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Abstract:
<p>This deliverable is a progress report of task T4.2. It presents preliminary work toward the development of the data analysis and visualization tool that will be part of the Policy Making Toolkit to be implemented in WP4. First, it gives a summary of the current results of T4.1 that provide a first definition of information and data on which the data analysis and visualization tool will operate. Then a concise overview of data analysis focused on its application to the Policy Making Toolkit is given, followed by a proposal of the kind of data analysis functionality to be implemented in T4.2. A sketch of the proposed architecture of the data analysis and visualization tool is given, in terms of its components, users and functionality, and finally the next steps toward the development of this tool are summarized.</p>

Keywords:
Policy making toolkit, data analysis and visualization, data analytics, visual analytics.

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## 1 INTRODUCTION

### 1.1 PURPOSE OF THE DOCUMENT

One of the outcomes of the LETSCROWD project is the Policy Making Toolkit (PMT), whose goal is to support policy makers in the creation, enhancement and implementation of security policies in the protection of crowds during mass gatherings. The PMT will include a data analysis and visualization tool (DAVT) whose aim is to analyse the data defined and collected in T4.1 (including indicators, measurements and best practices about policies related to mass gathering events), and to provide visualization and assessment functionality that allow the PMT users to navigate such data and to investigate and assess the effects of measures put in place in several regions and the impact of their practices, improving their decision making process.

The purpose of this deliverable is to present a first sketch of the DAVT, based on the information on the PMT and on the data it will contain that are currently available from the WP2 and WP4 activities.

### 1.2 SCOPE OF THE DOCUMENT

This deliverable is a progress report that presents preliminary results on the development of the DAVT obtained during the first five months of task T4.2. Based on the available information from WP2 and WP4, the main type of data analysis that will be provided by the DAVT has been first identified, i.e., descriptive analytics. Then the general architecture of the DAVT has been sketched, in terms of its components, users, and a draft of the functionality of its different software modules. The main, next steps toward the design and development of the DAVT that involve the other WP4 project partners and Law Enforcement Agencies (LEA's) have also been identified. The final results will be reported in deliverable 4.7 which will be released on M19 and will contain the detailed architecture of the DAVT, a description of its functionality, and the details of its software implementation.

### 1.3 STRUCTURE OF THE DOCUMENT

This deliverable is structured into three sections, beside this introduction. Section 2 summarizes the goal of the PMT, and the results of the activities carried out in task T4.1 which provide the first input for the development of the DAVT. Then it provides a brief overview of data analysis (also known as data analytics, DA) with a focus on their application to LETSCROWD, and identifies the main type of DA to be implemented in T4.2. Section 3 sketches the proposed architecture of the DAVT in terms of its components, users, and functionality of the main software modules. Section 4 describes the next steps of T4.2 that involve the other WP4 project partners and the LEA's.

## 2 DATA ANALYSIS AND VISUALIZATION IN THE CONTEXT OF THE POLICY MAKING TOOLKIT

This section gives first a concise view of the PMT and of the current results of WP4, which are the basis for the development of the DAVT. Then the field of DA is briefly introduced, and the type of DA to be implemented in the DAVT is finally discussed.

### 2.1 POLICY MAKING TOOLKIT

The PMT will contain a database (DB) storing several kinds of information (summarized below) related to mass gathering events, together with tools for searching and analysing such information. This will make the PMT a knowledge-driven decision-support system for several types of users, including LEA's, event authorizers and policy makers. In particular, it will include a DAVT to be developed in T4.2, whose aim is to deliver analysis, visualization and assessment tools that allow the PMT users to navigate the data collected in T4.1 and to investigate and assess the effects of measures put in place in several regions and the impact of their practices, improving their decision-making process.

The envisaged functionality of the PMT is described in deliverables D2.1 and D2.2 (requirements and use cases), and D4.1. In particular, the following functionality, mentioned in the requirements, is relevant to the DAVT (the requirements ID's are reported in brackets):

- helping authorities to decide about approval of planned crowded events (PMT\_001), and allowing them to create reports after a decision and after an authorized event closes (PMT\_015);
- supporting policy makers in the development of different types of policies, for different levels of planning, control and management and diverse sort of events (PMT\_019);
- serving as a centralized reference database for LEA's and authorities across the EU (PMT\_020);
- allowing to create different kinds of reports to ensure EU standardization (PMT\_022).

Among the data that will be stored in the PMT, the ones relevant to the DAVT include:

- past mass gathering events (including, e.g., information on venues, event known types, type of incidents and incidents indexed with events), current policies and legal background;
- information on citizen's reactions and perceptions to complement the Eurobarometer, useful to the policy making process;
- a collection of best practices in security policy making;
- a set of indicators that will provide information to understand development, performance and position of security policy actions, obtained from a review and a systematic analysis of current policies and best practices.

With regard to users, it is planned that the PMT will serve different user categories (roles), including LEA's, Authority (which is responsible for event authorization) and Event Planner, and that new user roles can be created.

Finally, two results of the activities already carried out in task T4.1 are relevant to the DAVT: the definition of a taxonomy of policy issues related to mass gathering events, and the collection of a first set of policy documents related to crowd safety and security. These results are summarized in ANNEX A.

Such results define some of the data that will be stored in the PMT; in particular, the taxonomy provides an indication of how the information in the database (DB) could be structured, potentially including other kinds of information to be further defined, like past events and best practices. This is also a first step toward the definition of the functionality of the DAVT.

## 2.2 DATA ANALYSIS AND VISUALIZATION

Methodologies and processes for data analysis and visualization have evolved in the past 15 years into a field named "data analytics". This term denotes processes encompassing a wide set of data analysis techniques and tools, whose goal is to extract useful information from data (usually from "big data") to support decision-making in the private and public sectors, based on evidence, or data-driven (1). Their applications include policy making support, which lies in the scope of LETSCROWD.

Several experiences of the application of DA to policy making already exist, at different levels, and DA initiatives in this area have been launched by public authorities in Europe, e.g.:

- Evidence-based policy-making. Exploring opportunities from innovative data technologies in the European Commission. A study commissioned by the European Commission's Directorate-General for Communications networks, content and technology (DG CONNECT), 2015. Available at: <https://www.data4policy.eu/> (2)
- Big Data Analytics for Policy Making Report. A study prepared for the European Commission DG INFORMATICS (DG DIGIT), 2016. Available at: <https://joinup.ec.europa.eu/node/153807> (1)

The results of these initiatives provided evidence that DA is useful for several steps of the policy making process, and has a clear added value for policy makers, especially when it is structurally integrated in the policy making process (1).

The DA field is continuously and rapidly evolving, and is characterized by a multidisciplinary approach that involves research areas like statistics, data mining, machine learning and artificial intelligence. In the context of specific organizations, the DA processes can be carried out by *data scientist* professionals. There are also open source or commercial tools that provide specialized solutions in specific application areas, or more flexible solutions aimed at guiding the end users in selecting the most appropriate DA model.

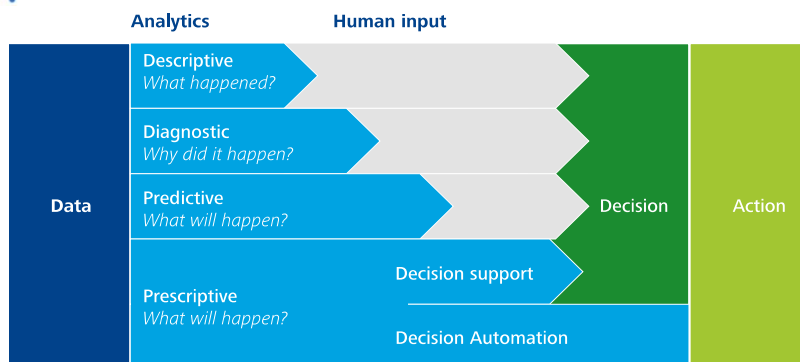
Usually DA is related to the management of "big data", which pose specific challenges due to their nature, and in particular: the heterogeneity of the data sources; the presence of unstructured data, the amount (volume) of data; their continuous generation often in real-time (velocity); and their variable quality ("veracity"). However this is not likely to be the case of the PMT, whose DB should contain a relatively limited amount of structured data coming from reliable sources. Nevertheless, effectively exploiting such data in the context of policy making for mass gathering events, and of related tasks (like event authorization), is not straightforward, and specific DA functionality can be of great help to this aim.

At a high abstraction level, DA techniques can be categorized into four main types (1):

- **Descriptive** analytics uses domain-specific intelligence and statistics to ask "What has happened?". It is used to describe the past using aggregated or detailed data. Visualization tool are often used for better and faster comprehension of the results.
- **Diagnostic** analytics uses data mining and correlation techniques to understand the reason behind what has happened, placing facts in a context. Visualization is often used also in this type of analytics, e.g., to identify outliers and changes over time.
- **Predictive** analytics uses statistical models and forecasting techniques to ask to predict future trends or events based on historical patterns in the data, estimating their likelihood.
- **Prescriptive** analytics directly affects action by using several techniques that include predictive models and simulation exercises, to ask: "What should we do?" It is used either in the context of decision support tools for end users, or to automate decision.

A feature distinguishing the above types of analytics, relevant to LETSCROWD (further discussed in section 3.3), is the degree of involvement of users in the DA process, as depicted in Figure 1: more advanced analytics functionality are characterized by a higher degree of autonomy.





**FIGURE 1 – Types of data analytics techniques (taken from (1))**

A specific kind of analytics which can be of interest to LETSCROWD is the emerging area of Visual Analytics (VA). As its name suggests, the basic goal of VA is to support data analysis with visualisations (2), superseding more basic tools like spreadsheets, standard charting techniques like 2D plots, line graphs and bar-charts, etc. Historically, VA originated as an evolution of the well-established field of data visualisation (3), and in particular from exploratory, interactive data analysis introduced in the 1970's (4); VA was then enabled since the 1990's by developments in several fields (tools for distributed storage and processing of data for the visual display of online information, improvements in graphical user interfaces and interaction devices leading to new visualization techniques, tools for distributed storage and processing of data), and by the integration with data analysis techniques like data mining (5) (6) (7).

Also in the VA sector several initiatives exist at the EU level. A notable one has been the VisMaster project (Visual Analytics - Mastering The Information Age), an European Coordination Action Project focused on the research discipline of Visual Analytics, funded by the Future and Emerging Technologies (FET) Programme within the 7th FP (Aug. 2008 - Sept. 2010): <http://www.vismaster.eu/>.

VA can be defined in more detail as a combination of "automated analysis techniques with interactive visualisations for an effective understanding, reasoning and decision making on the basis of very large and complex datasets" (3), or as "an integral approach combining visualization, human factors, and data analysis" (<http://www.visual-analytics.eu>). Similarly to DA, also VA is a highly interdisciplinary field. In particular, its applications include policy making (3).

At a high level of abstraction the process of VA can be summarized as follows (see also Figure 2), although the details can strongly depend on the specific application area (3):

- If heterogeneous data sources are used, they need to be first integrated. This requires suitable preprocessing steps. Further preprocessing steps can include data cleaning and normalization.
- The data analysis process in VA consists of several iterations between automated analysis steps (e.g., data mining) and user intervention. The user evaluates and refines the results of the automated analysis by interacting with the data through visualization, e.g., by considering different visual views on the data. Such an iterative process can allow misleading results to be detected at early stages, increasing the confidence on the final results.



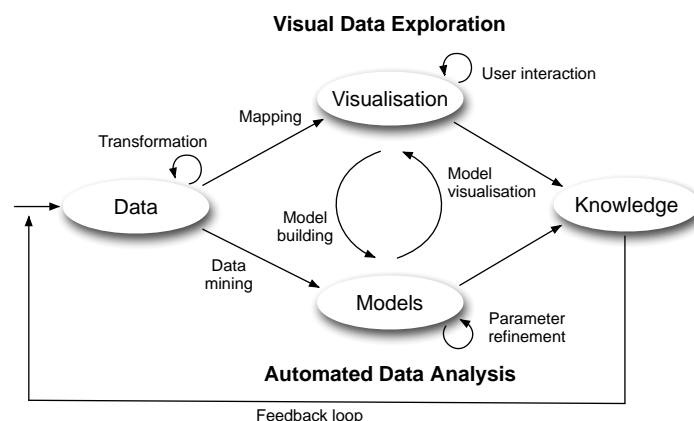


FIGURE 2 – High-level view of visual analytics process (taken from (3))

As a simple example of a descriptive DA/VA process in the context of LETSCROWD, one of the envisaged usages of the PMT can be considered, i.e., supporting public authorities in the decision-making process of event authorization. Given a request for a specific mass gathering event, the event authorizer may want to retrieve from the DB of the PMT information about past, similar events, e.g., to check if some incidents occurred during them. Such a query can be made through an easy-to-use graphical user interface (GUI) which allows the user to specify the search criterion based on predefined event characteristics (e.g., type of event, size of the crowd, type of venue, etc.); then the tool shows geo-localized information on the retrieved events, and allows the user to access further information on such events and to interactively modify the search criteria for a further retrieval step, if necessary. This would involve only visualization processes (the top part of Figure 2). In addition to visualization, automated data analysis processes (the bottom part of Figure 2) may be useful to other users, like LEA's and policy makers; for instance, they may exploit cluster analysis to automatically identify distinct groups of events in terms of some of their characteristics, which could provide interesting hints for further analysis.

### 2.3 DATA ANALYSIS AND VISUALIZATION APPLIED TO THE POLICY MAKING TOOLKIT

For the scope of the PMT, and in particular the support to policy making through a human-centred approach, DA solutions like prescriptive analytics, characterized by a high degree of autonomy, should be ruled out. Instead, **descriptive** analytics can be considered as the functionality of greatest interest, as it requires the highest involvement of end users. Currently, descriptive analytics are indeed the most widely used type of DA in the area of policy making (2).

Furthermore, implementing the DA functionality in the form of **VA** can be a useful option for LETSCROWD, since two main features of VA turn out to be particularly relevant to this project (3) (2):

- visualisation is inherently used in VA techniques in the context of semi-automated, interactive exploration and analysis processes which tightly involve the end users, which is coherent with the human-centred approach of LETSCROWD toolkit;
- visualization is often a useful medium for making complex data accessible to end users, and for the effective communication of results to enable successive action; in particular, in the field of policy making VA can enable innovations in terms of best practices (although it is subject to risks as the one mentioned at the end of this section): in the context of LETSCROWD this could be enable, e.g., providing actionable information to policy makers.

Accordingly, the implementation of the descriptive analytics type for the DAVT is envisaged, possibly using a VA approach.

Finally, in existing studies at the EU level in the area of DA for policy making some potential risks have been pointed out as well, and should be taken into account also in LETSCROWD. In particular, care must be taken to avoid that data-driven approaches reduce transparency of the policy process; this can happen when data

collection and DA techniques (e.g., machine learning techniques) are not fully understood by policy makers or other stakeholders, which could lead to drawing wrong conclusions or arriving at misleading pictures (2).



### 3 ARCHITECTURE OF THE DATA ANALYSIS AND VISUALIZATION TOOL

This section sketches the architecture and functionality of the DAVT, on the basis of the discussion in the previous section.

#### 3.1 COMPONENTS

The DAVT will consist of three main components:

- The **DB** of the PMT developed in WP4, which will contain the data defined in T4.1; in particular, the DB will contain the following four kinds of data planned by deliverables D2.1 (requirements) and D4.1:
  - documents on security policies, possibly categorized using the taxonomy of policy issues defined in deliverable D4.1;
  - information on past mass gathering events;
  - indicators and measures;
  - information on citizen's reactions and perceptions.

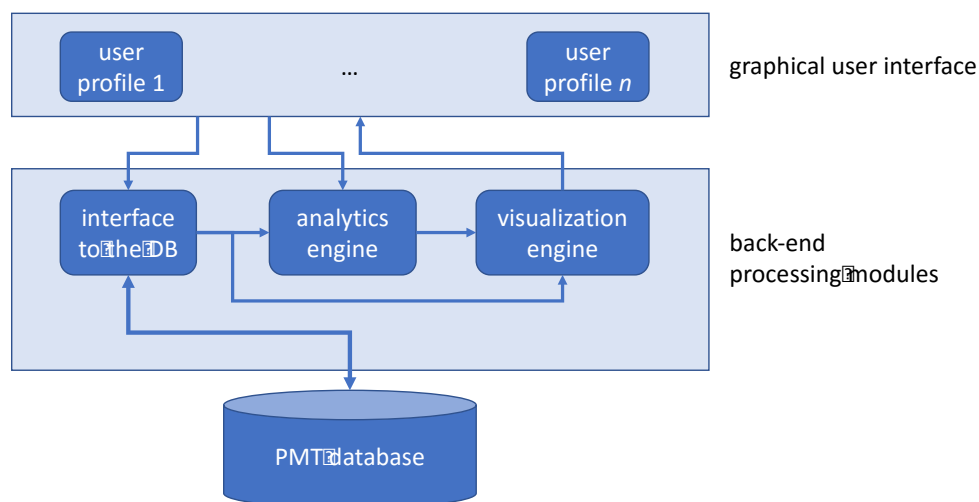
To define in detail the functionality of the DAVT it will be necessary to know the conceptual model (e.g., an entity-relationship diagram) that will be used to formally describe the above data. For the implementation of the DAVT, more specific information will be necessary, including the logical model of the DB (e.g., the relational model) and the DBMS used. In particular, to widen as much as possible the scope of the data exploration and analysis process, the four kinds of information listed above should be properly linked in the DB, starting from the conceptual model. For instance, the taxonomy of policy issues, or a suitable subset of it, could be used to characterize also past mass gathering events beside documents on security policy.

As planned in the requirements, the DB will be populated with an initial set of data before release. The availability of an initial set of data of the different types listed above will be fundamental also during the development of the DAVT.

- A **software layer** that will implement the **back-end processing modules** of the DAT, which can be subdivided into three broad groups:
  - **interface to the DB** for retrieving data (querying);
  - **analytics engine**, to implement data summarization and processing functionality which will be deemed useful to the PMT (e.g., cluster analysis could be useful to reveal hidden patterns in past mass gathering events); in particular, such functionality will be implemented interactively, according to the human-centred approach of LETSCROWD, to keep the PMT users in control of the data analysis process;
  - **visualization engine**: it should include suitable visualization tools commonly used in DA, and especially in VA, like dashboards and geo-spatial visualization tools (to show, e.g., geo-localized information on mass gathering events).
- An easy-to-use, **graphical user interface** (GUI), which will allow end users not expert in data analysis to access all the functionality of the DAVT. In particular, a dedicated GUI will be developed for each user profile of the PMT to take into account different needs of end users; potentially different access permissions to the DB will be managed through suitable security levels (in the case when users of the PMT should be allowed to access only a subset of data in the DB, pertinent to their profile). A web-based GUI is envisaged, to maximize flexibility in the deployment of the DAVT.

The functional scheme of the DVAT is shown in Figure 3.

Currently, several solutions are available to implement the three kinds of software modules above, including open source solutions for DA tools [DG CONNECT REPORT]. Whenever possible, publicly available open-source software tools will be exploited.



**FIGURE 3 – Functional scheme of the data analysis and visualization tool**

### 3.2 USERS

According to the requirements (deliverable D2.1), the PMT will have different user roles, and should allow to create more roles as needed; at least two roles are currently planned: Event planner, and Authority (which has to decide about event authorization). This has some implications for the DAVT. The main one is that different user profiles should be implemented, and mapped to user roles; for each user profile a specific set of analytics functionality should be planned, including a potentially different subset of data that can be accessed on the DB through suitable security levels, as well as a dedicated GUI. To widen the scope of the PMT it could be useful to include also LEA's among the PMT user roles, e.g., to allow them to provide feedback to policy makers based on information extracted through the PMT (possibly including the DAVT).

The specific functionality of the DAVT for each user profile will be defined in the continuation of the WP4 activities, starting from the information already collected in WP2 through LEA's questionnaires, including the different processes of interest in the area of mass gathering events, e.g., interactions between LEA's and policy makers, data/information used, existing formal or informal procedures, etc.

### 3.3 FUNCTIONALITY

From a high-level view, the DA functionality that is planned for the DAVT on the basis of the discussion in section 2 is descriptive analytics, using a VA approach. The possibility of including diagnostic or predictive types of analytics will be considered, depending on the needs of the end users that will be elicited in the continuation of WP4 activities, and on the available data.

At this stage of task T4.2 activities, only a sketch of data analysis tasks that could be carried out using the DAVT can be given, e.g.:

- comparing past mass gathering events exhibiting some features of interest (like type of event, location, etc.), e.g., to support decision about the authorization of a new event;
- searching for policy documents related to certain kinds of mass gathering events, to understand how they are regulated and/or managed at different levels (local, regional, national, or in different countries).

## 4 NEXT STEPS

In the following a summary is given of the next steps toward the development of the DAVT, pointing out the ones which require the involvement of the other WP4 partners.

- Identifying in detail the high-level functionality the DAVT should implement for each user profile of the PMT, in terms of data exploration, analysis and reporting. This includes understanding the role of the LEA's in the different processes related to mass gathering events, both short-term ones (e.g., management of a specific event) and long-term ones, i.e., whether and how LEA's are or can be involved in the policy making process (e.g., by providing feedback or advice to policy makers). Consequently, this will allow to define what kind of information the PMT, and specifically the DAVT, can allow LEA's to obtain to support their activities, and possibly to enable or improve their effective involvement in the policy making process. This can be obtained by integrating the LEA's questionnaires collected at the beginning of WP2 with more focused meetings between LEA's and the other project partners involved in WP4.
- Defining the other kind of information that will be stored in the DB of the PMT (e.g., indicators and measures, past mass gathering events), to enable the definition of the high-level functionality that can be actually implemented by the DAVT, among the ones identified in the step above (these two steps can interact).
- Developing a prototype of the GUI of the DAVT.
- Defining the conceptual and logical models of the data that will be stored in the DB of the PMT, and then the DBMS software tool, to enable the implementation of the back-end processing modules of the DAVT, i.e., the analytics engine and the interface to the DB for data retrieval.
- Analyzing the available open-source solutions that can be potentially used to implement the software modules of the DAVT.
- Developing a prototype of the DAVT.

## 5 ANNEX A

In this section the current results of the activities of task T4.1 which are relevant to the DAVT are summarized, i.e., the definition of a taxonomy of policy issues related to mass gathering events, and the collection of policy documents related to crowd safety and security.

In the context of LETSCROWD, "policy" is defined in D4.1 as "a set of ideas or principles of action adopted by authorities", and "policy issues" are defined as "the current and/or potential problems in relation to the protection of people in mass gatherings that may require policy making".

The taxonomy of policy issues defined in D4.1 is organized as a two-level hierarchy, and every second-level category is associated to a set of possible values. The taxonomy is summarized below, with the values of the second-level categories shown in brackets:

- Events considered
  - Type (sporting, religious, cultural, political, special, other)
  - Venue (indoor, outdoor, contained, uncontained, other)
- Legal issues
  - Roles (public authorities, organizer, LEA's, stakeholders, others)
  - Responsibilities (public authorities, organizer, LEA's, stakeholders, others)
  - Authorization (authority, events/activities not permitted, administrative process, organizer duties, requirements/conditions)
  - Infractions/sanctions (organizer, spectators/citizens, stakeholders, LEA's, others)
  - Citizen rights (rights/restrictions, privacy, information/awareness, insurance coverage, complaints, others)
- Security issues
  - Organization (leadership authority/structure, LEA's involved, other agents, communications, procedures, others)
  - Planning (risk assessment, emergency plan, meetings, inspections, gathering information, others)
  - Police and security measures (access control, crowd management, cybersecurity, alarm/warning, surveillance, security personnel, asset deployment, other)

A first set of policy documents related to crowd safety and security have also been collected in T4.1, from both EU and non-EU countries. They have been categorized according to the above taxonomy of policy issues. Such documents have been further categorized according to their scope (national, regional or local), and a textual description has been added either to each second-level category of the taxonomy, or to specific values of second-level categories.



## 6 REFERENCES AND ACRONYMS

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### 6.2 ACRONYMS

#### Acronyms List

DA	Data Analysis/Analytics
DAVT	Data Analysis and Visualization Tool
DB	Database
GUI	Graphical User Interface
LEA	Law Enforcement Agency
PMT	Policy Making Toolkit
VA	Visual Analytics

TABLE 1 – Acronyms