIS equals $40:

"In 2010, 761,609 offender profiles were uploaded to CODIS. At $40

[7] The states are California, Florida, Illinois, New York, Texas and Virginia.

[8] Attrition can be defined as "the shortfall between the number of offences committed and the number of offenders convicted" ([66]: 1).

[9] The deterrence effect is the hypothesis stipulating that individuals will be deterred from committing crimes when they assess their risk of being arrested is high.

apiece, this cost the state and federal governments approximately $30.5 million, but saved at least $1.2 billion annually by preventing new crimes" ([25]: 25).

Doleac's results cannot be underestimated, but also raise some immediate questions. Nevertheless, her work provides more than anecdotal information regarding cost-effectiveness of DNA databases, partly caused by a net deterrent effect of having one's profile included in a DNA database.

Researchers in the Netherlands have also measured the cost-effectiveness of DNA matches. The authors in one study suggested that sampling convicted offenders positively contributed to the detection of suspects [24]. However, they were unable calculate cost-effectiveness due to the unavailability of cost data [24]: 78. Another considered the NDNAD and the DNA database in the Netherlands, and found that newly uploaded traces match a known individual in the database at a rate of 50% and 59%, respectfully [35]. The authors criticize that these numbers distort the contribution of DNA databases to solving criminal cases as they do "not answer the question in how many cases the analysis of a DNA trace actually results in the identification of a suspect through a DNA database match and which other factors are of relevance" [35]: 851. The authors argue that the type of crime scene attended should be considered. In their assessment of forensic reports related to Severe and Violent Crimes (SC, n = 116) as well as High Volume Crimes (HVC, n = 2791), the researchers concluded:

"The data show that in 3% of the SC-cases and in 1% of the HVC-cases, the DNA from the crime scene yielded a "cold hit" in the DNA database leading law enforcement to a suspect in a case, which had no previous suspects" ([35]: 855; see also [33]).

The European Network of Forensic Science Institutes (ENFSI) publishes statistical data in their survey on DNA databases in Europe. As a measure to determine the optimal database structure—here regarded as ratio between the number of DNA traces and DNA reference profiles—ENFSI records the sizes of databases, in particular in relation to the number of DNA profiles originating from traces and known individuals. Where ENFSI refers to the "stain-person matches per person" they calculate the total number of matches between stain(s) and person (s) divided by the total number of individuals included in the database. In one study, the stain-person matches per person ratio between the Dutch national DNA database and NDNAD for the year 2011 are compared [38]. Based on that measure, the databases perform more or less equally. However, if one takes into comparison the relative size of the databases, 10% and 0.74% of the English (and Welsh) and Dutch population included in the database in 2011 respectively, it is concluded that such equal performance is achieved with less infringement of privacy and bodies as well as less financial resources in the Dutch case.[10] Thus, the "Dutch model contributes to processes of criminal investigation more effectively, more efficiently and cost effectively than does the English model" ([38]: 320; see also [39,40]).

Santos and colleagues [41] used qualitative and quantitative data from nineteen countries and their databases to conclude that "DNA database's performance in terms of person-stain matches is not linked to its size in terms of individuals included" (2013: 9). The authors outline that countries with the highest proportion of their population included in the database do not necessarily hold DNA databases with a significantly higher performance than the countries with comparatively lower proportion of included individuals [41]. This finding corresponds with the recent deletion of ˜1.7 m DNA profiles from the NDNAD. Removal of such a large quantity of DNA profiles from persons has not result in fewer matches (see [42], also [43]).

[10] England and Wales and the Netherlands have very different inclusion regimes; while in the former, DNA from anyone arrested for a recordable offence will be included in the NDNAD, the latter includes DNA from specific groups of suspects and convicted offenders, see: [38].

3. Available information regarding DNA data exchange and comparison in the Prüm regime

While the above discussed studies are incomparable and sometimes draw (partly) opposing conclusions, they provided evidence of the positive effect that national (and state) forensic DNA databases have on criminal justice systems (see [33,44]). They also demonstrate the difficulty in measuring the contribution of DNA databasing in a single jurisdiction's criminal legal system and its ability to help solve crimes. Assessing the impact of DNA databases and their interconnectedness across several jurisdictions is even more complex. The diverse inclusion and retention rules resulting in different DNA typing practices (e.g. only convicted offenders are included in a database, or everyone arrested for a recordable offence, see [7,41,43,45–47]) provides a major problem. The different trajectories pertaining to legislating and setting up DNA databases is another.[11] Furthermore, the differences in the modes of organizing criminal justice systems and therewith governance of DNA databases differs between nations. Whereas in some countries a national DNA database is the responsibility of the office of the prosecutor (e.g. Belgium, Netherlands), most countries' DNA databases are police databases (e.g. Germany, England and Wales, see below; [48,12,13], 2019). Due to such and other contingencies, it is extremely hard to determine how the cross-border exchange and comparison contributes to combating crime and terrorism. This may also provide some explanation for the lack of studies attending to this issue. The limited number of studies that are available on the cross-border exchange of DNA data of the Prüm regime do not deviate much from what is known, and therefore it is important to keep this in mind when considering any discussion on the quantitative and qualitative information available in relation to Step 1 and Step 2 of the Prüm regime.

A wealth of information about the exchange and comparison of DNA data is available. Delegates attending a Working Party on Information Exchange and Data Protection (DAPIX) meeting in 2011, agreed to a model to report statistical data regarding Prüm DNA exchange and comparison. The model provides information on the size of a Member States' DNA database, the number of sent and received DNA profiles, and the number of stain-person, stain-stain and person-person matches of individual countries.[12] But this information is not consistent.[13] Assuming that each Member State annually submits this mandatory form, much quantitative information *should* be available. However, that information is not publicly accessible; and even if published on the website of the European Council of the European Union, the data is difficult to find, incomplete and very hard to compare.[14] The Prüm regime therefore challenges principles of good governance, including "efficiency and effectiveness, transparency […] and accountability,"

[11] While, for example, the Netherlands and Austria were among the first countries to adopt a database, countries like Italy and Greece were only starting the legislative process to implement DNA databases after the Prüm Decisions were established (see [6]).

[12] http://data.consilium.europa.eu/doc/document/ST-14103-2011-REV-1/en/pdf (accessed 31 May 2018).

[13] Kees van der Beek, *The Prüm System: Taking Stock of over years of transnational DNA data comparison and looking ahead*. 12 November 2018, EXCHANGE International Conference: Contemporary Challenges to Forensic Genetics in Society, Braga, Portugal.

[14] This is further exemplified by the response to a request for document 5509/18 which included information about the statistics of DNA exchange and comparison for the year 2017. The request was made by one of this article's authors while preparing a report on the Prüm Decisions commissioned by the European Parliament's Policy Department for Citizens' Rights and Constitutional Affairs at the request of the LIBE Committee Source (see [64]). The request was denied because disclosing such information was considered to "undermine the protection of the public interest as regards public security." Personal communication from: Directorate-General Communication and Information, Knowledge Management, Transparency, Head of Unit, dated 9 July 2018.

which are part of the Council of Europe 12 Principles of Good Governance.[15]

Despite such difficulties, Santos and Machado [49] were able to trace data related to DNA exchange and comparison for the years 2011 through 2015. The data deficiencies allowed them to only rank countries according to the total volume of matches, how reference samples in a national DNA database contribute to the identification of DNA trace profiles in databases of other countries, and how many matches found in a national DNA database compare to the number of cross-border matches in that country. The authors also found evidence that DNA traces from unsolved crimes in Western European countries often match DNA reference profiles included in databases of Eastern European countries [49]. Based on their study, Santos and Machado argued for the need to make more data available, including "statistics on the total profiles sent and received, the number of confirmed matches, the number of matches reported for follow-up, the number of actual followed-up criminal cases and statistics on the judicial outcomes of the cases" (2017: 309).

Another source of information regarding Step 1 exchange and comparison of DNA data is provided by the Dutch DNA database custodian. According to the 2016 annual report of the Dutch DNA database, a total number of 10,286 hits were reported between 2008 and 2016 [50]. This number simply refers to the total number of hits between traces and persons in every possible combination between every country that the Netherlands has been exchanging data with (i.e. Step 1). It is of course noted that a hit in step 1 of the Prüm regime does not mean that a person is arrested, or a crime is solved. Also, if there is a hit, this does not necessarily mean that the profile is connected to the crime. The category of "NL Trace, Foreign Person" includes the traces of unsolved crimes in the Dutch database matching a reference profile in another Member State's national DNA database. In the Netherlands, between 2008 and the end of 2016, a total number of 3876 such matches were found within Prüm step 1 [50]. These matches have the potential to be significant for authorities because, with additional analysis or specific requests for further information, they can associate names to traces, thus potentially facilitating useful information for unsolved cases (e.g. by identifying or exonerating individuals).

The scarcity of data available is made more complex by the generation of false-positive matches (i.e. matches that are invalid/untrue). The Council Decision 2008/616/JHA, from of 23 June 2008, describes the standards and technical protocol of Prüm such as norms for evaluating and reporting (no) matching. It is considered a full match when all allele values are the same (at least six full designated loci must match before a hit is considered and a response is provided). It is classified as a near match when the value of only one of all the compared alleles is different. A near match is only accepted if there is at least six full designated matched loci in the two compared DNA profiles. Regarding reporting rules full matches, near matches and 'no hits' should be reported. Considering the high volume of profiles that are available for comparison in the Prüm regime (see [6,51,52,12,13]), some practitioners and scholars consider the six (and seven) loci matching rule to be ethically problematic due to the high frequency of false-positive matches reported. Such false-positives may lead to false incrimination [53] and might also be associated with a potential pressure to confirm 'near matches' as reliable leads for subsequent police investigation [12,13,54]. On the other hand, some forensic experts argue that approximately 40% of 6-loci matches and 94% of 7-loci matches are true matches.[16] Considering that different Member States might diverge in the technical assessment of the quality of the match and in the absence of any unified criteria regarding the characteristics of the profiles that are sent under Prüm, there are clear implications to the assessment of Prüm's efficacy.

As previously mentioned, Step 2 occurs after a hit has been found and allows the searching Member State to issue a request for "personal data from the Member State administering the file, and, where necessary, to request further information through mutual assistance procedures" ([2]: 2). We found one study that considered the effectiveness of cross-border exchange and comparison of DNA data by examining Step 1 and Step 2 (see [55]). That research, based on data provided by the Dutch DNA database custodian for the year 2010, recorded the drop-out of cross-border DNA matches. For the year 2010, a total of 2020 matches were found in Step 1 for the Dutch database, 568 (or 28%) were found between foreign reference profiles and traces of unsolved crimes kept in the Dutch database. Only 138 (6.8%) matches resulted in a mutual legal assistance request, and after receiving the requested information from foreign authorities, the police were informed about 86 (4.2%) of those hits leading to 37 (1.8%) matches being deployed in a prosecution. A number of reasons for the drop-out on various levels of decision-making were given, including tactical[17], reliability[18], legal[19], priority[20] and suitability[21] ([55]: 20).

Other studies also suggest that drop-out may occur due to differences in organization and jurisdiction between the international partners [48,12,13], in press. Within the EU, the custody of DNA databases ranges from police forces to judicial authorities. As mentioned above, in most countries forensic DNA databases are under the responsibility of a government ministry generally responsible for policing and national security (e.g. the Ministry of the Interior, Ministry of Internal Affairs or Ministry of Home Affairs; see [48]). However, in Belgium, the Netherlands, Portugal and Sweden, DNA databases are governed by the Ministry of Justice, a ministry responsible for organizing the justice system and overseeing public prosecutors. Given the diverging rationales that such different entities might have in relation to crime control—police agencies work with investigative clues and intelligence [56] and prosecutors are mainly interested in rendering proof—-diverging practices emerge when submitting or responding to international legal assistance procedures [12,13]. Different criteria and practices consequently emerge. While some countries provide the non-genetic information associated to the profile after a match, others ask for additional analysis, and some countries only provide information through a judicial rogatory commission (Machado and Granja, 2019). This means the level and speed of exchange of information through Prüm regime is inconsistent contributing to a lack of equality.

4. The Prüm regime's past, present and future

Since the signing of the Prüm Convention in 2005, the Prüm regime has been the subject of critique and comments by scholars, amongst others, in social sciences, surveillance studies and law. For example, several authors observed a democratic deficit and a lack of accountability and transparency when the Prüm Convention was transposed into EU *acquis* [14,15,57–59]. From the analysis presented in this

[15] See: https://www.coe.int/en/web/good-governance/12-principles-and-eloge (accessed 19 November 2018)

[16] Kees van der Beek, *The Prüm System: Taking Stock of over 10 years of transnational DNA data comparison and looking ahead*. 12 November 2018, EXCHANGE International Conference: Contemporary Challenges to Forensic Genetics in Society, Braga, Portugal.

[17] Assessment by the custodian of the DNA database whether a match may be considered *relevant* and qualifies for follow-up in the form of a match report to the prosecutor.

[18] Assessment by the custodian of the DNA database of the *reliability* of a match in terms of its evidential value including the possibility of it being a false positive match.

[19] Assessment by the prosecutor of the *legal basis* of the DNA profile involved in a match in terms of retention and exchange.

[20] Assessment by the prosecutor of the need for a follow-up procedure subject to the *opportunity* principle.

[21] Assessment whether the foreign follow-up information received might have *prosecution value* for the case in hand.

article on more than a decade of the Prüm regime, it is clear that issues of transparency and therewith accountability remain problematic. Such is even more challenging if one realizes that, according to other authors, the EU area is increasingly managed in accordance with the emergence of a police state where a logic of crime control trumps due process [52,60,61]. While we realize that not everyone subscribes to such analyses and discourses, they are important because they provide a critical perspective on the political, legal and social legitimacy and acceptability of the Prüm regime (see [5,15,17]). Thus, there are still pressing ethical, legal and social implications of the Prüm Decisions and its regime that remain unsolved see [5,8,18,22,53,54,62,63,6].

The Prüm Decisions have not been amended or altered since their enactment a decade ago. This unaltered status of the Prüm regime is related to an informal Ministers' meeting in Germany in 2007, when it was decided that the technical implementation of the solutions already in place "must remain unchanged."[22] While it was expected that, and stipulated in, the Prüm Decisions that each Member State would be compliant by 2011, it is currently anticipated that this will not occur until the spring or summer of 2019 [64]. Once all the Member States have implemented the Prüm Decisions, it is highly likely that the Commission will propose amendments. While it is currently unknown what the Commission will decide, possible changes include: first, exchanging and comparing DNA data with other countries and partners, including South-East European countries (see below) and Europol; second, modernizing the Prüm infrastructure and technology; and third, starting the exchange of forensic data on weapons, facial recognition, missing persons and unidentified corpses[23] [64]. In addition to these modifications, the complete implementation of the Prüm Decisions may also be followed by a further harmonization of Step 2 [64]. In short, the forthcoming amendments are likely directed at enlarging the scope and depth of the so-called "next generation Prüm."

Meanwhile, on 13 September 2018 in Vienna, the Police Cooperation Convention for Southeast Europe (PCC SEE) signed a Prüm-like agreement and a memorandum of understanding on automated exchange of DNA, fingerprint and vehicle registration data[24] . Like Prüm, the agreement is aimed at "strengthening cross-border cooperation, particularly in combating terrorism, cross-border crime and illegal migration" [65]. Austria, Hungary, Bulgaria and Romania are already signatories of the PCC SEE Agreement, indicating that Prüm Member States can connect to it: "Once a positive evaluation of a Party in the context of this Agreement (Article 21) or the European Union has been made, the respective Party is entitled to apply this Agreement immediately in relation to all other Parties which also have been evaluated positively" [65].[25]

The probable enlarging of the scope and depth of the next generation Prüm, and the increasing emergence of Prüm-like agreements clearly outline how Prüm represents an "aspirational regime". Such uses are, however, "aspirational" as they are continually developing, requiring further investments in material infrastructures, including software packages, laboratory facilities, paperwork and (legal) rules and standards, and because they are orientated towards future goals, such as preventing crimes, producing state security and ensuring public safety ([19]: 12). The aspirational nature of the expansion of the Prüm regime—either the amendments to the pre-existing regime, as the expansion to other countries—is, however, based on an overall lack of available, relevant, accurate and comparable data that concretely allow for the objective, independent and systematic analyse of the Prüm regime's contribution to combating cross-border crime and terrorism, and potentially illegal migration through the PCC SEE.

5. Conclusion and recommendations

Internal borders in the EU-area have been dissolved resulting in the relatively free movement of persons and goods through the EU-area. In this context, it is important that police and judicial authorities are able to work together and exchange data on DNA, fingerprints and vehicle registration plates across borders. However, since a large volume of personal and non-personal data is circulating across borders privacy is at stake, and the potential abuse of power by states and judicial authorities remains a challenge. Therefore, it is of the utmost importance for European democracy that accurate information is made publicly available for review and analysis. This is currently not the case—the information that is available is incomplete, hard to find, and mostly incomparable. Thus, the utility and efficacy of the Prüm regime cannot effectively be measured in a meaningful way by independent parties, making it impossible to answer the question whether the Prüm regime is a proportional crime control mechanism.

Against the backdrop of a deficiency of verifiable and quantitative information about the Prüm regime's performance, we also referred to the critique that the Prüm Decisions and its regime have triggered. Scholars in law, the social sciences and activists, to mention only a few, have criticized Prüm for a lack of democratic scrutiny, challenged its legitimacy, aired concerns about privacy protection, and feared a further expansion of the EU as being managed in accordance with crime control mechanisms. As such, there are serious concerns about mechanisms providing or facilitating the Prüm regime and its practitioners' trustworthiness. These issues have been raised for over a decade yet remain largely unresolved and lies directly in contrast with the Council of Europe's 12 principles of Good Governance.

These concerns over accountability and transparency, pose further questions to the anticipated expansion of the Prüm regime, through exchanging new modalities and connecting with new countries. Based on our review, we would consider it beneficial to amend the 2008 Prüm Decisions only after a rigorous evaluation of the Prüm regime. Such evaluation should be based on quantitative, reliable and verifiable data in combination with qualitative information, such as studies based on the perspectives of professionals directly involved in Prüm [12,13]. By publishing those evaluations as well as the data underpinning them, would, in our view, be a significant step in strengthening analyses of the Prüm regime's efficiency and effectiveness while at the same time improving transparency and accountability.

Acknowledgement

The European Parliament's Policy Department for Citizens' Rights and Constitutional Affairs at the request of the LIBE Committee commissioned a study (IP/C/LIBE/IC/2018-059) entitled Cross-border exchange and comparison of Forensic DNA Data in the Context of the Prüm Decision. The current article is based on that study. The article has furthermore received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement N.º [648608]), within the project "EXCHANGE – Forensic geneticists and the transnational exchange

[22] See https://www.parlementairemonitor.nl/9353000/1/j4nvgs5kjg27kof_j9vvij5epmj1ey0/vi3aqkaxuix2/f=/blg11264.pdf (accessed 11 October 2018).

[23] Under Prüm only 'stains' (unknown samples recovered from crime scenes that are not mixtures) and 'person' (reference) profiles are shared, however, some countries have sent profiles from unidentified bodies as 'stains' in order to aid in identification of the individual (see [67]). Several Prüm countries have been collecting such data and exchanging them, which potentially leads to missing persons being found and identified thereby providing answers to surviving family members about the status of their vanished kin.

[24] The agreement was signed by Albania, Austria, Bulgaria, Hungary, Macedonia, Moldova, Montenegro, Romania and Serbia.

[25] Bordering on but not within the remits of the Prüm Decisions are the bilateral agreements that many European as well as other countries have made to connect their databases with the USA Combined DNA Index System (CODIS). In 2014, Belgium, Austria, Switzerland, Czech, Germany, the Netherlands, Finland, Spain, Estonia, Greece, Denmark, and South Korea were known to have made such arrangements with the USA but DNA has thus far not been exchanged (see [61]).

of DNA data in the EU: Engaging science with social control, citizenship and democracy" led by Helena Machado and hosted at the Communication and Society Research Centre, Institute for Social Sciences of University of Minho (Portugal). The views expressed in this paper are those of the authors alone and do not necessarily reflect the organizations they represent.

References

[1] EU Council, "Prüm Convention." Official Journal of the European Union. Brussels, EU Council, 2005, pp. 1–44.
[2] EU Council, Council Decision 2008/615/JHA, of 23 June 2008, on the Stepping Up of Cross-border Cooperation, Particularly in Combating Terrorism and Cross-border Crime, Official Journal of the European Union 210 (2008) 1–11.
[3] EU Council, Council Decision 2008/616/JHA of 23 June 2008 on the implementation of Decision 2008/615/JHA on the stepping up of cross-border cooperation, particularly in combating terrorism and cross-border crime, Official Journal of the European Union 210 (2008) 12–72.
[4] EU Council, Prüm decisions: presidency progress report, Official Journal of the European Union (2018) 1–6.
[5] C. McCartney, T. Wilson, R. Williams, Transnational exchange of forensic DNA: viability, legitimacy, and acceptability", Eur. J. Crim. Pol. Res. 17 (4) (2011) 305–322.
[6] B. Prainsack, V. Toom, Performing the Union: the prüm decision and the european dream, Stud. Hist. Philos. Biol. Biomed. Sci. 44 (1) (2013) 71–79.
[7] F. Santos, Overview of the Implementation of the Prüm Decisions, Report, available: (2016) (last accessed 14 January 2019), https://eg.uc.pt/handle/10316/41091.
[8] A.O. Amankwaa, Trends in forensic DNA database: transnational exchange of DNA data, Forensic Sci. Res. (2019), https://doi.org/10.1080/20961790.2019.1565651.
[9] Council of the European Union, Clarification on DNA Concerns Raised at Previous DAPIX Meetings (Brussels, 12 April 2018). Available at: (2018) (accessed 2 January 2019), http://www.statewatch.org/news/2018/apr/eu-council-dna-concerns-7772-Rev-1-18.pdf.
[10] M. Lynch, S.A. Cole, R. McNalley, L. Jordan, Truth Machine. The Contentious History of DNA Fingerprinting, The University of Chicago Press, Chicago and London, 2008.
[11] R. Williams, DNA databases and the forensic imaginary, in: R. Hindmarsh, B. Prainsack (Eds.), Genetic Suspects. Global Governance of Forensic DNA Profiling and Databasing, Cambridge University Press, Cambridge, 2010, pp. 131–152.
[12] H. Machado, R. Granja, Ethics in transnational forensic DNA data exchange in the EU: constructing boundaries and managing controversies, Sci. Cult. (Lond) 27 (2) (2018) 242–264.
[13] H. Machado, R. Granja, Police epistemic culture and boundary work with judicial authorities and forensic scientists: the case of transnational DNA data exchange in the EU, New Genet. Soc. (2018) forthcoming.
[14] T. Balzacq, From a Prüm of 7 to a Prüm of 8 +: What Are the Implications? Policy Department C Citizens Rights and Constitutional Affairs (2005) 1–7.
[15] T. Balzacq, D. Bigo, S. Carrera, E. Guild, The treaty of prüm and EC treaty: Two competing models for EU internal security, in: T. Balzacq (Ed.), 2006) *Security Versus Freedom?* A Challenge for Europe's Future, Routledge, 2006, pp. 129–150.
[16] P. De Hert, S. Gutwirth, Interoperability of police databases within the EU: an accountable political choice? International Review of Law, Rutgers J. Technol. Law 20 (1–2) (2006) 21–35.
[17] P. Luif, The treaty of prüm: a replay of Schengen? In European Union Studies Association, Tenth Biennial International Conference (2007) Retrieved from http://aei.pitt.edu/id/eprint/7953.
[18] B. Prainsack, V. Toom, The Prüm regime. Situated dis/empowerment in transnational DNA profile exchange, Br. J. Criminol. 50 (6) (2010) 1117–1135.
[19] Matthias Wienroth, (online first). "Socio-Technical Disagreements as Ethical Fora: Parabon NanoLab's Forensic DNA Snapshot™Service at the Intersection of Discourses around Robust Science, Technology Validation, and Commerce, BioSocieties (2018) 1–18.
[20] J.K. Roman, S. Reid, J. Reid, A. Chalfin, W. Adams, C. Knight, The DNA Field experiment: cost-effectiveness analysis of the use of DNA in the investigation of High-volume crimes, Urban Institute Justice Policy Centre: NIJ U.S, Department of Justice, 2008.
[21] Human Genetics Commission, Nothing to hide, nothing to fear? Balancing Individual Rights and the Public Interest in the Governance and Use of the National DNA Database, Human Genetics Commission., London, 2009.
[22] C. McCartney, Trans-national exchange of forensic (bio) information, in: G. Bruinsma, D. Weisburd (Eds.), Emerging Issues in International Forensic Bioinformation Exchange, University of Leeds, London, United Kingdom: Springer, 2010, pp. 1–27.
[23] D.B. Wilson, D. McClure, D. Weisburd, Does forensic DNA help to solve crime? The benefit of sophisticated answers to naive questions, J. Contemp. Crim. Justice 26 (4) (2010) 458–469.
[24] M.D. Taverne, J.F. Nijboer, M.F. Abdoel, S. Faroq, DNA In De Databank: De Moeite Waard? Een Procesanalyse Binnen De Strafrechtsketen Met Het Oog Op De Effectiviteit En Efficiëntie Van De Toepassing Van De Wet DNA-onderzoek Bij Veroordeelden" (DNA in the Database: Worth the Effort? a Process Analysis Within the Chain of Criminal Investigation With a View on Effectiveness and Efficiency Applying the Law on DNA Research on Convicted Offenders), WODC, Den Haag, 2013.
[25] J.L. Doleac, The effects of DNA databases on crime, Am. Econ. J. Appl. Econ. 9 (1) (2016) 165–201.
[26] A.O. Amankwaa, C. McCartney, The effectiveness of the UK national database, Forensic Science International: Synergy (2019), https://doi.org/10.1016/j.fsisyn.2019.03.004.
[27] J. Goulka, C. Matthies, E. Disley, P. Steinberg, Toward a Comparison of DNA Profiling and Databases in the United States and England, Available from RAND Corporation, Santa Monica, CA, 2010https://www.rand.org/content/dam/rand/pubs/technical_reports/2010/RAND_TR918.pdf.
[28] Home Office, Forensic Science and Pathology Unit, DNA Expansion Programme 2000–2005, Reporting Achievement, London, 2005.
[29] M. Briody, The effects of DNA evidence on homicide cases in court, Current Issues Criminal Justice 14 (2) (2002) 159–181.
[30] M. Briody, The Effects of DNA Evidence on Homicide Cases in Court, Aust. N. Z. J. Criminol. 37 (2) (2004) 231–252.
[31] M. Briody, T. Prenzler, D.N.A. Databases and Property Crime: A False Promise? Aust. J. Forensic Sci. 37 (2) (2005) 73–86.
[32] M. Briody, The effects of DNA evidence on property offences in court, Current Issues in Criminal Justice 17 (3) (2006) 380–396.
[33] J.M. Anderson, C. Matthies, S. Greathouse, A.V. Chari, The unrealized promise of forensic science – an empirical study of its production and use, Ssrn Electron. J. (2018), https://doi.org/10.2139/ssrn.3178156.
[34] R. Williams, J. Weetman, Enacting forensics in homicide investigations, Policing Soc. 23 (3) (2012) 376–389.
[35] A.A. Mapes, A.D. Kloosterman, C.J. Poot, DNA in the criminal justice system: the DNA success story in perspective, J. Forensic Sci. 60 (4) (2015) 851–856.
[36] Robert J. Kane, On the limits of social control: structural deterrence and the policing of 'Suppressible' crimes, Justice Q. 23 (2) (2006) 186–213.
[37] A. Bhati, C.G. Roman, Evaluating and quantifying the specific deterrent effects of DNA databases, Eval. Rev. 38 (1) (2014) 68–93.
[38] V. Toom, Forensic DNA databases in England and the Netherlands: governance, structure and performance compared, New Genet. Soc. 31 (3) (2012) 311–322.
[39] A.O. Amankwaa, Forensic DNA retention: public perspective studies in the United Kingdom and around the world, Sci. Justice 58 (6) (2018) 455–464.
[40] David Skinner, Matthias Wienroth, Was this an ending? The destruction of samples and deletion of records from the UK police national DNA database, In press, Br. J. Hist. Sci. (2019) 1–26 retrieved from https://eprint.ncl.ac.uk/254864 (last accessed 22 March 2019).
[41] F. Santos, H. Machado, S. Silva, Forensic DNA databases in European countries: is size linked to performance? Life Sciences, Society and Policy 9 (1) (2013) 1–13.
[42] A.O. Amankwaa, C. McCartney, The UK national DNA database: implementation of the protection of freedoms act 2012, Forensic Sci. Int. 284 (March) (2018) 117–128.
[43] H.M. Wallace, A.R. Jackson, J. Gruber, A.D. Thibedeau, Forensic DNA databases – ethical and legal standards: a global review, Egypt. J. Forensic Sci. 4 (3) (2014) 57–63.
[44] A.A. Mapes, C. de Poot, A. Kloosterman, De Rol Van DNA Bij Het Vinden Van Een dader, Tijdschr. Voor Criminol. 56 (3) (2014) 29.
[45] M. Cho, P. Sankar, Forensic genetics and ethical, legal and social implications beyond the clinic, Nat. Genet. 36 (11 Suppl) (2004) S8–12.
[46] N. Van Camp, K. Dierickx, National Forensic Databases: Social-ethical Challenges & Current Practices in the EU, Available at European Ethical-Legal Papers, Leuven, 2007 (accessed 21 July 2017), http://www.academia.edu/attachments/6227872/download_file.
[47] H. Machado, S. Silva, Voluntary participation in forensic DNA databases: altruism, resistance, and stigma, Sci. Technol. Human Values 41 (2) (2016) 322–343.
[48] PIES, PIES Project – 4000002150 – Final Implementation Report, National Institute of Criminalistics and Criminology, Brussels, 2016.
[49] F. Santos, H. Machado, Patterns of exchange of forensic DNA data in the European Union through the Prüm system, Sci. Justice 57 (4) (2017) 307–313.
[50] NFI, Nederlandse DNA-Databank. Jaarverslag 2016. Den Haag: Nederlands Forensisch Instituut, (2017).
[51] K. Van der Beek, Forensic DNA Profiles Crossing Borders in Europe (Implementation of the Treaty of Prüm), Profiles in DNA, Promega, 2011.
[52] E. Topfer, "Network with errors": Europe's emerging web of DNA databases, StateWatch Analysis (2011).
[53] C. McCartney, Forensic data exchange: ensuring integrity, Aust. J. Forensic Sci. 47 (1) (2014) 36–48.
[54] C. McCartney, Transnational exchange of forensic evidence, in: G. Bruinsma, D. Weisburd (Eds.), Encyclopedia of Criminology and Criminal Justice, Springer, New York, 2014, pp. 5302–5313.
[55] M.D. Taverne, T. Broeders, The Light's at the End of the Funnel! Evaluating the Effectiveness of the Transnational Exchange of DNA Profiles Between the Netherlands and Other Prüm Countries, Parish Legal Publishers, Zutphen, 2015.
[56] M. Innes, N. Fielding, N. Cope, The appliance of science?: the theory and practice of crime intelligence analysis", Br. J. Criminol. 45 (1) (2005) 39–57.
[57] E. Guild, Memorandum. Prüm: an Effective Weapon Against Terrorism and Crime? edited by House of Lords, London, 2007.
[58] R. Bellanova, The 'Prüm process': the Way forward for EU police cooperation and data Exchange, in: E. Guild, F. Geyer (Eds.), Security Versus Justice? Police and Judicial Cooperation in the European, Union. Farnham, Surrey, Ashgate, 2008.
[59] D. Bigo, S. Carrera, E. Guild, R.B.J. Walker, The Changing Landscape of European Liberty and Security: The Mid-term Report of the CHALLENGE Project, Int. Soc. Sci. J. 59 (192) (2008) 283–308.
[60] T. Bunyan, Just over the horizon: the surveillance society and the state in the EU, Race Cl. 52 (3) (2010) 1–12.
[61] V. Toom, Trumping communitarianism. Crime control and forensic DNA typing and

Databasing in Singapore, East Asian Sci. Technol. Soc. Int. J. (2014) 273–296.
[62] C. McCartney, Opting in and opting out: doing the hokey cokey with EU policing and judicial cooperation, J. Crim. Law 77 (2013) 543–561.
[63] S. Hufnagel, C. McCartney, Police cooperation against transnational criminals, in: N. Boister, R.J. Currie (Eds.), Routledge Handbook of Transnational Criminal Law, Routledge, Oxon and New York, 2015, pp. 107–120.
[64] V. Toom, Cross-Border Exchange and Comparison of Forensic DNA Data in the Context of the Prüm Decision. European Parliament, Brussels, 2018http://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL_STU(2018)604971.
[65] PCC SEE, Agreement between the parties to the police cooperation convention for Southeast Europe on the automated Exchange of DNA data, Dactyloscopic Data and Vehicle Registration Data, Police Cooperation Convention for Southeast Europe., Vienna, 2018.
[66] J. Burrows, M. Hopkins, A. Robinson, M. Speed, N. Tilley, Understanding the Attrition Process in Volume Crime Investigation. (Home Office Research Studies 295). Home Office: London, Available from (2005) https://www.gov.uk/government/publications/understanding-the-attrition-process-in-volume-crime-investigations.
[67] S. Romano, The Italian Legal Framework for the Management of Missing Persons and Unidentified Dead Bodies, and the Rights of the Relatives: Italian Legal Briefing, available from (2016) http://www.mediterraneanmissing.eu/wp-content/uploads/2015/10/Mediterranean-Missing-Italian-legal-memo.pdf.