The Case for Collaborative Policy Experimentation Using Advanced Geospatial Data Analytics and Visualisation

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Abstract. *PoliVisu* is a new Research and Innovation project specifically designed to utilise stakeholder knowledge by creating a more collaborative policy making process. By harnessing visualisation technologies, *PoliVisu* begins to close data gaps that have long impeded effective policymaking. As problems are illuminated, policy-making can become more targeted, with attention appropriately and efficiently directed; more tailored, so that responses fit divergent needs; more nimble, able to adjust quickly to changing circumstances; and more experimental, with real-time testing of how problems respond to different strategies. This paper outlines the theory behind the design of *PoliVisu* and the expected impact of this new policy modelling approach.

Keywords: Policy · Co-creation · Collaboration · GI · Geospatial · Analytics Visualisation

1 Introduction

1.1 Objective

PoliVisu is a new Research and Innovation project designed to evolve the traditional public policy making cycle (outlined by Patton & Sawicki[1]) using big data. The aim is to enhance an open set of digital tools to leverage data to help public sector decision-making become more open and democratic by (a) experimenting with different policy options through impact visualisation and (b) using the resulting visualisations to engage and harness the collective intelligence of urban stakeholders for collaborative solution development.

Working with three cities – Ghent, Belgium. Plzen, Czech Republic and Issy-les-Moulineaux, France - to address societal problems linked to smart mobility and urban planning, the intention is to enable public administrations to respond to urban challenges

[1] https://www.researchgate.net/figure/260579927_fig1_Fig-1-Policy-Analysis-Cycle-Patton-and-Sawicki-1993.

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by enriching the policy making process with opportunities for policy experimentation at three different steps of the policy cycle (policy design, policy implementation, and policy evaluation). Experimentation of policy options will enable the cities to *work with all city stakeholders from residents and visitors to businesses and academia,* to tackle complex, systemic policy problems that require a collaborative approach for innovative thinking to develop transformative solutions.

PoliVisu believes that over the next decade cities will experience a paradigm shift in the way they are governed thanks to an explosion of data and enabling technologies such as blockchain, artificial intelligence and cognitive computing. Today, however, many cities are just at the start of the transformation journey. A recent Forrester report found that only 12% of city data is analysed and used for decision-making and management, currently leaving 88% untouched[2]. It follows that whilst cities are data-rich environments, they lack (a) the technical skills and knowledge needed to make sense of the data, and (b) the principles and protocols to use the data morally and ethically to make decisions. Recognising these challenges *PoliVisu* sets out to provide public administrations not just with tools for open evidence-based policy-making, but also with a broader understanding of the methodology and implications of how to combine data with social innovation to enhance the democratic value of policies.

1.2 Transport as a Test Case

PoliVisu's approach to data-driven policy experimentation will be tested in the field of smart mobility, chosen because transport forms the backbone of all urban economies. The ability to move freely, cost-effectively and easily is one of the most important drivers of economic and societal development. Its policies are interdisciplinary with a direct impact on urban development and the environment. For example, urban congestion, an exponentially growing problem in Europe contributes to over 40% of all CO_2 emissions and up to 70% of other pollutants[3]. The cost to society includes impact on health and damage to the environment. The cost to drivers of wasted time across all 45,662 major European traffic hotspots (identified in 2016) could amount to €207.9 billion by 2025. It's clear that European cities require effective strategies to help overcome these challenges.

But policy making can be a long and laborious process, which struggles to keep up with the realities of everyday life. For instance, despite policies like the Kyoto Protocol, which over 10 years ago, set out strategies to cut CO_2, cities like Paris are suffering the highest levels of air pollution in over a decade[4]! Today's policy makers have a need to act urgently, working with city managers to craft, trial and assess short-term measures, including new transport initiatives, to more rapidly achieve their overarching policy goals.

[2] http://datasmart.ash.harvard.edu/news/article/analytics-excellence-roadmap-866.

[3] *Network Design and Optimization for Smart Cities, Chap. 7, p. 45*

[4] *Independent, December 2016* http://www.independent.co.uk/news/world/europe/paris-pollution-increase-air-smog-france-capital-car-limits-fossil-fuels-weather-a7500426.html.

Making agile policy decisions however, is easier said than done. Until recent years, transport was a comparatively staid field with policy making mainly focusing on the physical compliance activities of transport providers, for example road use, licensing, insurance, and safety. There was little evidence of collaborative working with other stakeholders, understanding user behaviour, and innovation levels were, generally spoken, low. Fast forward fifteen years, the evolution of the Internet means it's all change! Today the world is experiencing an explosion of new technology (Internet-of-everything, cognitive analytics, sensors) that is rapidly modifying the nature of transport; connecting information rather than just people and goods. New technology and the resulting location based geographical information (GI) it produces is changing the nature, costs and impact of transport on a real-time basis. It is this shift in speed, detail and synchronicity that presents a suite of new opportunities for public sector policy makers.

Whilst the private sector understands the power of the new prospects unleashed by the transport data tsunami, e.g. the release of 'big' flight data by the airline industry for open innovation to generate more effective sales, much of the public sector has yet to catch up. Decision makers are still rooted in traditional ways of doing things, making policy decisions based upon static models of consultation and closed planning meetings over a timeframe of a year or more. As a result, decision making is often siloed and slow, with thinking and solutions out-of-date by the time policy is ready to be implemented.

Yet it's clear to even the oldest most recalcitrant politician that the world has changed. Technology has changed us all, and so solving mobility problems in old ways no longer works. Whilst many administrations are utilising a range of innovative solutions to combat urban challenges (e.g. variable congestion charging) no-one is yet harnessing the full disruptive power provided by big data and analysis to prepare collaborative solutions that utilise the knowledge and experience of a range of urban stakeholders.

When it comes to modern transport policy, legislation and regulation will mean the difference between a potentially green utopia and a congested dystopia. Adopting new technology alone is not enough, systemic thinking is needed and the use of big data can help. Whilst the concept of driverless cars is undeniably cool, what happens if we have ever more cars clogging up our streets, polluting the air, driving around endlessly, free from the need to ever pay for parking? What type of policies will create more green, pedestrian spaces in cities? Should cities be taxing journeys not cars; establishing high levies for single passenger journeys rather than increasing fuel costs? New methodologies and tools are needed to explore, experiment and test innovative approaches to addressing policy challenges.

1.3 Challenges to Over Come

To take advantage of the increasing opportunities presented by city data for improving collaborative policy-making *PoliVisu* believes two major sub-challenges must be addressed:

- *Data Literacy:* The benefits (and risks) of data (especially Geographic Information (GI)) are not always widely appreciated by policy makers outside of specialist data teams, and as a result the use of data in the policy making remains low
- *Advanced Technology:* As policymakers move towards using data the need for advanced analytical techniques and easy to use tools to extract trusted intelligence from data becomes crucial

Although a variety of previous projects across the globe (e.g. Ordnance Survey MasterMap[5] and ESRI[6]) have furthered the state-of-the-art in using data for improving the policy process, they have generally tended to focus on research in niche aspects of the policy cycle or indeed in narrowly defined target areas such as crisis management rather than encompass wider societal challenges such as mobility. They also tend to focus on providing a specific solution to a direct challenge rather than enabling administrators to experiment and test a range of creative policy options that challenge conventional thinking to stimulate more creative solutions.

PoliVisu goes beyond the state-of-the-art to create new policy experimentation methodologies for use with visualisation tools that utilise open GI data to stimulate innovative thinking around complex mobility challenges. The use of interactive maps, heat maps and charts to understand user behaviour (e.g. shifts in traffic flows/volume due to changing events) enables inter-disciplinary actors to explore new policy ideas together in a holistic, comprehensive, systematic, analytic, and visual manner before deploying costly pilot schemes.

Using visualisation tools, analysis of problems can have greater depth as many layers of data relating to the physical and social world can be considered together. With big data the tools can explore impacts across a whole city, rather than just one or two small localities. Instead of providing spreadsheets of uninspiring figures to illustrate the impacts of, for example road routing decisions, visualisations provide *one version of the truth* for all to use. Visualising the data can make relationships more apparent, dependencies and interactions can be more clearly viewed and the trade-off between a variety of possible solutions can be modelled and evaluated. *PoliVisu* overcomes the current challenges that hinder the use of data for policy making as follows:

(1) *Data Literacy: PoliVisu* ensures the opportunities presented by big data in policy making are open to all public administrations across Europe by developing and testing a collaborative framework for policy design and big data interplay that public administrations can use alongside their current process (evolution, not revolution). *PoliVisu* will package its data tools and support material in a Playbox (online toolkit) enabling public administrations to undertake policy experimentation, and will offer free training to cities across Europe to use the *PoliVisu* Playbox to learn how open and big data can be harnessed for policy making. Positive user-stories from the results of the *PoliVisu* testing will be developed and disseminated

[5] https://www.ordnancesurvey.co.uk/business-and-government/products/mastermap-products.html.

[6] http://www.esri.com/industries/federal/policy-making.

to showcase the business case and provide incentives for the use of data for policy making

(2) *Advanced Technology: PoliVisu* will make it easier to analyse data and derive accurate insights for policy development in a real-world context by providing decision-makers (policy and operational) with visual, map-based, interactive data analytic tools that will facilitate data-driven decision making. *PoliVisu* will integrate crowd-sourcing applications that utilise existing social media channels to support collaboration and open policy making, and will ensure all *PoliVisu* tools are scalable, pluggable and interoperable so they can be used with any administrations existing (data) platforms. The tools will be tested with the use of real big data sources including real-time data publication in RDF and its further combined use (e.g. road sensor data, parking availability, traffic cameras data, city bike rental availability, public transport schedules GTFS data etc.).

2 Approach

2.1 Reimagining the Policy Making Lifecycle

PoliVisu is designed to advance policy development in the age of big data, to deliver a trusted, scalable and transferable solution for accelerating the adoption of data-driven policy-making. More specifically it is designed to stimulate innovative solutions to societal challenges by making it easier for policy makers and their stakeholders to access, visualise and use a wide variety of big geo-data sources to explore and co-create policy.

PoliVisu achieves the above by conceptualising the policy making process as a fast policy experimentation cycle consisting of three steps - Design, Implementation and Evaluation - thereby transforming traditional processes into a continuous policy adaptation cycle. The new approach reduces the gap between city policy making and operations by converting traditional high level strategic policies into more adaptive, better, context driven solutions thanks to the use of big data. An overview of the imagined *PoliVisu* Experimentation Cycle (Framework) follows.

CYCLE A. *Policy design process:* The current policy design process starts with the identification of a need for a policy solution. The identification of such a need is often based on the assessment by the public, involved actors and participants of the output of existing policies. The policy design process can be very complicated. It is often iterative, with different options and solutions being proposed and having to be reworked in response to feedback from decision makers, stakeholders and the public at large. The range of options is often constrained by interfaces with other policies or legal requirements. Different stakeholders will have different and possibly conflicting views on the proposed solutions - or even whether a new policy is needed at all - and will try and influence not only the policy but also the views of others to their advantage. Effective co-creation means sharing sufficient information in accessible ways to enable the public to make meaningful inputs and choices, and to do so in trusted ways that can counter biased interpretations from others trying to influence public response, hence the use of *PoliVisu*'s data visualisations to share one version of the truth.

This identification process begins with consulting different stakeholder groups. The policy need will be researched by or on behalf of public institutions and evidence for the policy need will be collected from stakeholders and the community. During this phase, it is key to congregate objective data about all policy aspects involved (for example, mobility impact, environmental impact, impact on society and financial implications). Based on the research and other evidence, a public institution often produces a discussion paper summarising the evidence and suggesting the main principles for future policy. The discussion paper may be part of further consultation with stakeholders and the public seeking to establish consensus on the need for policy creation or change and the main principles on which to develop detailed proposals. Based on consensus of the discussion paper (or, at least, clearly defined positions), concrete policy options can be developed.

PoliVisu supplements and speeds up this paper process through online visualisations of different policy options and their impacts in order to experiment with finding new solutions that work for the majority. One or more concrete policy options can then be subject to a further consultation with stakeholders and the public using traditional and social media methods. After the consultation step and feedback step, a policy decision will be formulated.

CYCLE B. *Policy implementation process:* A first transversal step is the communication of the decided policy as a result of the policy design process. *PoliVisu* explores the policy using relevant data to provide insights by using advanced visualisation techniques, including interactive map tools and graphs. The next step is to publish the policy. Using a combination of its own media and external publication channels such as press, PoliVisu will explain the policy to external audiences. The *PoliVisu* visualisations will be an essential part of the publication besides the use of social media to interact with the public.

Next *PoliVisu* will help with reaction monitoring. During this step, new techniques will be used to monitor the opinions published in newspapers and on the internet. Part of the monitoring is also the ability to measure source reliability. With the information gathered, the Impact of the announcement can be assessed by measuring the number of reactions, the location, the mood etc. to verify public acceptance. The impact data will be collected and managed via a number of specific components that will be used, adapted or developed during the project by integrating advanced visualisation tools dealing with live and big data, social media tools capable of collecting reactions and web publication interfaces needed to publish information online.

The collected input will be managed and analysed using advanced *PoliVisu* tools or cities' own management dashboards for policies. The outcomes can be used to support both operational decisions and policy decisions dependent on elements such as impact, importance, and implementation time. The results will also be used to influence policy communication itself. This will be achieved by publishing information on channels managed directly by the cities and or via external channels like newspapers and social media.

CYCLE C. *Policy evaluation process:* PoliVisu adopts a multidimensional impact assessment approach to comparing the impact of its activities on different policy areas

like environment, mobility, financing and citizen welfare. As a result of the multidimensional impact assessment, implementation and monitoring actions will be formulated and used to drive the decision-making process. The multidimensional long-term monitoring can influence both the implementation process and the way new policies will be designed in the future (Fig. 1).

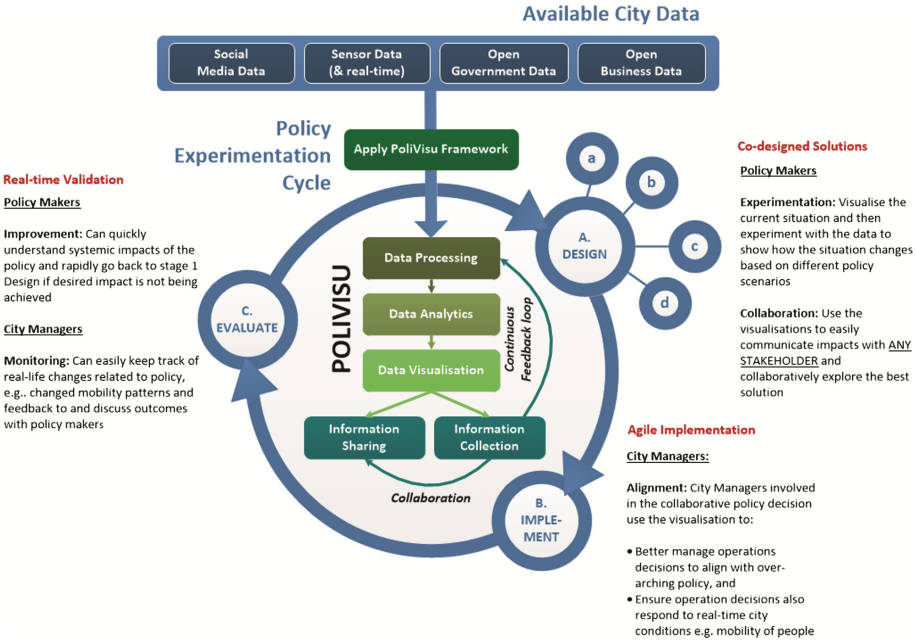

Fig. 1. High level concept of the policy experimentation cycle

2.2 Creating the PoliVisu Playbox

To ensure all cities have the opportunity to avail of the lessons and tools from *PoliVisu*'s research and innovation work, they will be packaged into the *PoliVisu* Playbox for data-driven policy experimentation. The key components include:

- POLIVISU FRAMEWORK: The *PoliVisu* framework will develop a policy experimentation cycle outlining the rationale for, and how and where and how big data can be utilised for smarter decision making. It will highlight the types of data that is potentially useful for decision-making, where it is commonly found and how it can be harnessed and utilised. Considerations around privacy and legal concerns will be addressed to establish processes that deliver accurate/truthful policy scenario visualisations as well as mechanisms for ensuring fair collaborations.
- BUSINESS CASE FOR DATA AND POLICY: The use of data for policy purposes makes it possible to assess the potential policy impact of measures to elaborate long-term trends and the impact of decisions made in the past. The use of big data is important to take fact-based decisions taking information from different sources into

account (transport, environment, land-use planning, demographic). Being able to describe these benefits in policy-maker's own language (non-academic) is vital to the engagement and take-up of *PoliVisu.*

- AVAILABLE DATA: Open data is a key component of the project. The pilot cities have been involved in open data projects and initiatives and have an existing source of available open (some big) transport and geo data to use, as well as established relationships with private sector data suppliers. This available data provides a comprehensive foundation for use in policy experimentation.
- GEOSPARC GEOSPATIAL[7]: A set of free and open source geospatial tools for publishing, visualisation and analysis of spatial data to create interactive digitals maps. The maps can be integrated within any software (CRM, ERP, Document Management Systems etc.) or within existing business processes. These maps form the base layer of the *PoliVisu* visualisations.
- WEBGLAYER[8]: WebGLayer is a JavaScript, WebGL based open source library for coordinated multiple views Visualisations. The library is focused on spatial data and large datasets (up to 1.5 million data records). It was developed and supported by EU CIP project OpenTransportNet[9] for traffic flows and traffic accidents and will be expanded and enhanced within *PoliVisu* to facilitate a wider range of visualisations that meet cities' needs when working with smart mobility policy.
- MICKA[10]: MicKa is an open source system for metadata management used for building Spatial Data Infrastructure (SDI) and (INSPIRE-compatible) geoportal solutions. It contains tools for editing and management of metadata for spatial information, web services and other sources (documents, websites, etc.). It includes an online metadata search engine, portrayal of spatial information and download of spatial data. MicKa will be *PoliVisu's* metadata editor.
- TRUTHNEST[11]: TruthNest is a social media evaluation tool that helps clients to locate credible sources of information efficiently, verify the sources of that information and monitor the social ecosystem effectively by creating smart, semantically meaningful, context-aware, dynamic, cross-network streams. TruthNest today is used by several media companies. *PoliVisu* will enhance TruthNest with improved analytics of social media trustworthiness and automated processes to provide stakeholder input on matters influencing policy.
- WARP 10[12]: Cityzen Data is a big data solution company that provides an advanced big data software solution (Warp 10) based on "Geo Time Series" technology. Warp 10 addresses data coming from a large range of sensors, meters, IoT and more generally to any flow of data measured in time and space. Warp 10 is open source and scalable to support even the biggest of big data. The open solution allows implementation of advanced data analytics including machine learning/pattern detection.

[7] http://www.geosparc.com/.
[8] http://webglayer.org.
[9] http://www.opentransportnet.eu.
[10] https://micka.geology.cz.
[11] http://www.truthnest.com.
[12] http://www.warp10.io.

- MACQ[13]: The Macq smart mobility platform offers smart city and traffic management solutions based on live data streams coming from a range of mobility and traffic related sensors including detection and counting of vehicles, ANPR, classification, intersection traffic lights, urban centralized traffic coordination, variable message signs, intelligent cameras, centralized edifice management (tunnels, bridges, locks …), control and monitoring of highway lighting, weather stations, safety management in tunnels in cities and highways. This data will be used in *PoliVisu* data modelling.
- SENSLOG[14]: SensLog is an integrated solution for sensor networks. SensLog consists of a data model and server-side application which is capable to store, analyse and publish data in various ways. SensLog receives measured data from nodes or gateways, stores data properly in the database, pre-processes for easier queries if desired and then publishes data through the system of web services. SensLog is suitable for sensor networks with static sensors (e.g. meteorological stations) as well as for mobile sensors (e.g. tracking of vehicles, human-as-sensor). *PoliVisu* will use the Senslog source code freely available on GitHub to manage its sensor data.
- OPEN TRANSPORT MAP[15]: OpenTransportMap is an open source traffic volumes modelling tool providing interactive web visualisation of traffic volumes. OTM provides detailed traffic model at the city/region level with hourly traffic intensities. In *PoliVisu*, the aim is to automate the traffic modelling engine for the cities so that actual/forecasted traffic impact can be calculated real-time for any roadworks.

These existing pluggable and portable open source components can be adapted to create advanced visualisations for policy making. The use of modular technologies is a strategy to ensure the PoliVisu solution can be easily adopted for integration within cities' existing policy platforms (for instance a city's existing website or citizen participation platform) as previous project experience has shown that cities already have too many stand-alone platforms for a variety of operations and often prefer pluggable, interoperable and configurable solutions. The modular approach also ensures scalability as new modules for Artificial Intelligence and more complex algorithms can be added as technology improves, thereby PoliVisu can keep one step ahead of the market. Technical and functional specifications for integration will be developed in collaboration with cities at the start of the project. However, the diagram below depicts which logical layers and technical components will be used during the process flow for accessing, analysing and visualising data (Fig. 2).

Data Processing: PoliVisu will access very diverse data sources including big datasets, sensor data, social media, open data, metadata, spatial data, etc. The aim is to set up an infrastructure of "smart data", which means that any data coming from sensors or other sources are stored as row data, can be used in any application, can be analysed and correlated with other sources of data and can be used to provide detection of patterns to understand the effective functioning of any infrastructure, system, services or process

[13] https://www.macq.eu/macq_images/static/images/Macq-brochure-M3-EN.pdf.
[14] http://www.senslog.org.
[15] https://inspire-reference.jrc.ec.europa.eu/apps/open-transport-map-otm.

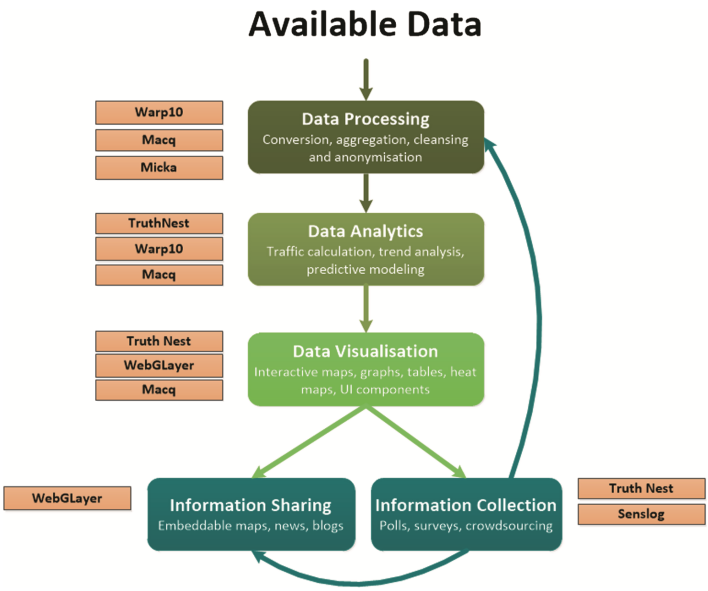

Fig. 2. Technical component mapping against processes to achieve policy impact visualisations

within the city. This smart data architecture will leverage Geo Time series™ in which all sensor data or any probe measuring an event will be defined in time and space (location). This allows the management of data in a very efficient way and agnostic on the types of applications using the data.

Another important responsibility are the processes and techniques to make the data usable for policy making in terms of privacy through anonymization, aggregation, blurring, etc. Big data (e.g. data coming from automatic number plate recognition or ANPR) provides a high level of detail on mobility and traffic flows. The level of detail captured and stored therefore raises questions about privacy. Police departments are allowed to store this kind of detailed information for a limited time period. If that information needs to be stored for a longer period (for instance to perform historical analysis), certain anonymization is required so that no private personal details can be extracted from it. Especially when such detailed information is made open data. Technical components Warp 10, the Macq system, Micka (metadata), SensLog and the Geospatial components provide capabilities to support data processing.

Data Analytics: The resulting smart data infrastructure provides a horizontal and reproducible approach for analytics and functional applications like (a) analysis of road safety, the use of traffic infrastructure and car parks, (b) understanding the impact of weather, seasons, date and time on traffic and mobility, (c) predict the evolution of infrastructure usage (incl. Traffic models), (d) predict faults or problems on city systems, transport infrastructure, congestions. The data analytics layer performs traffic calculations, discovery of correlations within or between data sources, detection of trends, social media or sentiment analysis, impact assessment, spatial analysis and modelling. Data

analytics are provided by Warp 10/Cityzen Data, the Macq system, TruthNest, the OpenTransport Map Traffic Modelling and the Geospatial components (spatial analysis).

Data Visualisation: The data Visualisation layer foresees the necessary tools, GUI components, libraries and widgets to present the results of the data analytics in a set of powerful yet easy-to-use and intuitive visualisations. A strong focus is on presenting the spatial-temporal aspect of the data in an "interactive" and "connected" way. Interactivity means that the user can interact through the GUI and the system will respond (near) real-time. Connectivity is realised by integrated, linked and synchronised graphs, (heat) maps and tables.

This layer also delivers functionality to integrate multiple dimensions of data into a single-screen visualisation, to present a correlation between metrics or to highlight trends. Another important aspect of data presentation is the use of inline and smart user guidance and tooltips taking into account that an increasing amount of data Visualisations will be handled on touch and mobile devices. WebGLayer, TruthNest, the Macq web frontend and the Geospatial components deliver data visualisation functionality.

3 Ambition

PoliVisu is designed to go beyond the state-of-the-art in: (A) The use of data for decision/policy making in the public sector, and (B) The use of big data for visualisation's. This research will be expand at the start of the project, but initial findings highlighted below, demonstrate how *PoliVisu* goes beyond the state-of-the-art in these areas to deliver an original solution for data-driven policy making.

3.1 Data Driven Decision Making in the Public Sector

Whilst not as prolific as in the private sector, Government has started to utilise their data to react to citizen demands and concerns, and to even proactively anticipate an issue before it develops into a crisis. Examples of advanced data-driven decision-making happening right now within public agencies across the globe conducted by the Peppers & Rogers Research Group[16] include:

Citizen Complaints: The Hong Kong government's Efficiency Unit[17] acts as single point of contact for many government departments to handle citizen complaints and suggestions. Each year, the unit receives 2.65 million calls and 98,000 emails. The office partnered with a text-mining firm to build a complaint intelligence system to analyse all the data and uncover patterns to help establish the root causes of many problems. Report generation is shortened from one week to one click, and the responsible department is immediately informed of issues.

[16] *Achieving Excellence Via Data Driven Decision Making in Government* https://issuu.com/govsummit/docs/achieving_excellence_via_data-drive.

[17] http://www.eu.gov.hk/en/index.html.

Transportation: West Virginia's Department of Transportation[18] continuously tracks traffic at 2,500 spots around the state to understand a variety of components such as average daily traffic, vehicle type information, intersection turning movement information, and annual vehicle miles. The information is used by the planning team to plan infrastructure enhancements and prioritize new construction projects.

Utilities and Energy: Eastern Denmark used to work with 16 partners to balance electricity supply on a daily basis in order to anticipate the right amount of power consumption and production needed. After partnering with Copenhagen Energy, which drove the use of data driven decision- making, consumption can now be predicted on an hourly basis to minimize production waste[19].

Education: Countries economic development and competitiveness needs a high-quality education programme across all levels of schooling. Delivering education through a blanket approach does not help every student reach their full potential as students have different needs, competences and capabilities. Data driven decision making can be used to determine personalised education plans, enhance curriculums, plan staff recruitment and even offer the optimal location for new education buildings.

Going a step further and actually using the data for official policy making is still largely confined to theoretical concepts or only specific types of data rather than a sufficiently large combination thereof. Previous projects financed through Horizon 2020 and FP7 funding as shown below have made great strides in pushing forward open and linked data on a more technological level in public administrations, but take up has been low. Additional projects include:

ASK[20] is an innovative concept providing a 'data broker' model to connect policy makers and young people over Twitter. The data broker dashboard is specifically designed to reformulate dry policy texts into more engaging material that will spark reaction from both young people and policy makers fuelling debate and insights that close the gap between what policy makers think young people care about and the actual needs/concerns of youth.

COCKPIT[21] (Citizens Collaboration and Co-creation in Public Sector Service Provision) explored how Web 2.0 social media could be used for collaboration and cooperation between citizens themselves, and between citizens and public administrations. Their resulting model is still widely referenced today.

Puzzled by Policy[22] used algorithms and apps to create a tool that after a short, fun, interactive quiz plotted a user (citizen) on a political dimension map so they could see other groups/communities/organisations that shared their viewpoints. Policymakers benefited from the analysis of the data seeing where general consensus lay for specific issues around immigration.

[18] http://www.transportation.wv.gov/highways/programplanning/plan_conf/Documents/2011PC/GTI__Section.pdf.
[19] http://cleancluster.dk/wp-content/uploads/2015/05/Co-creating-the-cities-of-tomorrow.pdf.
[20] www.ask-project.eu.
[21] http://www.igi-global.com/article/citizens-collaboration-creation-public-service/70075.
[22] www.puzzledbypolicy.eu

WeGov[23] provided social networking technology to deliver new opportunities for policy makers (eGovernment) to engage with the community (eSociety). The project delivered a toolkit for policy makers helping them to take advantage of new (at the time) channels such as Facebook and Twitter.

OCOPOMO[24] (Open Collaboration in Policy Making) addressed two levels of scientific and technological advancements: (1) Socio-political: to formulate, model, evaluate and monitor social and economic policies of governments, which are supported by (2) Scientific and technological innovations.

CROSSROAD[25]: Created a participative roadmap for ICT research in electronic governance and policy modelling. The roadmap identified emerging technologies, new governance models and novel application scenarios in the area of participation, electronic governance and policy modelling, leading to the structuring of a beyond the state-of-the-art research agenda, fully embraced by research and practice communities.

WAVE[26]: (Welcoming Argument Visualisation to Europe) explored how an argument visualisation modelling platform could be used to break down complex policy arguments into easily understandable bite size chunks and bring citizens into the debate. The platform was critically well regarded but too complex for the average person to use. The debategraph tool is still in use today by academic organisations and media platforms such as The Guardian online.

PoliVisu goes beyond the state-of-the-art in data driven decision-making in the public sector by (1) bringing in a true collaboration aspect to the process. *PoliVisu* makes the data easily understood by a range of stakeholders who provide feedback into the decision/policy process via traditional methods or via social media. (2) *PoliVisu* removes the need for replacing or adding another platform into a city's mix of management tools as its modular and reusable components can be integrated in existing solutions (for instance a city's existing website or citizen participation platform). (3) *PoliVisu* is designed to be transferable so whilst it is tested in the smart mobility arena it can be used for any area of policy making where geo-data is relevant, such as infrastructure planning, environmental strategy, energy use etc. Finally, (4) whilst *PoliVisu* provides technical tools the Framework is actually technologically agnostic and can be flexible adapted to accommodate future new components with ease.

3.2 State-of-the-Art for Data Visualisations

Recent explosion of data in terms of size has been accompanied by a proliferation of tools offering effective and appealing data visualisations. Existing solutions on the

[23] http://www.wegov-project.eu/.
[24] http://www.ocopomo.eu/results/presentations/crossroad-ws-ifip-egov-2010/files/ocopomo.pdf.
[25] http://is.jrc.ec.europa.eu/pages/EAP/CROSSROAD.html.
[26] http://www.participatedb.com/projects/15.

market include desktop applications that are used by non-experts and the more technically minded alike (e.g. Tableau[27], R[28]), JavaScript libraries that are popular with developers (e.g. D3[29], Leaflet[30]) and web applications that cater for both audience types (e.g. CARTO[31], Mapbox[32]).

Because data is increasingly about interactions and relations, it is hardly surprising that cutting edge visualisation tools must be able to deal with complex connections and networks. Geospatial and interactive features are also important as they allow users to plot data on customisable maps with additional location based information and to pan or zoom to particular points and interact with them to see any extra details. For next generation tools time resolution functionality, which allows to observe temporal patterns, is equally important, as are 3D and animation capabilities.

Perhaps a somewhat less intuitive requirement for next generation tools is that they should be accessible to experts and non-experts alike, while acting as a knowledge base and centralised hub for visualising different types of data in unique and innovative ways. To tick this requirement, they should be made accessible via a web application to eliminate the need to install special software, and their interface should be simple and intuitive to encourage data interaction for the average user and eliminate the need for coding.[33]

PoliVisu goes beyond the state-of the art in data visualisations by combining several elements of the tools above to focus on displaying policy scenarios in a holistic manner. The result is an integrated data presentation where map, graphs and tables are linked in an interactive way. *PoliVisu* focuses on very powerful map visualisation and data selection options and integrates several live data feeds coming from a variety of data sources. The possibilities for displaying the results of selection and analysis is far more advanced than in existing online GIS or map visualisation tools. *PoliVisu* also advances the state of the art in data modelling as close-to-real-time traffic model recalculations requires a significant computing power which has not been available until recently. The research of the MapReduce programming model done by the *PoliVisu* team and the recent availability of parallel cloud computing technologies allows to perform such big data calculation in almost real-time which makes it usable for these web applications. It is planned that the automated traffic volumes forecasting for multiple (overlapping) road works will be implemented for the Czech and French pilots.

3.3 Innovative Potential

Combinatorial Experimentation: As more and more public administrations begin to embrace and implement the concept of a smart city, the amount of data, including real-time datasets, being generated is enormous and constantly growing. This presents both

[27] https://www.tableau.com.
[28] http://www.computerworld.com/article/2497304/.
[29] http://www.d3technologies.com/.
[30] http://leafletjs.com/plugins.html.
[31] https://carto.com.
[32] https://www.mapbox.com/.
[33] http://www.itf-oecd.org/sites/default/files/docs/15cpb_bigdata_0.pdf.

an opportunity and a challenge; an opportunity because new data can reveal how cities function at ever smaller scales and over very short time periods; a challenge because the amount of new data that is being generated is so huge that it is not possible to visualise it all, which means most of this information will be 'lost' or unused. The problem of 'too much data' can also limit the capacity for experimentation, forcing users to focus on fewer data sources than they may otherwise would. Such a selective approach can in turn limit big data's potential to reveal hitherto unsuspected or unobserved patterns as its *real added value lies in combinatory use with other data sources.* As an acknowledgement of this fact, *PoliVisu* assembled a solution covering several data sources (e.g. social media, sensors, repositories) and provides tools (e.g. WebGLayer, Geosparc, Micka, TruthNest) for effective combinatorial experimentation with them all.

Holistic Policymaking: The idea that government should base its decisions on data, evidence, and rational analysis is not new or inventive. What's new is the opportunity created by *PoliVisu* to crystallize problems and highlight a range of effective solutions. It's hard to believe that current policy making persists much as it always has, even though technology has raced ahead and decision-making is transformed in the private sector. *PoliVisu* helps provide a broader vision to modernise and revolutionise national and local government. Too often, the various steps discussed above—technology deployment, data generation, policy development, and impact measurement—are pursued almost as separate enterprises, with little thought given to how they connect to and support each other, but *PoliVisu* brings these components into a coherent whole to implement data-driven policymaking.

Smart City Data Infrastructure: PoliVisu provides the start of a robust data architecture for smart cities, helping to identify and address some of the data gaps, the lack of systematic analysis, and poor information management and dissemination that currently hinders the use of data for policymaking.

Data-driven Leadership: Less tangible but equally important is the need to change the way we think about policymaking. Refined data permits more targeted, tailored, and experimental policymaking. Success depends on recognizing these opportunities and devising new approaches to take advantage of them. *PoliVisu* provides a first step to breaking down these barriers, and help cities reap the benefits of a data-driven government that is more effective, efficient, open, and accountable.

4 Expected Impact

Impact will be demonstrated and extrapolated from three pilot sites that will use the *PoliVisu* methodology and tools for real life policy scenarios, thus enabling the measurement of both quantifiable and qualitative impact measures on their internal processes and smart mobility policy outcomes. The results will be transferred across Europe through free training and sharing of the *PoliVisu* Playbox.

The new approach to policy experimentation will deliver impact by harnessing the levelling power of visualisations to facilitate easier inclusion of non-government players

in the decision-making process e.g. citizens, businesses, NGOs. This will make policy making more democratic and transparent by clearly showing the potential/real impact of mobility policies in an easy to understand manner. The application of visualisations will ensure daily policy decisions are data driven and evidence based. At the same time, accessibility will be increased as visualisations will be embedded into any website or existing platform for ease of sharing. Therefore, not only will the adoption of *PoliVisu* tools and processes ensure policy teams receive the support they need to enhance the effectiveness of their policy making processes, but citizens and other stakeholders will also be able to avail of the opportunity to become valuable policy influencers and solution co-creators. The ability to quickly experiment and understand the impact of a variety of policy solutions will result in saved time and costs.

This innovative approach should increase trust in decision-making by using data to present one version of the truth for all stakeholders to openly and collaboratively work with one another. PoliVisu will amplify the perceived legitimacy of government by responding to citizens' concerns through co-created policy solutions resulting in improved effectiveness of outcomes.

5 Conclusion

The *PoliVisu* innovative approach should increase trust in decision-making by using data to present one version of the truth for all stakeholders to openly and collaboratively work with one another. PoliVisu will amplify the perceived legitimacy of government by responding to citizens' concerns through co-created policy solutions resulting in improved effectiveness of outcomes. The first results from the project will be published towards the end of 2018.

References

1. Ghorbani, A., Deschene, F., Dignum, V., Jonker, C.: Enhancing ABM into an inevitable tool for policy analysis. J. Policy Complex Syst. **1**, 61–77 (2014). https://doi.org/10.18278/jpcs.1.1.3
2. Bektaş, T., Crainic, T.G., Van Woensel, T.: From managing urban freight to smart city logistics network (Chap. 7). In: Network Design and Optimization for Smart Cities, p. 45. World Scientific Publishing (2017)
3. Shehab, K.: Paris Suffers Worst Pollution for at Least a Decade. Independent, December 2016. http://www.independent.co.uk/news/world/europe/paris-pollution-increase-air-smog-france-capital-car-limits-fossil-fuels-weather-a7500426.html
4. Wiseman, J.: Analytics Excellence Roadmap: A Four-Stage Maturity Model for Data-Driven Government. Harvard Kennedy School Ash Center for Democratic Governance and Innovation (2016)
5. Ordnance Survey Master Map. https://www.ordnancesurvey.co.uk/business-and-government/products/mastermap-products.html
6. ESRI Policy Making. http://www.esri.com/industries/federal/policy-makin
7. Achieving Excellence in Data Driven Decision Making in Government. Peppers & Rogers Group. UAE Governance Summit (2015)