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The sharing of ballistics data across Europe and neighbouring territories

F. Jeane Gerard[a], Rebecca L. Crookes[b], Susan Elliott, Michael Hellenbach[c], Athanasios Stamos, Helen Poole[d] & Erica Bowen[e]

Correspondence regarding this article should be sent to Jeane Gerard at the Centre for Research in Psychology, Behaviour and Achievement, Coventry University, Priory Street, Coventry. CV1 5FB. United Kingdom; jeane.gerard@coventry.ac.uk

F. Jeane Gerard
[abce]Centre for Research in Psychology, Behaviour and Achievement
Coventry University
Priory Street
Coventry
CV1 5FB
United Kingdom
jeane.gerard@coventry.ac.uk

Rebecca L. Crookes
Centre for Research in Psychology, Behaviour and Achievement
Coventry University
Priory Street
Coventry
CV1 5FB
United Kingdom
becky.crookes@coventry.ac.uk

Susan Elliott
Centre for Research in Psychology, Behaviour and Achievement
Coventry University
Priory Street
Coventry
CV1 5FB
United Kingdom

Michael Hellenbach
Centre for Research in Psychology, Behaviour and Achievement
Coventry University
Priory Street
Coventry
CV1 5FB
United Kingdom

Athanasios Stamos
Centre for Research in Psychology, Behaviour and Achievement
Coventry University
Priory Street
Coventry
CV1 5FB
United Kingdom

Helen Poole[1]
[d]School of Health, Life and Social Science
Coventry University
Priory Street
Coventry

[1] Dr Helen Poole is now at the University of Northampton: Ashton Building, Park Campus, Boughton Green Road, Northampton NN2 7AL United Kingdom

CV1 5FB
United Kingdom
Helen.Poole@northampton.ac.uk

Erica Bowen[2]
Centre for Research in Psychology, Behaviour and Achievement
Coventry University
Priory Street
Coventry
CV1 5FB
United Kingdom
E.Bowen@worc.ac.uk

[2] Prof. Erica Bowen is now at the University of Worcester. National Centre for the Study and Prevention of Violence and Abuse (NCSPVA). Institute of Health and Society. University of Worcester (BB199). Henwick Grove. Worcester. WR2 6AJ

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Abstract

The current study explored the use of ballistic examinations and cross-border information sharing across 14 European countries. The presented data were collected using a mixed methods technique consisting of semi-structured interviews and questionnaires that were completed by participants. The results painted a very heterogeneous picture of the use of automated ballistic systems across these countries, as well as how ballistic analyses are integrated in the fight against gun-enabled crime. Three super-ordinates themes emerged from the thematic analysis: use of automated ballistic systems; Ballistic evidence recovery and analysis; knowledge exchange and best practices. The ability to draw firm conclusions regarding the value of ballistics comparison systems, either on a national or cross-border basis, is hampered by inconsistencies regarding data recording practices and definitions. Therefore, key recommendations are suggested to establish better cross border cooperation between member states and develop a better understanding of data sharing procedures.

Keywords: Firearm; Ballistic evidence sharing; European ballistic database; Open case file; Cross-border comparison

1. Introduction

Previous research has illustrated the importance of sharing ballistic evidence across borders [1]. The use of automatic ballistic comparison systems is now commonplace within forensic labs, enabling quick comparison of recovered bullets and cartridge cases from crime scenes to a database. When analysing ballistics evidence, ballisticians must examine and compare the unique markings that are transferred onto the bullets and cartridge cases when fired from a firearm. This is known as 'rifling', in which unique lands and grooves are indented on the bullet as a result of traveling through the barrel of the gun. Additionally, markings and impressions can be made by the firing pin, breech face and ejector/extractor marks on the cartridge cases [2]. These markings provide essential evidence for linking bullet/cartridge cases to guns.

Further, experts are able to link firearms to crimes by comparing these unique markings. Therefore, many forensic institutes maintain what are known as open case files (OCF), where exhibits (i.e. bullets and cartridge cases) from unsolved crimes are stored [3]. Confiscated guns can be test fired to compare the projectile with the OCF, as well as new evidence found on crime scenes, to find potential "links". The exhibits of an OCF are organised according to "class characteristics": *for bullets, these characteristics include the calibre, number, and direction of land impressions together with their width and pitch; for cartridge cases, characteristics include the calibre, shape of firing pin impression, breech face impression, and the position and shape of ejector and extractor marks* (pp238) [1]. However, figures reported on ballistic analyses and the prevalence of their use to combat GEC are missing.

The manual search using microscopes can be used in conjunction with automated systems to compare markings. As such, the use of automated ballistic comparison technology enables ballisticians to compare bullets/cartridge cases at a much faster rate and to combat gun crimes by linking firearms to crimes [4], known as hits. Ballistic automated comparison systems enable the conversion of spent cartridges and bullets in a two- or three-dimensional image that will be used to compare to other pieces of evidence recorded on the system. As such, correlation scores will be typically calculated for the firing pin impression, breech face, and ejector mark and ranked according to the most likely match on the system for cartridge cases to the least likely match. The most likely matches will be compared by ballistic examiners and confirmed in order to establish the presence of a hit [5]. Correlations are calculated using computer algorithms, in which images

of ballistic material are compared the content of OCF to run a correlation process, leading to a "hit list" ranking potential matches to the item being considered. Therefore, the number of hits that were identified by each country concern cases in which a spent cartridge or a bullet retrieved in a criminal investigation were matched with an item stored in the OCF within the country. There are two types of hits: "warm" hits that are investigative or intelligence-led, whereby investigators indicate a probable connection; and "cold" hits, in which a link or identification is made when no previous intelligence existed [1]. De Ceuster et al. [1] noted that OCFs are of great value when finding "cold" hits. The process of double casting (making microscopic quality replicas from ballistic evidence), has also been used as an alternative to sending original evidence for the purpose of international comparison or linking previous crimes, as well as in situations whereby the ballistic systems used were not interoperable between the interested parties [11].

However, De Ceuster et al. [1] highlighted numerous limitations of ballistics comparison systems, such as: the limited capabilities of the correlation algorithms; the size of the database reducing the 'hit' rate as it increases, the creation of 'noise' by non-relevant evidence in large databases; the correlations influenced by factors such as the material in which the bullet or cartridge case was made or the presence of lacquer on the casing. Due to numerous limitations found with regard to the correlation efficiency, De Ceuster et al. [1] concluded that the use of cross-border sharing systems had little value at that time.

Despite the limitations raised by De Ceuster et al. [1], numerous advantages have also been shown, such as economic benefits and time efficiency with the possibility of a faster process of ballistics identification, and the reduction of backlogs and delays of these analyses, which in turn prevent further gun-enabled crimes [6,4,7]. Another argument favouring automated ballistic systems that is worth mentioning concerns the successful results that were obtained by the National Integrated Ballistic Information Network (NIBIN) in the USA. In 1999, in an attempt to improve the efficiency of ballistics imaging in the USA, as well as sharing ballistic intelligence between the different States, the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) and the Federal Bureau Agency (FBI) agreed on the implementation of a new system "NIBIN", under the responsibility of the ATF. According to King, Wells, Katz, Maguire and Frank [5], NIBIN was considered an effective system, totalling over 47,000 'hits' by 2012.

Automated ballistics systems are widely used across Europe. Several countries including the United Kingdom, Belgium, the Netherlands, Croatia and Kosovo* have adopted the use of this technology, although the use of automatic ballistic comparison systems is not homogeneous, with different systems used in different countries such as PAPILLON Arsenal, Evofinder and the Integrated Ballistics Identification System (IBIS). These systems provide the possibility to compare evidence at a national level but also offer the possibility of comparing evidence at an international level where weapons appear to travel across countries. However, compatibility issues arise between systems due to the use of different file formats, which in turn render data sharing problematic [1].

The Interpol Ballistics Information Network (IBIN), founded in 2009, supports the cross-border exchange of ballistic data within the EU and beyond, for countries which are equipped with IBIS technology. However, non-IBIN member countries can also benefit from IBIN's international ballistics database through Interpol, using evidence recovered from test fires or double-casting resin replicas (making copies of bullets/cartridge cases) that can then be entered on IBIS and compared with other IBN member countries (cf. Interpol website).

The transit of firearms and their use in individual and mass shooting incidents has increased the prioritisation of firearms trafficking investigations across Europe. This issue is even more pressing given the recent increase in shooting incidents across Europe, which has led to Europol placing the trafficking of firearms on the watch list of the Serious and Organised Crime Threat Assessment [8]. Consequently, it was essential to obtain an up to date picture of ballistics technology and information sharing across Europe in order to determine whether the conclusions made by De Ceuster et al. [1] have been remedied by updates, or whether they are still applicable today.

Therefore, given the absence of research providing evaluations on cross-border facilitation of sharing ballistics data, this mixed-methods study aimed to provide a holistic exploration concerning the perceptions of first hand users on how ballistic analysis can help to fight against gun enabled crime (GEC) across Europe and gather qualitative data which has been neglected thus

* All references to Kosovo are without prejudice to positions on status, and are in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.

far. More specific objectives were to: (1) review the latest available figures for the number of ballistic evidence that were received in the labs, as well as submitted to the automated system within selected European countries; (2) identify the number of hits and to examine how ballistic data was shared across borders; (3) provide a detailed analysis of how ballistics intelligence is currently collated, used and shared between European Countries, Western Balkans and transnationally; (4) explore the perception of efficiency of ballistic comparison systems and whether ballistic intelligence provides evidence, that crime guns do travel across EU borders; and finally (5) identify areas of good practice for the ballistics procedure and to outline recommendations to improve such procedures. As such, a comprehensive study exploring the perceptions and understanding of core EU member states as well as select countries from Eastern Europe could be instrumental in strengthening protocols that are already implemented to share data throughout Europe. In addition, recommendations are needed in order to establish better cross border cooperation between member states and develop a better understanding of data sharing procedures, which should be implemented.

2. Method

The EU-funded project Examination of Firearms and Forensics in Europe and aCross Territories (EFFECT) [9] aimed to provide EU policy makers with a definitive body of knowledge concerning the nature, extent and impact of gun enabled crime (GEC), the effectiveness of interventions aimed at combating GEC and the cross-border sharing of ballistic intelligence. The overall project was divided into three strands: policy and legislation around firearms, policing gun crime, and ballistic analysis. This current study reports the findings from the latter strand, using mixed-methods consisting of the use of quantitative questionnaires (to fulfil objectives one and two), and semi-structured interviews (to address objectives three to five).

Research design

The design of the questionnaire drew together previous studies and other relevant literature exploring the potentiality of a European shared database [1]. It also reflected the methodology used in King et al. [5] in which they investigated homicide cases that were resolved using the NIBIN system. The questionnaire (see Appendix 1) consisted of questions on the automated

systems in use (if any) or alternative methods (e.g., double casting), the quantity of bullets and cartridge cases acquired and correlated in the system nationally, and the number of hits derived from the correlations, as well as the existence and use of a Service Level Agreement.

Information gathered from the semi-structured interviews will be focusing on the objectives set in the introduction on the topic of ballistic analysis to fight GEC. Interviews to ballistic experts aimed to collect more detailed data exploring the process of handling firearms, spent brass and fired bullets from crime scene, the challenges and the processes, the use of ballistics comparison system and automated system, international ballistics connection, recommendation on how gun crime could be prevented nationally and at international level.

All interviews (conducted with individuals or groups) followed an interview guide designed specifically for different stakeholder organisations (i.e. policy makers, police, ballistic experts, statisticians, members of non-governmental organisations). This ensured that the data generated were comparable and reliable.

Sample

Individuals working for organisations involved in combatting GEC in Europe were invited to participate in the interviews and questionnaires. Recruitment was conducted via email and utilised a snowballing technique. Key stakeholders were identified and contacted directly, either using generic contact details that were publicly available on organisation websites, or directly contacting a named person provided through project partners and their connections. The nature of the research was explained in the initial contact and a request for participation was made.

Individuals conducting ballistic analyses were contacted in 14 countries; of these, 42 participants were recruited from: the UK, France, Belgium, Germany, The Netherlands, Italy, Spain, Portugal, Former Yugoslav Republic of Macedonia (FYRM), Croatia, Serbia, Kosovo*, Sweden and Denmark. In the case of five countries, it was not possible to conduct individual interviews; instead, group interviews were preferred by the stakeholder organisation. In these instances, the role of each participant was clearly identified. All group interviews were conducted face-to-face, and individual interviews were conducted either in person or using Skype.

All interviews were conducted by an experienced multi-national team of six researchers between July and November 2015. Where possible, the interviews were conducted in English and transcribed verbatim. However, interviews in Germany, Italy, and France were conducted in their

native language by our bi-lingual interviewers. These interviews were transcribed and translated into English by the respective interviewers. One interview was conducted using a translator who was appointed by the stakeholder's organisation. In this instance, only the answers provided by the translator in English were transcribed. Of the nine questionnaires distributed to participants working in forensics, eight questionnaires were completed and returned to the researchers between August 2015 and April 2016. For Denmark, information from the questionnaire was discussed in their interview, and data has been extracted from this.

Ethical approval

Ethical approval was obtained prior to the start of data collection from the University Research Ethics Committee. At the start of each interview, written consent for each participant was obtained. Further, all participants were fully debriefed at the end of the interviews. Participants were informed of their right to withdraw their participation and were given up to seven days after the interviews to withdraw their data from analysis. Given the high sensitivity of the project, all personal information that explicitly identified individuals and organisations were removed from the transcripts and details of participants remained fully confidential.

To avoid publication of sensitive data pertaining to ongoing operations by law enforcement agencies, participants were given increased ownership of their statements. As explained in the consent form, participants could express their wish to view the transcribed interviews before the analysis would commence. In order to maintain validity of research findings, statements could not be altered and would still be included in the analyses. However, participants were given the opportunity to identify any statements which they did not wish to be published.

Data analysis

The data collected from the questionnaires were collated and a descriptive analysis is presented in the tables in the results section. Furthermore, the rich, qualitative data collected from the semi-structured interviews were subjected to Thematic Analysis, in accordance with the guidelines by Braun and Clarke [10]. The transcripts were coded by the lead author and the second author then reviewed the codes and transcripts to establish that the codes were valid and that saturation had been reached. Excerpts were selected from the transcripts which provided the

clearest support for the themes identified and these are presented in the next section. In addition, these themes are consistent across the countries represented.

3. Results

The results outlined in this section are structured and discussed according to the three superordinate emergent themes: "use of automated ballistic systems", "Ballistic evidence recovery and analysis", and "knowledge exchange and best practices" that arose from the qualitative analysis. In addition, answers returned from the nine completed questionnaires were analysed in a descriptive manner and presented to support the qualitative analyses, as presented below.

3.1. Use of automated ballistic systems

This theme discusses the use of automated ballistic systems across the participating European countries. The need for automated ballistics intelligence systems was broadly accepted by participants due to the number of pieces of evidence being received by forensic science laboratories, particularly when police requires the acquisition of all viable ballistics pieces. Such systems were also felt to make analysis easier and clearer, accelerates the process of identifying correlations, and provides a clear picture of gun usage across a whole country and are an important asset in the fight against GEC. Moreover, one participant emphasised their desire for all countries to be connected

> *We think that it could be really, really good for the investigations of ballistic crimes to have automatic ballistic system linked around all Europe because it's very easy for us to check any case with Portugal or with Denmark or the United Kingdom because we belong to the IBIN network but not so easy to do it against Germany, Austria, Belgium and some other countries that don't belong to this network* (1MESB)[3].

[3] In order to ensure participant anonymity, each participant was assigned a reference code and generated as follows: participant number within the country; gender (male or female); country (initial of country); and role (initial of role: e.g. B = ballistic; LE = law enforcement; P = Policy; NGO = non-governmental organization). For instance, 1FUKLE means participant 1, female in the United Kingdom, representing law enforcement.

It was acknowledged that automated systems can only perform part of the task, and once correlations are identified, ballistics experts are required to undertake manual comparisons to identify probable hits. Nevertheless, the systems were largely regarded as increasingly efficient with advances in technology, with some participants highlighting their desire to upgrade their current systems.

However, for countries with low levels of gun crime, some participants did question the value of automated comparison systems. Participants also acknowledged there is still room for improvement:

> *And the system nowadays, I think, they could probably improve, still improve, but they are quite efficient in a sense that finding their matches, if the signature is reproducible, it will come up high in the ranking list* (4MBEB).

As displayed in Table 1, three countries use Evofinder, six countries use a version of IBIS, and interestingly, two countries (Belgium and France) use more than one system. For Belgium, new items of evidence were being recorded in the latest system (Evofinder), and all the physical evidence from their OCF was scanned back on the new system (4MBEB). France had been carrying a double seizure of elements on both Cible and Evofinder whilst Evofinder becomes fully operational and networked. In addition, France will re-enter the physical elements stored in their OCF on their new system (1MFRB).

Table 1. Use of automated ballistic systems across countries

Country	System used	Date acquired
Belgium	IBIS Heritage	2002-2010
	Evofinder	Acquired in 2010, in use since 2014
Denmark	IBIS HD3D (bullet and cartridges)	/
FYRM	IBIS BrassTrax V2.4	2007
France	CIBLE	1994 – present
	Evofinder	March 2015 – present
Germany	Evofinder	2006
Netherlands	IBIS BrassTrax	2007

Portugal	IBIS Heritage	2015
Spain	IBIS Heritage	1999
	IBIS Trax (BrassTrax)	2006
	IBIS Trax (BulletTrax)	2009
Sweden	IBIS 3D HD	2013 (IBIS 2D since 2003)

Participants whose questionnaires were not available stated that they were using other systems. For instance, Russian Arsenal (Papillon) was used in Serbia and was also said to be used in Bosnia-Herzegovina and Albania (1MRSP). Kosovo* stated in their interview that IBIS Trax (BrasstTax and BullettTrax) was used, whilst the UK said the latest version of IBIS HD3D is used their country. The Carabinieri (Italian gendarmerie) in Italy were said to use IBIS but the version used varied across the country.

3.2. Ballistic evidence recovery and analysis

This theme refers to the ballistics process and analysis of recovered evidence. Five sub-themes were evident from the data: the process of ballistic analysis; open case file; test firing and the use of double casting; correlations and hits, and laboratory standards and timeliness.

3.2.1. The process of ballistic analysis

Participants widely reported that every effort is made to recover all ballistic evidence from crime scenes, including bullets, cartridge cases and firearms. There was also a general agreement amongst participants that cartridge cases make for better evidence, as bullets are often too damaged or unusable for analysis.

Although some participants discussed following a protocol for analysing markings, it was apparent across the data that how this protocol is followed varies between countries. As such, when analysing different marks on cartridge cases to compare other exhibits and testing a potential match, inconsistences between processes are apparent in terms of the markings that are analysed. Participants from the Netherlands and Germany stated they do not examine other marks aside from the breech face and firing, as this is time consuming and ineffective; in their opinion, such items

are not the best evidence, and are not considered in the correlation (2MFDB). Conversely, practices in France, Portugal and Belgium examine all markings independently (fire pin, breech face, ejector), as well as other factors that would affect the analysis such as a change in light. Participants from Denmark pointed out that 'wear and tear' on bullets and cartridge cases can also occur, which can also impact on the analysis and comparison process (1MDKB).

Table 2 displays the number of cartridges and bullets that were submitted to a lab or acquired into a ballistics comparison technology system over the last 12 months. It must be noted that out of the nine countries, three gave approximate numbers and one did not possess this information. Moreover, Belgium reported their numbers in terms of items or group of items rather than per item of ballistic material, whilst Spain had differentiated numbers in terms of test-fire bullets/cartridges and unknown bullets/cartridges, and Germany reported that their numbers referred to evidence ammunitions. Additionally, FYRM reported that they did not have the equipment for inputting bullets and no database to assess the exact number of cartridges or bullets they had on their system at the time of the interview. This highlights the lack of standardised procedure for recording this type of information, thus rendering international comparisons difficult.

Table 2: Number of ballistic items that were submitted/acquired over a 12-month period (data received between August 2015 and March 2016)

Country	*No. of submitted bullets*	*No. of bullets acquired in ballistic system (%)*	*No. of submitted cartridge cases*	*No. of cartridge cases acquired in ballistic system (%)*	*Backlog (case)*
Belgium	110	82 (75%)	143	86 (60%)	17
Denmark	380	380 (100%)	994	994 (100%)	0
FYRM	~100	NA	~2600*	~340*(/)	Unknown
France	/	1985 (/)	/	3869 (/)	420**
Germany	550	1890* (/)	540	3030* (/)	~11000

Netherlands	~1200	0 (0%)	~2000	~400 (5%)	<5
Portugal	293	667* (/)	72	3114* (/)	0
Spain	1263	615 (49%)	3230	1465 (45%)	~300
Sweden	707	~800 (100%)	1097	~1600* (100%+)	~20

* In the case of Germany, Portugal, Sweden and the FYRM, acquisitions are greater than submissions. They may be reporting the total held on the OCF (Germany reported they retain an OCF of about 3,000 pieces), as opposed to acquisitions during that year. Alternatively, submissions may have been counted per case, or else may have been submitted from a previous period and only acquired within this period due to a backlog. ** to the 30th of June 2015

As shown in table 2, only a proportion of the ballistic items received at the laboratory were acquired into the ballistic system, though Denmark and Sweden had submitted all items. Amongst cartridge case acquisitions, which are generally regarded as the most successful for generating hits, acquisition rates varied between 5% of submissions in Spain, to 100% in Denmark. The lower rate of submissions in some of the countries might be the result of variations in policy. In Sweden for example, the policy is to acquire all pieces onto the system other than approximately 5% of pieces that are not suitable for IBIS (e.g. partial bullets) (3MSWB). In other countries, there are limitations on how much material from each case should be acquired into ballistic systems.

Another possible reason why all pieces may not have been acquired is due to backlogs; that is, the number of ballistics related cases more than 3 months old at the time of interview awaiting processing. However, backlogs were not reported as a major issue for most participants. Some participants stated the size of backlogs can fluctuate depending on the time of year. Participants from Spain and the FYRM did report having a backlog, both having stated that this is due to the number of cases and the circumstances surrounding them. At the time of the interview, the backlog across countries reportedly ranged from no cases up to approximately 11000 cases, although seasonal variations were identified. Portugal and Denmark both reported not having any backlog.

Additionally, another cause of delays echoed amongst the participants was other forensic processes (for example, DNA testing), as ballistics teams are the last in the process to receive the evidence. However, according to a few participants, it is rare to find DNA on bullets and cartridge cases (2MFDB).

3.2.2. Open Case File

The perception of best practice with regard to populating the OCF and automated ballistic systems was found to vary greatly between countries. Countries using an IBIS system agreed that all ballistic evidence should be inputted into the system. This included non-crime evidence, such as antique firearms. However, unless there is some indication that they have been involved in a crime, this type of evidence will not be looked at. Moreover, concerns were expressed by some of the participants about overloading systems with data, and the subsequent increase of 'noise' in the system, which may reduce efficiency and compromise the identification of probable hits. Thus, some participants considered that maintaining a smaller database increases the likelihood of obtaining a true match.

It was also apparent that there were differences in terms of how far back ballisticians look at ballistic items, depending on the type of crime committed, and any statutory limitations on prosecutions.

> *"But those manual searches on a typical shooting would be local, so it would only be the Forces which are looked by that lab and it would go back two years. However, if it was a homicide and therefore it's that much higher profile and more emphasis on getting any potential links, if there are, we would do a 5 year manual search and that would be done at all of the laboratories"* (3MUKB).

With regard to the evidence which is submitted into the OCF, it was deemed good practice to select the best elements that present different brands, though according to 4MBEB, it is a rare occurrence to gather all evidence into an OCF. Data suggests that typically, 2-3 cartridge cases are selected and put into the system from each case. Fragmented bullets should not go in the OCF, but they can still be matched to other bullets (4MBEB). In France, open cases are only kept for ten years, as the cases have expired judicially. When the expiration time has reached, open cases are destroyed (1MFRB).

Other participants simply reported that OCFs were not being efficiently and effectively used by investigators and prosecutors, due to a lack of awareness or lack of resources or time to send in evidence. As such, not all the pieces of ballistic evidence is being sent in, thus rendering the OCF incomplete, and therefore they cannot find the hits (1MLNB). Consequently, the majority of participants suggested there is a need to raise awareness of the importance of bringing together all ballistic material for analysis to increase the efficiency of the OCF, given efficiency relies on knowledge and consistency.

In addition, the issue of poor continuation in terms of training (e.g., relocation of staff trained in firearms matter or discontinuation of jobs, lack of hand-over of the expertise) was raised by some participants which has repercussions in terms of submission of ballistic material for analyses. Furthermore, in terms of lack of resources and heightened workload for the investigators occur when a ballistic hit is found with a cold case which means that extra work will occur. A participant has observed resistance or lack of interest from investigators to look at a cold case, when their own case is solved and judged:

> *It sounds terrible but you think he or she, as investigators, they are investigating a murder. Actually being told that that weapon was used 18 months ago in another part of the country it's like, doesn't affect the murder they are investigating. It's just more paper work and more work for them.* (3MUKB)

Two participants raised an issue of independent experts (1MFRB, 4MBEB). The use of independent experts can hinder the process of ballistics analysis, as they do not have access to the national database impair evidence gathering at a national level and prevent full comparisons between the recovered evidence and the OCF. For instance, 1MFRB provided an example in which a serial killer was able to commit more crimes with the same gun because the ballistic evidences were never passed onto the national police to be linked together. As a result of this investigation, ballistic criteria that ensure that experts are accredited, had to be implemented within the Justice system, to avoid such problems re-occurring. This account also highlighted how the lack of integration of independent experts with central system had led to the loss of highly valuable intelligence.

In addition, a crucial element that was highlighted was that an incomplete OCF will automatically have a negative impact on the probabilities of finding a match and therefore lowering the possibilities of having an efficient system:

> *I am sure that we don't have all the evidence of all the shootings incidents that took place in Belgium, in here, which of course makes the open case files, less efficient on the long run; if you don't have too much evidence from the scene of the crime to compare with these firearms, of course it makes your database not so, extremely efficient* (4MBEB).

3.2.3. Test firing and the use of double casting

It was deemed good practice to test fire all firearms retrieved from crime scenes and compare the spent bullets and cartridge cases against the OCF and automated databases.

A minority of participants regularly mentioned using double casting methods in the interview, with the only down side noted by participants being that the process of double casting was time consuming (1MESB). It was reported that double casts tend to be produced if the evidence needs to physically moved (4MBEB) and upon requests from IBIN members (2FMKB) to carry out comparisons.

Table 3: The use of double casting

Country	*Does the country use double casting?*	*No. of double casts produced*	*No. of double casts submitted to other country*	*Percentage double-casts submitted to another country*
Belgium	Yes	Approx. 50	Approx. 20	40%
Denmark	Yes	Approx. 30	30	100%
FYRM	No	/	/	/
France	Yes	None	None	/
Germany	Yes	Approx. 10	5	50%
Netherlands	Yes	Approx. 10-20	Approx. 25-40	100%+
Portugal	Yes	5	15	100%+
Spain	Yes	44	16	36%
Sweden	Yes	2-3	2-3	100%

Although double casting [11] was used by all countries except one (see Table 3), a much smaller number of casts was produced (varying between none to approximately 50) when compared to the number of exhibits received. Although in France, facilities existed to produce double casts, none were manufactured during the period 2015-2016, as double casting is only undertaken when collaborating with IBIN (1MFRB). Of those who did produce double casts, four submitted 100% or more double casts to another country, and between 36% and 50% of double casts were submitted by the other countries. This suggests that for many countries, double casts are not produced

speculatively, but with a view to submit evidence into, or to compare the evidence to, another country's database. The majority of countries that used double casting techniques also reported using automated comparison, but seemingly there were differentiations in the usage of double casts. For some, double casts were used for international comparison within Europe whilst others regarded the original evidence as easier to compare, or even to protect the evidence:

> *Sometimes, we use double casting of course, for our own work. If we have lead bullets that could be worn out because we take out the lead bullets from the files and put them into microscope we will wear them down so that the traces will disappear. Lead is soft and in that case, you can do double cast so you don't destroy the evidence*. (3MSEB)

3.2.4 Correlations and Hits

The anomalies in data presented in table 4 suggested that countries used different measures for recording hits. For example, the number of correlated cartridge cases ranged from 43 in Portugal to a maximum of 175,800 in Spain. However, Spain reported that they not only included physical evidence in this number, but also online evidence. When asked for further information, they cited the number of acquired pieces, suggesting different understandings about the nature of a correlation. Additionally, the number of correlated bullets ranged from 0 to a maximum of 36,900 (see below for clarification).

Table 4: Correlation, hits and use of IBIN

Country	*No. cartridge cases correlated*	*No. bullets correlated*	*No. of hits in the last 12 months*	*% of correlations resulting in a hit*	*Use of IBIN to seek international ballistic connection?*
Belgium	86	82	3**	1.7	No
Denmark	994	380	7**	0.5	Yes
FYRM	340	0	3	0.88	Yes
France	Not counted	Not counted	14	/	No

Germany	3030	1890	28	0.57	No
Netherlands	400	0	46	11.5	Yes
Portugal	43	4	47	100	Yes
Spain	Max. 175800	Max. 36900	43	0.02*	Yes
Sweden	~800	~ 1600	~ 60	2.5	Yes

**The correlation figures for Spain appear anomalous, and this may be a total figure rather than just correlations for the last 12 months. **For Belgium and Denmark, participants specified in their questionnaires that the hits obtained were only cold hits.*

The percentage of correlations that resulted in hits ranged from 0.02% (although this was likely a result of the interpretation of 'correlations') to 100% in Portugal. Although it appeared that a hit rate from correlations of between 1% and 10% can be expected, there were clearly differences in the way hits were being recorded. Furthermore, there was no discernible pattern between the hit/correlation percentage and the ballistic system in operation in a country. For example, Belgium and Portugal used the same system, with very different reported hit rates. Interview information explained some of these anomalies. As demonstrated in Table 4, Belgium and Denmark identified that the hits that had been obtained were cold hits; i.e. hits that had not been intelligence-led. In Belgium, it was stated that one hit was obtained by using the double casting method, but it was intelligence-led. Therefore, there have been no cold hits using that method (4MBEB). In terms of hits, there was a variation in terms of how hits are defined through the participating countries:

> *We did have some cross-border hits but, as I said, they were all from investigative leads. Which is not plain for me to be called hits. Called hits is like: oh, oh, I found a match, it's in the Netherlands, great, and we didn't know about it. But if they say, oh, we have this firearm being seized, it was probably used in this crime from the Netherlands, can you check that? and that is what we had at some point, we had a match, maybe two, cross border. So it was actually more of a confirmation, than an essentially a called hit.* (4MBEB).

> *...we do it upon request and you go specifically for the country that you have intelligence on* (1MDKB on comparing with IBIN).

The number of bullets and cartridge cases submitted into the labs in the last 12 months differed across countries, ranging from approximately 100 to 1200 bullets, and approximately 143 to 2730 cartridge cases. These items were recovered from crime scenes, test fires or unknown origins. Moreover, a range of crimes (e.g., gang-related armed robberies, illegal possession of a weapon, firearm possession and homicide) lead to hits not only within the participating countries but also cross-countries and appear to vary across time:

> *So we have three years ago, we have 200 hits, because case goes to is a gang, they work and armed robbery of banks. It's a big gang, I think around 20, almost 30 people. They work in groups, they go to the bank one day and the other group go to the other bank so and other guys go do the work.* (1MPTB)

Eight of the countries that participated in the project were members of IBIN. During the last 12 months, only two of the international comparisons through IBIN were successful, with hits found between Portugal and Spain as well as between Denmark and Sweden; three hits were reported by respondents from Denmark with Sweden within the previous year. From the interviews, it appeared that the UK and the Netherlands also got a hit but not through IBIN. The FYRM had used IBIN to find a correlation but the results were negative. Belgium, France and Germany all received requests from IBIN but with no correlation found. Despite less than half of our participants having raised doubts as to whether hits could be found outside of neighbouring countries, the examples of hits that were provided were found geographically close. As such, an example of an international hit via IBIN was given by Danish participants:

> *I have an example of when a correlation was identified by using IBIN; it was actually a robbery in Sweden but since Sweden, Denmark and Norway are part of the IBIN, so it was an IBIN search, it's a firearm that was used for a robbery in the northern part of the Sweden and was found in Denmark; and we test fired it and it was a cold hit and we identified it in IBIS*. (1MDKB).

In addition, when discussing the possibility that ballistic analyses could provide evidence that firearms travel across countries to be used in other countries, a participant from Belgium explained the outcomes of discussion that arose at an international experts' workshop about gun crime:

> *So everybody, alright everybody, many people explained about the situation in their country, what do you see, what kind of firearm do you see, and it was already clear that you see different guns in different countries or different areas of the country, so there must*

be roads, that those guns come in but there they are disposed or being sold on the black market and they might be used but you see them only occasionally, coming towards other countries. (4MBEB).

Although, one of the limitations highlighted by a participant is the difficulty to link a ballistic hit with perpetrators of gun crime:

Yes maybe one day we will be able to do a hit between France and Spain, maybe, but it is still ballistic hits, it is not identifications of people (1MFRB)

In terms of participants' perception of the usefulness of automated ballistic systems, all raised the potential of this capability and its support for decision making but the adoption of the same system by all participants would not meet each country's current requirements. Another concern regarding the use of cross-national comparison technology was a perception that this would breach data protection legislation and a way of improving combatting GEC internationally would be:

And I think if we have a more universal / similar legislative standard and to have a better network of personal contacts, that would be really helpful. (1MFDLE).

3.2.5. Laboratory standards and timeliness

The importance of ballistic lab accreditation was evident, in which all ballistic processes have to be undertaken under service standards. Moreover, the importance of accredited staff was voiced, whereby trained lab technicians must meet the conditions within experience, training (which can be internal to the Institution) and diploma. As such, efforts are being made towards accrediting the laboratories. For instance, five countries (France, Kosovo, Portugal, Italy and the FYRM) reported working towards the ISO 17025 accreditation, which is seen by most ballistic experts as the best current standards.

As outlined in Table 5, participants reported on whether their lab implements a service level agreement (SLA). This SLA details the time in which labs will report results from a ballistics comparison to an investigator or intelligence officer.

Table 5: Service Level Agreement and timeliness

Country	Presence of SLA	Standard case	Urgent case	Possibility of fast response

Belgium	No	60 days max	30 days max	Yes
Denmark	No	5 days	90 minutes	Yes
FYRM	No	30 days	1 day	Yes
France	Yes	20 days max	police custody timeslot	Yes
Germany	No	Varies	8 hours	Yes
Netherlands	Yes	30 days max	6 days max	N/A
Portugal	No	/	/	Yes
Spain	No	Varies (over 12months)	Varies (max 60 days)	Yes
Sweden	No	120 days	5 days	N/A

Out of the nine countries, seven said that they did not have any SLA in place, whilst two said they had: France and the Netherlands. In France, it was reported that it usually takes around 20 days maximum for non multi-disciplinary files, but that ballistic analysts can always respond within the police custody timeslot and when an investigation needs urgent answers (1MFRB). In the Netherlands, it was discussed that 'standard' comparison cases have a turnaround time of 30 days, whilst tailor made cases (ballistic, technical, reconstruction questions) have a turnaround time of 60 days. In addition, a 'rush' of 'urgent' cases can be processed within 6 days. The ballistic analysts argued that they deliver their reports in 95% of cases within the agreed time (2MNLB).

For the seven countries that do not have an official SLA, they all aim to work within a specified timeframe. For 'standard cases', the turnaround time reportedly ranges anywhere from 5 days to 12 months. For 'urgent cases', these are prioritised and can range between 90 minutes to 60 days. Turnaround times are dependent on numerous factors including crime type (i.e. the more severe the crime, the quicker the turnaround) and level of danger the firearm presents, whether there is a victim, the location of the suspect, and the location of the ballistic lab and the technology at their disposal.

In practice, most participants reported that there is always an arrangement that can be made where flexibility can be afforded, and at least provide some oral feedback to help investigators in need of an urgent response. Given labs were able to prioritise cases, it was widely agreed that there

was no need for 'walk-in Wednesdays'[4], as urgent cases could be processed immediately and quickly.

3.3. Knowledge exchange and best practices

Many of the participants were part of the European Network of Forensic Science Institute (ENFSI) Working Group, and five participants described how the regular meetings provide opportunities of knowledge exchange between members and the sharing of best practice. Such meetings, events and workshops were deemed useful for the continuation of training, providing insights into other procedures or activities implemented by different laboratories across the various countries and exploring what works for each individual country. For instance, a participant from Spain discussed a previous collaboration with colleagues in the San Francisco Police State provided training on sub-class characteristics (1MESB). Participants from Denmark also reflected this practice, by having collaborations with other police agencies for training purposes:

> *Yes we went to NABIS seminar last week and we just heard an investigator talking about that, saying that in most of the cases they went directly for the person behind the firearm, instead of going for the firearm and the story of the firearm actually. So there's a lot of information there that's lost and that's our opinion as well* (1MDKB).

Additionally, ENFSI consisted of seventeen Expert Working Groups at the time of data collection, and most of the ballistic experts were members of the Firearms/Gunshot residues (GSR) group, which is considered a very important international network with a yearly conference in which presentations and workshops are delivered to share knowledge based practice. Furthermore, on top of the existing network expert groups (e.g., ENFSI, Firearms/GSR), some of the participating countries work routinely in close relationship, such as Portugal and Spain or Denmark with Sweden and Norway, who share common borders.

> *Since 2001 we have shared network with Norway and Sweden so everything that is brought into the Danish database is correlated against Norway and Sweden and vice versa* (1MDKB). *And we have also some very good partners in both the Nordic countries but also the rest of the EU, and Europe* (1MDKB).

[4] Walk-in Wednesdays: were developed by the Los Angeles Police Department (LAPD), to provide immediate feedback to the investigators concerning their ballistic evidence, after entering these into IBIS and searching NIBIN database.

The overall perception is that it is important to be able to share information across countries with some countries recognising how IBIN has helped to fight against organised crime (2FMKB), but also improved the possibility of making international connections to combat transnational crime by comparing ballistic data (1MESB). On the other hand, for participants who do not use IBIN, some felt that IBIN is not necessarily the best solution for them to share cross-border information:

> *But as a country we refuse [to become part of IBIN] because, what's the point for us to know that a gun has been seized in Guatemala or somewhere else in the world. It will hardly ever have anything to do with Germany. At the same time, we do help whenever we get any queries through the normal Interpol way.* (2MFDB)

Together, participants identified NABIS in the UK as being best practice in the fight against GEC. According to participants from the UK, good practice was deemed as having a good picture of gun usage, ballistic links, and gun market across the nation. Further, participants looked to the use of "inferred weapons" (1MXKP) as being good practice. According to 3MUKB, an inferred weapon is when a weapon is used in a crime (and has not been used in a previous crime), which will be identified in terms of specific type and send in an intelligence report. This allows the police to know the exact numbers of weapons that are actually being used or have been discharged in the UK. 1MXKP advocated that Kosovo is also utilising a similar method:

> *So the inferred weapons, and actually, we are looking for the inferred weapons because by looking for the weapon, you will come to the crime. And I think it speeds up significantly the issue* (1MXKP).

4. Discussion

This paper is the first descriptive and qualitative account of ballistic analyses in Europe using a mixed method design. The interviews showed cultural variations in the handling of ballistic testing and comparison, and how this could impact on the efficiency of systems with the potential for losing important intelligence that would not be shared efficiently. Moreover, there is currently no single shared European database and, at present, the possibility of linking databases on an EU-wide basis is restricted due to the use of reportedly incompatible systems. Whilst there are processes for cross-border checking through the Interpol IBIN system, double-casting and linking compatible systems in neighbouring countries, the capacity for cross-border networking is

currently limited. Communication on data sharing is also done on a case-by-case basis depending on the participants needs.

Taking into account the findings from both the qualitative and quantitative parts of this study, the ability to draw firm conclusions regarding the value of ballistics comparison systems, either on a national or cross-border basis is hampered by inconsistencies regarding data recording practices and definitions. As with other forms of forensic evidence, there is clearly a process of attrition, which starts with the collection of ballistic material from crime scenes and test fires, through to the submission of bullets and cartridge cases, the acquisition of pieces onto automated systems or through manual comparison, the number of correlations that are identified, and then those that result in a hit. Following this, further attrition will occur through the investigation and prosecution process. Due to anomalies and differences in recording and reporting of this process, it is difficult for this study to accurately state the average number of hits as a percentage of the number of ballistics items submitted and acquired. In order to assess the effectiveness of ballistic intelligence systems in identifying hits therefore, more consistent and robust systems are clearly required to evaluate this process, or a more in-depth study that follows individual cases in a consistent manner would need to be undertaken.

The results showed that all countries included in this study are using an automated ballistic system, the choice of which varies across the European territory with two main systems: IBIS and Evofinder. As such, a previous study suggested that complete interoperability between the two systems could only be possible with the full cooperation of the manufacturers [12]. Though, as discussed by De Ceuster et al [1], this is unrealistic, given the financial gain at stakes, that manufacturers will share their intellectual property to create an interoperable system. Double casting, however, which is used in all the countries who responded to the questionnaire apart from one, can be seen as an alternative that enables every country to examine evidence across border when there is an intelligence lead. As such, this process has been used by seven out of nine countries to search for an international ballistic connection.

Further, as expected [1], spatial proximity of the hits was observed in the interviews (e.g., Denmark and Sweden or Portugal and Spain). The obtained hits were mainly based on previous intelligence about a case which then confirmed the correlation. However, most participants agreed over the fact that cold hits would be more useful for investigative purposes but issues of implementing routine search for cold hits were raised. In parallel to the current study, colleagues

also looked at correlating 1000 cartridge cases from crime scenes from Serbia with the databases of Denmark, Italy, Kosovo*, Norway, Serbia, Sweden and the FYRM. A total of 53 probable ballistic connections were identified, mainly within Serbia, but also with countries outside Serbia including Kosovo* and Sweden (see EFFECT project report [13]). Although, the experiment was only done on a small scale, these findings demonstrated a clear potential in understanding the movement of criminal firearms. It would therefore be beneficial to develop a series of pilot studies identifying and assessing the number of firearms that are travelling across Europe (for example, from South-East Europe to Northern Europe) and their travel routes.

In addition, issues were also found when looking at the figures provided in the questionnaire, as variations were found in terms of how ballistic hits are counted and how they are defined. As a result, it is paramount that best practice guidance is developed and should include defining ballistic hit recording protocols. To have a clear view of international ballistic connections, an agreed definition and method of counting should be approved between the European countries. There is a need to record figures related to ballistic intelligence in a standardised manner with a common language in order to assess accurately how firearms are trafficked.

Conversely, taking into account that some of the participant's countries do not have a complete national OCF for various reasons (independent experts not feeding in their ballistic items, conscious decision by an investigation team to not use the ballistic analyses, lack of awareness of the existence of the OCF), the number of national hits, which varied between three and sixty in the current study, would be affected. Therefore, ballistic intelligence training and best practice guidance should be developed for relevant staff in member states, including Investigators, Intelligence Staff, and Prosecutors. This should include the provision of knowledge and understanding regarding the value of carrying out checks against the OCF.

The interviews showed mixed opinions as to whether a shared system is needed, with some participants expressing an interest in having everyone connected via a shared system. In addition, there is some acknowledgement that such capacity would be beneficial, and this is further explored below. However, participants also highlighted that major issues would arise by having such a system that would need to be resolved if they wanted to even consider being part of a shared European network.

Consequently, recommendations in terms of how our results should be contextualised within the different northern, southern and eastern European cultures need to take into account the cultural diversity reflected in our interviews (e.g., different judicial system, political and economic situation of the country). Therefore, should a shared European database be created, the following recommendations outlined henceforth should be considered.

Firstly, there should be a single point of contact with whom all labs working in ballistic analysis can centralise results and material for the whole country. This contact would also be responsible for maintaining and monitoring the OCF. This would enable each country to have a global picture of the nature and the prevalence of gun problems (e.g., what type of guns are used in their country to commit crime and from where they originate) but also in terms of ballistic analysis and correlations with previous crimes.

An action plan for 2015-2019 was set up in November 2014 at the Council of the European Union, which includes the creation of Firearms focal point (FFP) for every partner in South East Europe reporting through Europol. These focal points would lead data collection by using a standardised template fulfilling the intelligence requirements. The European agenda, in charge of combatting illicit trafficking, is set to improve, among other actions, the operational cooperation between EU member states and other countries. As such, the current findings reemphasised the need for inter-connected national focal point on firearms, creating a better intelligence picture of illicit trafficking in firearms by providing an expert analysis and strategic reporting [14]. The Commission has offered to facilitate the exchange of ballistics' information by using a ballistic network and other relevant systems already used by member states, as well as supporting a FFP within each Member State who would report back to Europol FFP on the analysis of ballistic and criminal intelligence of their own countries [14]. It appeared that none of the interviews mentioned FFPs and therefore, this re-emphasised the need to establish these FFP within each member state who should take a leading role in coordinating ballistic intelligence through an agreed protocol and memorandum of Understanding (MoU) and report to a dedicated European Firearms Fusion Centre within Europol.

Secondly, participants from Belgium and France raised the use of independent experts as problematic, given the lack of standardisation between their procedures. Therefore, independent experts should be accredited in order to ensure their competence of performing ballistic analysis is of a similar quality and standard as that of national labs. Furthermore, private experts should be

expected to feed material back to the central single point of contact (FFP) to ensure the OCF is kept up to date, and the results of their analyses should be recorded.

Thirdly, the training of the different actors involved in the fight against gun crime should be systematic and consistent with a top to bottom approach. As such, it would be very interesting to have a survey for the ENFSI members to assess which are the competencies and skills that are essential to work as an accredited expert (see the ISO 17025 norms) and whether there could be a possibility of monitoring how this is implemented across Europe. To ensure best practice, all labs across EU and South East Europe should strive for ISO 17025 accreditation. Consideration should also be given to the development of accreditation standards for firearms experts and the creation of a register of firearms experts working inside the EU. Such a register could be held by ENSFI.

Fourth, a decision would need to be reached within each country as to who would be in charge of maintaining and implementing a ballistic database. With regard to resources within an inquisitorial system, a governmental agreement should be sought to allow ballistic analysis to be affordable for everyone, to ensure all investigating judges can use the database, or at the least afford to submit firearms, bullets and cartridge cases into the OCF. Another issue that was raised pertains to the workload for the investigators when a link is found with another case and the resistance or the lack of interest to look at a cold case, when their own case is solved and judged. Although it might not be possible to inject more resources to support the investigators in their workload, due to the current economic climate in the European context, it is vital to raise constant awareness of the benefits of populating the OCFs and of having a clear picture of gun usage in a country. With the increase in usage of machine gun (AK types of weapons) in terrorist attacks, such as those seen in Paris in 2015, ballistic analyses might reveal where these weapons might have previously been used. Therefore, the intelligence that could be gathered from ballistic connections will support in preventing these weapons to transit via the identified routes. Again, the proposed European Firearms Fusion Centre could act as the conduit for the facilitation of Pan-European investigations and intelligence matters following a cross-border ballistic hit facilitated by the ballistics correlation server.

Fifth, all participants agreed that the use of an automated ballistic comparison system speeds up the comparison process. However, the use of such systems is not homogenous among countries, in that different countries use different systems. Therefore, it is recommended that consideration should be given to implementing an EU-wide Ballistics Information Network. The

network should facilitate the proactive correlation of European ballistic material based on an agreed Pan-European protocol. Such a network should incorporate a common set of processes and products in line with those of the Firearms Focal Points. To inform such a development, a feasibility study should be carried out to determine the achievability of a pan-EU network. Such a study should assess the technical and process capabilities required to implement such a solution. The study should specifically seek to address participant's concerns regarding data noise, whilst providing a detailed understanding of the potential limitations and benefits of such a system.

Moreover, according to De Ceuster et al [1], OCFs are integral when finding cold hits (whereby no previous intelligence existed). Therefore, another question that arose is: should automated ballistic systems be used to confirm a lead (i.e. warm hits), or should it be used for cold cases when there is no prior information leading to the hit? Currently, it appears that running automatic correlations against a shared network, such as IBIN, would not be feasible for the reasons cited in the introduction. As such, the feasibility study that is recommended in the previous point would address the concerns raised by participants.

An agreement needs also to be reached in terms of what should be included in the shared database, as caution has already been recommended in several past studies indicating that in terms of firearms for example, ideally, all should be included in the system [15]. However, issues were raised that shotguns tend to leave unclear/poor identification marks and that guns with interchangeable barrels are also problematic in terms of identifications [15]. In addition, a shared European system was considered inefficient in terms of staff use and technology for several reasons highlighted in De Ceuster et al [1]. Indeed, the potential for achieving reliable hits decreases the greater the size of the database which mitigates against a multi-country database. Ultimately, the data presented are supportive of the previous findings by De Ceuster et al [1,16], in that the additional workload in terms of running comparisons was also stressed by the participants. And finally, the low cost-benefit ratio that was found by De Ceuster et al [1] with a small hit rate should be considered against the high cost of equipment and personnel.

Sixth, another concern that was expressed by a number of participants relates to legislation issues and data protection that can be involved in sharing the data through a network. This is an important issue as one of the key benefits of sharing ballistic intelligence is the anonymisation of the data and the fact that no personal information is exchanged. As such, a definitive statement on

the position of ballistics data in relation to European Data Protection regulations should be clearly articulated in order to facilitate the consistent sharing of information on a pan-European basis.

Finally, participants who had identified best practice in their interviews mentioned the importance of integrating the information received from the analysis with the intelligence on the weapon that was used and where was that weapon acquired and how did it travel. This gathering of information could help in linking gun-enabled crimes as well as resolving crimes where a suspect has already been identified from a previous case. Interpol and Europol should work closely to provide support, good practice guidance and technical capability to all EU countries and neighbouring states in regard to ballistics intelligence and the sharing of ballistic material. This should be in line with the development of the European Firearms Fusion Centre and the creation of an EU-wide Ballistics Information Network. Such work should ensure the development of a complete and robust Pan-European intelligence picture in relation to the criminal use of firearms.

This study is not without limitations; the interviews were conducted between July and November 2015, preceding the very lethal terrorist attack that occurred in Paris in November 2015 in which illegal guns were used. Therefore, participant views and opinions may have been altered. Another limitation of this study is that no questions were asked specifically about the number of international ballistic hits, and therefore, taking into account the concerns that were raised in De Ceuster et al. [1], a feasibility study should be carried out to determine the viability of a pan-European network. Such a study should assess the technical and process capabilities required to implement such a solution. The possibility of international ballistic linkages could highlight trends in the distribution of firearms across countries and would provide a critically valuable resource for the intelligence and investigative capabilities within Europe. However, there is currently no single central location where ballistics data and associated intelligence/information is collected, evaluated, analysed and disseminated.

Although at the time of the interviews not all countries possessed an SLA, all the participants reported working towards a deadline to provide full reports to investigation teams and mentioned prioritising cases according to their importance. Flexibility was reported by all participants to provide investigators with at least a verbal report of the results when they are urgently needed. Therefore, it can be argued that the creation of a standard, best practice time scale expectation for the acquisition, correlation, and reporting of ballistic crime related items should be

considered in order to increase the intelligence and investigative value of ballistic material. This should be based on crime type and public impact.

The limitations of the current study include that answers given by the respondents were not always easily interpretable, as the questionnaire did not give opportunity to expand on their answers. In addition, not all countries of the EU were interviewed (due to limited timeframe of the project) or agreed to answer this questionnaire. Future research could look at including all European countries (and candidate countries) to present a more exhaustive representation of different cultural perspectives on this topic.

5. Conclusions

The practices around ballistic analyses and sharing information on ballistic connections is heterogeneous across the countries looked at in the current study. Knowledge exchange between countries demonstrates clear benefits both for exchanging best practice, and for improving understanding of trends and issues in firearms movements, allowing for more efficient targeting of resources. It does appear that a better collection, integration, evaluation, analysis and dissemination of ballistic material, in conjunction with intelligence and reporting information could improve the combat against the use of illicit firearms both within the EU and South East Europe.

The possibility of drawing firm conclusions on the value of ballistics comparison system at national or international level is hindered by inconsistency in the reported figures that may cause data to be misread and misreported. As such, this has the potential to affect information quality but also important intelligence from central systems. The figures reported in this paper show that ballistic information is being collected and analysed in different proportions according to the different countries under study.

Variations in terms of systems, or version of systems, that are used by the different countries created a very fragmented picture of ballistic analysis with the added complication of a lack of interoperability of these systems to facilitate international comparisons. Despite the existence of processes to carry out cross-border comparison through double casting or Interpol IBIN system, the capacity for cross-border networking is limited. Some participants recognised that such capacity would be beneficial.

Acknowledgements

Funding: This work was supported by the European Commission, Directorate-General Home Affairs, Directorate A – Internal Affairs. [grant agreement No. HOME/2013ISEC/AG/4000005990]

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