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Improving use of location information in e-government processes: methodology and use case

European Union

Location Framework

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Enabling digital government through geospatial & location intelligence

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Contents

Abstract

Many e-government public services and underlying processes use location information but the use of this information is not always optimal, inhibiting both efficiency and effectiveness. This report describes a two-step methodology for analysing and improving how location information is used in e-government processes, together with an approach for estimating the impact of location enablement on the performance of e-Government processes. The use of the methodology is illustrated by examining an existing use case: the Traffic Safety Monitoring process in Flanders. The process and the current and potential integration of location information are described in detail, as well as the potential improvements, the potential impact of further spatially enabling the process and a series of recommendations.

This document is one of a series of guidance documents associated with the European Union Location Framework (EULF) Blueprint. It should be read in conjunction with the companion guidance document "EULF Design of Location-Enabled e-Government Services"

Keywords: location information, e-government processes, BPMN, traffic safety

1 Introduction

1.1 The European Union Location Framework

The European Union Location Framework (EULF) aims to maximise the potential of the vast amount of money spent on location-related information and services by governments across Europe by promoting a best practice approach for cross-sector and cross-border sharing and use of this information, based on user needs and priorities, and targeting actions that will deliver efficiencies, help improve digital public services, and contribute to job creation and growth. The vision for the EULF can be summarised as follows: *"More effective services, savings in time and money, and increased growth and employment will result from adopting a coherent European framework of guidance and actions to foster cross-sector and cross-border interoperability and use of location information in e-Government, building on INSPIRE".*

The EULF was established under the European Commission's Interoperability Solutions for European Public Administrations (ISA) programme, and now forms part of the European location Interoperability Solutions for e-Government (ELISE) action in the successor ISA^2 programme[1]. EULF guidance and actions are targeted at improving interoperability and use of location information in e-Government services, based on five focus areas:

Figure 1. European Union Location Framework (EULF) focus areas

Policy and strategy alignment: a consistent EU and Member State policy and legislative approach where location information plays a significant role.

Digital government integration: making location a key enabler in G2B, G2C and G2G e-government processes and systems.

Standardisation and reuse: adoption of recognised geospatial and location-based standards and technologies, enabling interoperability and reuse.

Return on investment: ensuring funding of activities involving location information is value for money, and taking action concerning this information to stimulate innovation and growth.

Governance, partnerships and capabilities: effective decision making, collaboration, knowledge and skills, related to the supply and use of location information in the context of digital government.

EULF outputs include:

- '**EULF Strategic Vision**' - a shared vision and rationale for a European Union Location Framework, defining the scope, governance and implementation approach;
- '**Assessment of the conditions for an EULF**' - an assessment of the state of play in the different focus areas of the EULF and the need for EULF action in these areas;
- '**EULF Blueprint**' – recommendations and guidance in the five EULF focus areas and role-based views for key stakeholder groups;
- **'EULF Guidelines'** – Detailed guidance on key topics introduced in the EULF Blueprint. This document "EULF An approach to improving the use of location information in e-government processes: methodology and use case" is one of these documents and is a companion to another guidance document: "EULF Design of Location Enabled e-Government Services".

1 https://ec.europa.eu/isa2/home_en

- '**EULF References**' - inventories, links and supplementary information related to the EULF;
- **'EULF Studies'** - assess the feasibility of EU action in various policy areas, involving the sharing and reuse of location information;
- **'EULF Pilots'** - create location interoperability solutions in various policy areas (e.g. transport, marine and energy) applying and informing EULF best practices in solving real-world problems.

1.2 Objectives, scope and target audience

1.2.1 Objectives

The overall objective of this document "EULF – Improving use of location information in e-government processes: methodology and illustrative use case" is to provide guidance on improving the use of location information in e-government processes. The specific objectives of the document are:

1) To explain the context of public sector business processes;
2) To elaborate the methodology for assessing the use of location information in particular processes and measuring performance;
3) To explain how the illustrative use case was identified;
4) To describe the results of the application of the methodology for the Traffic Safety Monitoring process in the Flemish administration.

Although the method is applied only to this one particular process, in one particular country/region (Belgium/Flanders), it is argued that the method is applicable and replicable for many other cases, in different sectors and even in multi-sector and cross-border contexts.

1.2.2 Scope

The use case assessment approach assumes that an operational e-Government process exists in which the use of location information and location enabled services already takes place, at least to a certain degree. It also assumes that the process owner, potentially with external partners, is already working to improve the process and the use of location information and location services in particular. In the context of this report, KU Leuven was already working on the Traffic Safety Monitoring process between 2012 and 2015. Therefore, it was feasible to prepare the use case assessment.

This use case assessment is not intervening in the existing process, nor is it focusing on developing new spatial data, new SDI components (web services) or applications. The focus is rather on the integration of existing components and the exploration / definition of potential new and innovative approaches that could enhance the process performance (in this case the use of linked data).

1.2.3 Target audience

The report is designed for use in public administrations by e-Government process and service owners, project managers, designers and implementers, ICT developers and system integrators, and data and geographic information specialists. It is also relevant for private sector companies providing ICT and outsourcing services to public administrations and/or looking to provide innovative services through public-private partnerships.

1.2.4 Structure of document

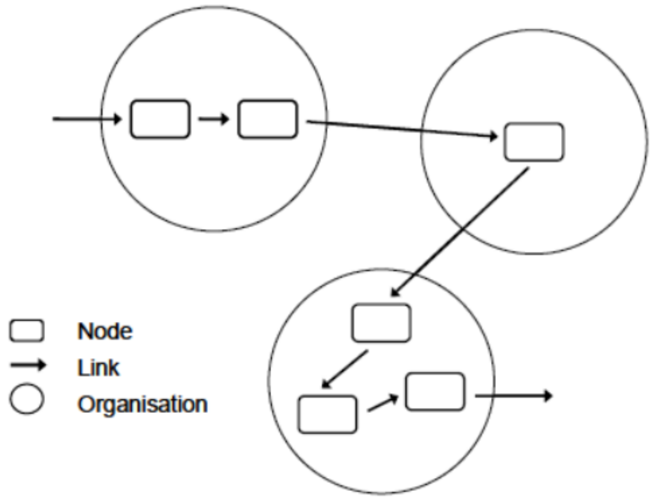
This document consists of five sections. After this introductory section 1, section 2 describes what is meant by public sector e-government processes. Section 3 describes the methodology for assessing e-Government processes in different steps and how performance can be measured to estimate the added value (benefits) of location enablement. There are then two sections relating to the application of the methodology in specific use cases. Section 4 describes the selection process for an illustrative use case. Other examples are highlighted in this section to show the types of processes that may be applicable. Section 5 describes the assessment done for the selected use case. It describes the Traffic Safety Monitoring process and its sub-processes in detail and discusses how the process was analysed and location information and location enabled services were used to improve process performance. Particular attention is also paid to the potential of introducing innovative technologies such as linked data. Finally, in Section 6 some general ideas and recommendations are formulated on how to conduct use cases based on the experience in this particular case of the Traffic Safety Monitoring process.

2 Public sector e-government processes

In the public sector, the implementation of policies mainly takes place through processes, in which policy is translated into practice. A public sector process can be defined as a set of related activities which transform a certain input of resources (e.g. a (spatial) dataset, a register, statistical data) into an output of products or services (e.g. a decision, a permit or an answer), which are often delivered to citizens, businesses or other administrations. Usually the transformation requires the processing of the input data and information to generate the required output. In the context of each policy area, many processes are in operation. Each public administration is involved in a large number of processes. Moreover, many of the processes are inter-linked. This means that, for example, a process might need the output of another process as input. For example, the initiation of a building permit might depend on the result of a check of the location of the cadastral parcel against the flood risk areas.

In the public sector, processes are often similar in structure, as their outcome is determined by law. Moreover, processes can involve different organisations (see Figure 2), at different administrative levels and/or in different thematic areas. Processes also consist of actions of and interactions among different organisations of government as well as actors outside government.

Figure 2. The process as a chain of activities within and between organisations



Source: Dessers, 2011

In other words, most processes consist of different – intra and inter-organisational – process steps and involve several interactions and exchanges between stakeholders. These interactions can be divided into Government-to-Citizen (G2C), Government-to-Business (G2B) and Government-to-Government (G2G) interactions[2]. Each of these interactions can take place in different phases of the process: at the start, at the end or during the process. Many government processes often start with a G2C or G2B interaction, e.g. a request from a citizen or a company, and also end with a G2C or G2B interaction, e.g. the delivery of a product or permission to a citizen or a company. But these G2C and G2B interactions can also take place during the process (e.g. public consultations), while also government processes exist without any G2C or G2C interactions. The latter often correspond with so called back-office processes (Pignatelli et al., 2016a).

E-Government processes are usually related to governmental policies and supported by the necessary legislation. Table 1 provides two examples of e-Government processes.

[2] It should be noted that more and more B2B, C2C and B2C interactions exist as well, but focus in this document is on the processes for which government is responsible or the process in which they are at least involved.

Table 1. Examples of e-Government processes

Policy area	**Transport**	**Health and consumers**
Policy themes	Intelligent Transport Systems (ITS)	Animal Health
Policy actions (Directives, Regulations, Decisions, Action Plans, R&D, ...)	Directive 2010/40/EU on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport and Action Plan for the Deployment of Intelligent Transport Systems in Europe	Council Regulation No 1/2005 on the protection of animals during transport and related operations and Animal Health Strategy for the European Union (2007-2013)
Processes	Traffic management	Animal transport monitoring

Source: Based on Vandenbrouke et al, 2014

A lot of the information used in e-Government processes has a geographic component, so the use and integration of spatial information in these processes is of great importance to the further development and innovation of public administration practices. Many of the challenges of contemporary society, such as protecting the environment, health, increased security, clean and efficient transport, socially just and sustainable development, risk management and enhanced service delivery to citizens require the integration of spatial information in the processes of public administration. The degree to which location information is used in existing processes is variable. Some processes use location information very intensively because of their territorial-based nature (e.g. spatial and urban planning), while some other processes do not have a clear location component and hence the need for location information might be less obvious (e.g. taxation of citizens). Table 2 provides some examples of processes and the level of location information integration.

Table 2. Integration of location information in some e-Government processes

Low integration	**Medium integration**	**High integration**
Registration of citizens Registration of companies Taxation of citizens Management of patient's health records	Planning of public transport Building permits Environment-related permits	Maintenance of addresses Registration of real property Design of land use plans

Source: Based on Vandenbrouke et al, 2014

The EULF aims to improve e-Government processes by integrating - where relevant - location information and location enabled e-Government services and by optimising the use of location information within the processes. The document *"EULF – Design of Location Enabled e-Government Services"* explains how particular location enabled e-Government services can be designed, implemented and evaluated (Pignatelli et al, 2019). In this report a method is described for embedding SDI/INSPIRE components into existing business processes, rather than developing fully-fledged e-Government applications.

3 Analysing existing e-Government processes

This section provides an overview into the way e-Government processes can be analysed. A stepwise approach is proposed including the mapping of the process (step 1) and the assessment of the process with regard to the integration of location information (step 2). Following this, the section also describes how the integration of location information within e-Government processes can bring added value through improved process performance.

3.1 A stepwise approach

Location enablement of e-Government processes starts with a good understanding of the process. A technique is proposed to map the processes by means of the Business Process Model and Notation (BPMN) standard. In a second step, the process should be analysed looking at where location enablement of the process could be envisaged.

3.1.1 Step1 – Mapping the process

The identification of different public sector processes in which location information is or can be used is a first step in the identification of the potential for location enabled e-Government services. Existing and potential location information processes should be described in terms of some basic characteristics, such as the objective of the process, relevant legislation, the responsible persons/organisations, involved actors, input at the beginning of the process, the process steps, and the output(s) as the result of the process. As the activities and processes of European Member States are strongly determined by EU policies and legal acts, and citizens and businesses in different Member States will have similar demands of their government, many location information processes will exist in all European Member States, and often these processes will be organised and structured in an identical or at least similar manner.

The **creation of a catalogue of location information processes in Europe**, both at national and EU level, might be a valuable instrument for comparing processes across different countries and learning from good practices in other Member States (or in another administration in the same Member State). Particular attention might be paid to the identification of the basic e-Government processes in which spatial data and information are – or potentially can be – integrated and/or to processes in Member States that are strongly or even fully determined by EU legislation, and thus strongly comparable among Member States. Typical examples of these are monitoring processes, in which Member States have to collect information on the status of development in a certain policy area such as the development of transport networks, the implementation of environmental directives …, and to provide this information to the EC.

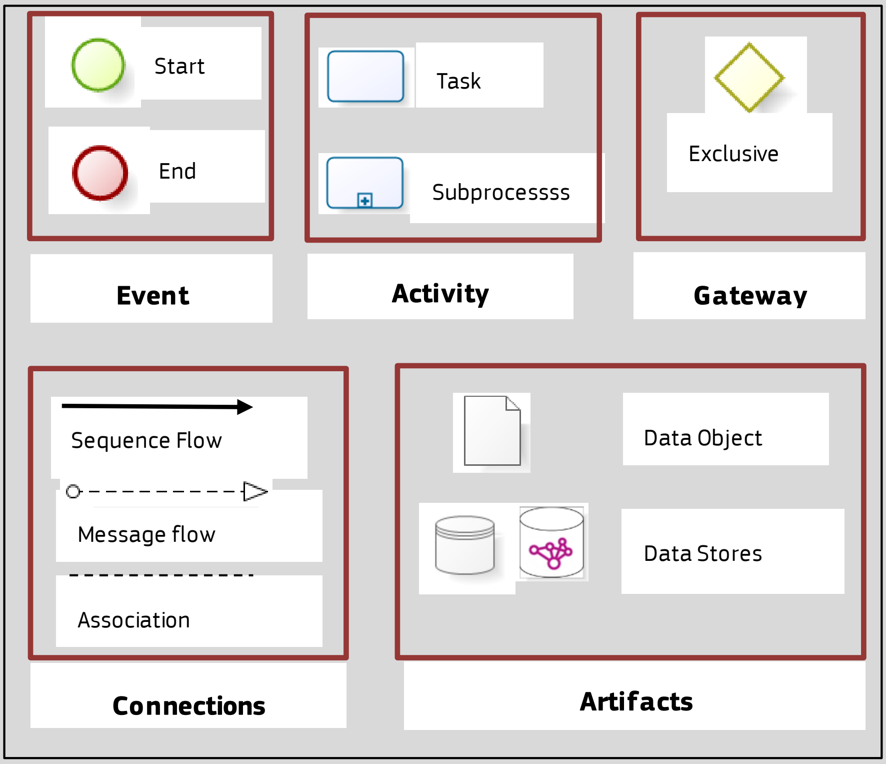
To gain additional knowledge on these – existing and potential – location information processes, it is necessary to understand the entire process, i.e. the sequence of events and interactions that take place between input and output. Therefore, process mapping or modelling tools should be used to describe a process at a high level of abstraction, providing insight in the different process steps, the actors involved and also the use of location data and technology. A process map will provide a schematic overview based on a common language of all the steps of a process starting from the action that triggers a process to begin and the action that reflects the end of a process. In this, it is important not only to describe the process as it is formally defined by legislation, but also and even more so, the process as it is executed in reality. In the activity of gathering information about the process, it is essential to involve both the persons that are internally involved in the process and the external customers.

Process mapping can be useful for different reasons. It can increase the transparency of processes and improve the communication and interaction between individuals, organisations and policy makers. Moreover, it can provide information on the actual status of the process and enhance the involvement of individual actors in the process. From the perspective of service design, and in order to develop use cases, process mapping allows us to truly understand the different steps in the process, the needs and requirements of a specific process, and the potential to improve the process through the implementation of location enabled services. Mapping location information processes should be done using international business process modelling standards. For the study of EULF use cases the BPMN standard is applied.

Business Process Model and Notation (BPMN)

BPMN is an Object Management Group (OMG) standard. It is a graphical representation for defining business processes in a business process model. BPMN provides organisations and process owners with the capability of understanding their internal and external business procedures in a graphical notation and give them the ability to communicate these procedures in a standard manner. Process modelling allows analysing and designing a business process flow.[3] BPMN works with several process elements (Silver, 2009). These include: event, activity, gateway, connections and artifacts (**Error! Reference source not found.**).

Figure 3. Basic process elements of Business Process Modelling and Notation (BPMN)



Event

An event is something that "happens" during a process. An event is always denoted by a circle.

Start Event: Indicates the start of a process or sub-process. It acts as a process trigger and is denoted by a single circle.

End Event: Indicates the end of a path in a process or sub-process. It represents the result of a process and is denoted by thick or bold border.

Activity

An activity describes the kind of work that must be done and is represented with a rounded-corner rectangle.

Task: A task is an atomic activity, meaning that it cannot be broken down further into subparts. A task is denoted by a rounded rectangle.

Sub-process: A sub-process is a compound activity containing subparts that can be represented as a process. It has its own start and end events. A collapsed sub-process is denoted by a rounded rectangle with plus [+] sign.

Gateway

[3] Bizagi Modeler software was used for the process modelling. Bizagi Modeler is a business process modelling and documentation tool used to visually diagram, model and document business processes in industry-standard BPMN. Bizagi is a member of the OMG and supports the current version BPMN 2.0.

 A gateway represents a control point that sets the conditions in the sequence flow. It is denoted by a diamond shape.

Exclusive: This symbol is used to create alternative flows in a process. One sequence flow comes in and one sequence flow goes out. The exclusive gateway represents an exclusive decision: based on some condition, only one of the output sequence flows is to be followed.

Connections

Flow objects are connected to each other using Connecting objects. Connections can be one of these three types: sequences, messages, and associations.

Sequence Flow: The sequence flow shows in which order the activities are performed. It is denoted with a solid line and arrowhead.

 ***Message Flow:*** The message flow is a common way to denote the information flows between a process and the external environment. It is denoted with a dashed line, an open circle at the start, and an open arrowhead at the end.

Association: An association is represented by a dotted line. It is used to associate an Artefact or text to a Flow Object.

Artefacts

Artefacts allow model developers to bring some more information into the model, so it becomes more readable.

 ***Data objects***: Data objects show the reader which data is required or produced in an activity.

 ***Data stores***: Data stores show the reader where the data are stored in an activity.

The elements are organised in swimming pools (usually organisations involved) and swimming lanes (departments of organisations).

For processes dealing with policy preparation, monitoring and evaluation, decision-making, or service provision, the notion of data and information flows is crucial (Roche & Caron, 2004). To perform the different tasks in such processes, data and information are needed as input, in order to process them and to create new data and information that can serve other organisations, policy makers or individual citizens and businesses. With the aim of improving processes through the design of location information services, during the mapping of a process it is necessary to identify and describe the data flows as well, and the location data flows in particular. Several questions need to be answered:

- What are the major process steps and what is their sequence (order)?
- Who are the major actors in the process?
- What triggers the process, what ends the process?
- Which existing information and data sets are used, from which sources (organisations/actors)?
- Which new information/data or other outputs are created throughout the process and by whom?
- In which process steps are location data used and/or created?
- How is the output distributed or used in other processes and by whom?

Particular attention should be paid to the interactions between different actors involved in the process. Within the context of e-Government processes several types of interactions can take place:

- G2C interactions: between Government and Citizens
- G2B interactions: between Government and Businesses
- G2G interactions: between Government and Government

Each of these interactions can be of different types: physical at a desk or in meetings, via phone calls and call centres, through regular mail or e-mail, or via websites or web applications. Within each e-Government process, such interactions can occur multiple times: a citizen can contact or be contacted by an authority several times, e.g. in order to request additional information in the context of a building permit process. Moreover, some processes might entail several iterations before a decision is taken and the process comes to an end. Over the past few years, digital interactions, mainly through the Internet, have become more prominent. The development of location enabled e-Government services especially focuses on supporting and improving these interactions through the use of location information and geospatial technologies. In the context of the study of use cases, the question on where in the process location information is accessed, used and/or generated, and how, is of utmost importance.

The modelling of the process should be handled with care, capturing the basic elements of the process, making it not too complex (detailed), and at the same time making it not too basic either. The document *"EULF – Design of Location Enabled e-Government Services"* contains some practical tips and recommendations on how to model e-Government processes (Pignatelli et al, 2019).

3.1.2 Step 2 – Assessing the process

The mapping and analysis of existing processes, in terms of different process steps, sub-processes, data flows and interactions should be the starting point for the analysis of how the process can be improved. Although mapping a process already can be a complex task, even more challenging will be to use this knowledge for improving the process. The process mapping will give process owners and other stakeholders insight on how the process works, and how the process performance can be improved, in terms of cost, time or quality (see section 3.2).

In many cases, location enabling services will not cover the entire process, but will deal with one or a set of interactions within the process. This means some prioritisation of services and integration of location information in the process will be needed. However, even if the decision is made to focus on a particular interaction or process step, the impact on other interactions and process steps should be taken into consideration. Based on existing practices of prioritisation in e-Government, the following criteria could be used in the prioritisation process (OECD, 2005):

- **Frequency of use:** how many people will benefit from a certain e-service and how many interactions could be supported through a service;
- **Added value for stakeholders:** what will be the added value of a certain e-service to different stakeholders, including both citizens and business but also public organisations and public servants;
- **Tendency of potential users to use the service**: to what extent will users prefer the new e-service to traditional non-digital services.

In general terms, it can be argued that the focus should be on the most common interactions for which there is the maximum potential for benefit to users and government and on the potential for re-using solutions. For the prioritisation of location enabled e-Government services, some criteria could be added:

- **Relevance of location information:** priority might be given to interactions and process steps that strongly rely on or require location information;
- **Added value of location information:** priority might be given to interactions and process steps for which the benefits of location enabling them will be high;
- **Availability of location information:** priority might be given to interactions and process steps for which the required location data – and other necessary components – are already available.

Although the original focus of service delivery might be on individual services, it is essential to recognise the added value of integrated services. Integration is about the vertical – across policy levels - and horizontal – across policy areas – integration of e-Government services. The aim should be to provide seamless services, integrating the information and services across government agencies into single electronic systems, transcending the administrative and thematic boundaries of government agencies. Rather than making information and services available for each policy area separately, it is recommended to organise the provision of information and services to citizens and businesses around their needs. An approach for doing this is to organise the provision of services around 'life events', i.e. important stages in the life of citizens, such as moving and changing an address, buying or building a house or starting a business. This requires the integration of data and services from different policy levels (local, regional, national, European), from different policy areas (spatial planning, mobility, environment, education and many others) and cross-border. The result will be that users will have a single point of contact for services and will only be asked once to provide location-related information.

In the context of EULF use cases, the focus is on embedding/using existing SDI components rather than the development of new location enabled e-Government services or applications (see Pignatelli et al, 2016). Spatial Data Infrastructures (SDIs) and INSPIRE are platforms for distributing location data, based on the infrastructures established at Member State level and the data sharing actions and policies of government agencies creating and maintaining location data. In that way, INSPIRE is an important driver for promoting and enhancing the accessibility to and sharing of location data at different levels (European, national, sub-national, local and organisational). SDIs and INSPIRE, in particular, provide several components that can be used as building blocks for the development of location enabled e-Government services and the implementation of use cases:

- A series of spatial data sets on 34 themes;
- Web map services (WMS, WMTS) to visualise and web feature services (WFS)[4] to download data;
- Metadata on data and web services, metadata catalogues and catalogue services to discover, find and understand the data sets and web services;
- Other services to process data (e.g. Web Processing Service of the OGC), to transform data, etc.

When assessing existing e-Government processes special attention should be paid to the way such components are already embedded (or not) and where they could be added in the process.

3.2 Approach for measuring process performance

As part of the assessment of e-Government processes and services, the impact of location enabling the processes on the process performance should be measured (or estimated). From that perspective, ideally process performance would be measured prior to adding location information components and after the process is spatially enabled. This section first describes what process performance means, secondly it proposes a method and a series of indicators for measuring process performance.

3.2.1 Processes and process performance

The concept of performance is used in many ways, by academia, practitioners, politicians and other stakeholders dealing with the measurement, analysis and/or management of performance. To create more clarity in the precise meaning of the concept and how it can be operationalised and measured, the difference should be made between the 'span of performance' and 'depth of performance' (Bouckaert and Halligan, 2008).

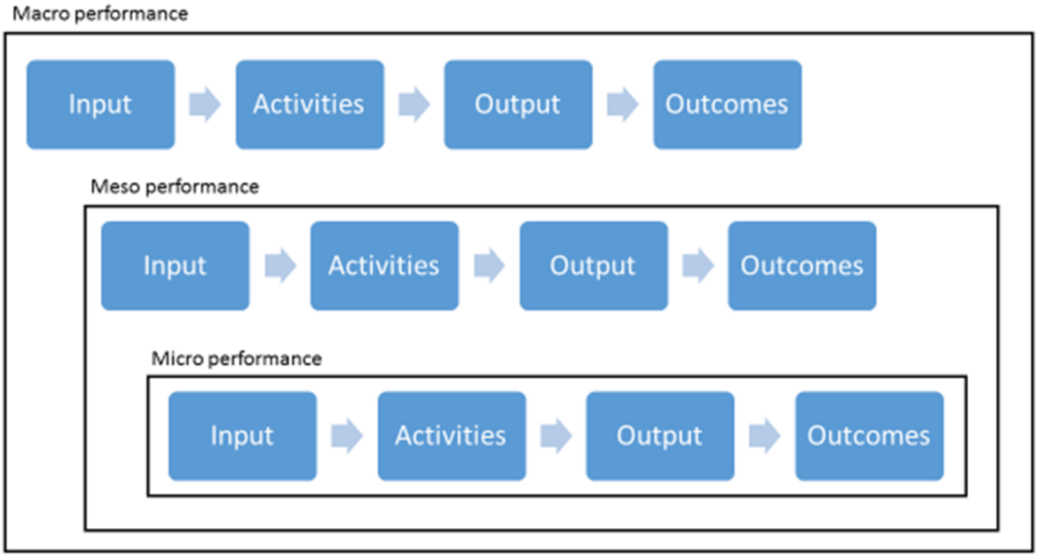
The depth of performance refers to the level on which performance can be measured and managed. Here, a distinction can be made between micro, meso and macro levels. Applied to the context of public sector performance, performance on micro level deals with the performance of an individual organisation, while performance at meso level deals with the performance of a policy process or policy chain. Macro performance finally is a government-wide performance.

Whereas depth of performance refers to the vertical dimension of performance, span of performance covers the horizontal dimension. Performance in the public sector deals with inputs that are processed in activities, which results in certain outputs. These outputs are not an end in themselves for the public sector but should lead to certain effects or outcomes. The performance of the public sector can then be measured by looking at the ratios between the inputs, outputs and outcomes, which can be expressed in terms of efficiency and effectiveness. If the focus is on efficiency, then the span of performance is relatively smaller, as only the relationship between input and output is taken into account. Looking at effectiveness means that the span of performance is broadened beyond the borders of a single organisation or process, and the effects or outcomes of providing certain outputs are also taken into account in the measurement of performance.

Analysing public sector performance is about combining span and depth of performance, i.e. measuring input, activities, outputs, effects/outcomes and even trust at different levels. This is visualised in Figure 6, which shows how micro, meso and macro performance are linked to each other.

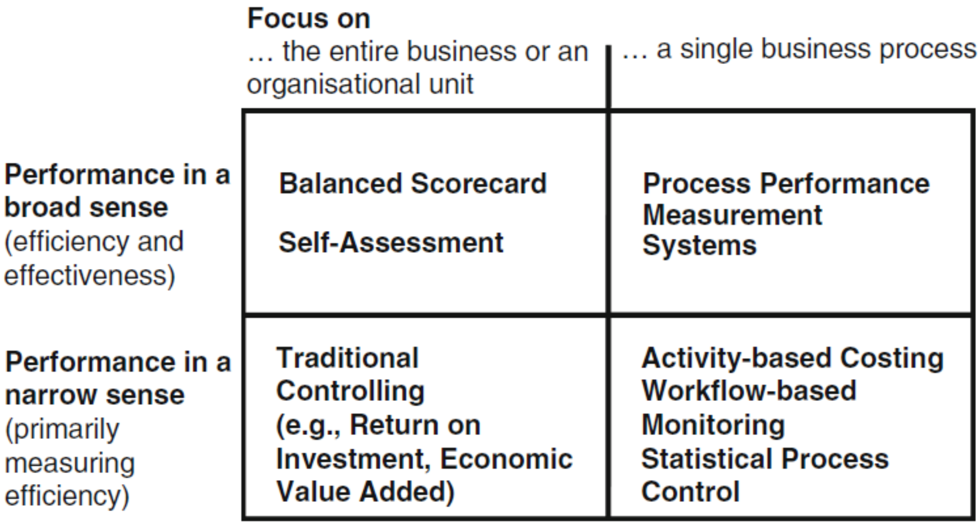
[4] Or atom feeds

Figure 4. Micro, meso and macro performance



The transformation of inputs into outputs which should lead to certain effects or outcomes within a single organisation will often be part of a broader policy process or chain, in which again inputs are converted into outputs leading to certain outcomes. The performance of public administrations can be measured and assessed by looking at the collection of all public sector processes, in which the implementation of policies takes place and policies are translated into practice. As most public sector services and products are realised by a range of organisations, public sector performance should not be measured solely at organisational level, but also – and maybe even especially – at the level of a policy process or chain. Many processes involve different organisations, at different administrative levels and/or in different thematic areas. Processes involve actions of and interactions among different organisations of the government as well as actors outside the government.

Figure 5. Comparison of existing performance measurement approaches



Source: Heckle & Moormann, 2010

Heckle & Moormann (2010) provide an overview of existing approaches for performance measurement, discussing not only the main objectives and characteristics of each approach, but also the similar elements between approaches. Figure 7 compares the different approaches in terms of the focus and scope of the performance they are addressing. With regard to the scope of the approaches, a distinction is made between performance in a narrow sense, in which the focus mainly is on efficiency, and performance in a broad sense, in which besides efficiency also other dimensions of performance, such as effectiveness are taken into account. Another dimension in which performance measurement approaches can be different to each other, is their focus. While some approaches primarily focus on an entire organisation or organisational unit, other approaches focus on a business process. Such a process can take place within a single organisation, but also between several organisations. The figure clearly shows the key characteristics of process performance and process performance systems, where focus is on individual business processes and performance is defined in a broad sense (efficiency and effectiveness).

3.2.2 Possible indicators to measure process performance

Measuring the performance of a process is a necessary first step for assessing and improving performance. Process performance measurement is about collecting quantitative and qualitative information about the process. Quantitative measures are especially considered to be essential as they provide input for the development and implementation of improvements in the process and for assessing the result of these improvements once this is done.

When talking about the collection of information on process performance, it is important to make a distinction between performance indicators, performance measures and performance figures (Baker and Hart, 1998):

- Performance indicators are indicators used for the assessment of process performance, and will be continuously monitored by the process manager;
- Performance measures represent the operationalisation of each performance indicator, as they determine precisely how each indicator will be measured;
- Performance figures are the results of the measurements and can be one single measure itself or a combination of different measures.

The start for measuring process performance is the definition of process performance indicators that allow a more detailed operationalisation of process performance. To do this in a structured way, many authors have suggested categories or groups of indicators. Van Aelst (2011) distinguishes between three main dimensions of performance, for which different indicators can be defined:

- **Time:** Time can be considered as a first indicator for the performance of a process but can be looked at from different angles and can be measured in different ways. An indicator that is often used is the lead time or flow time, i.e. the total time from the start of a process to the completion of a process. Other potential indicators related to time are service or actual processing time, which is the time actually worked on the process steps, and the waiting time (sometimes called 'dead time', which is the time a case is waiting for a resources to become available or a previous process step to be finalised).
- **Cost:** A second key dimension of process performance is the cost of the process, which can also be measured in several ways. Distinctions are made between different cost factors for creating time indicators: labour costs, IT costs, production costs, product costs, service costs, etc. Also, the distinction between fixed and variable costs is often used for designing cost indicators.
- **Quality:** A third key dimension of the performance of a process is the quality of the process, which mainly focuses on the product or service that is delivered at the end of the process to the customer. In the context of public sector processes, in most cases the customer of the process will be the citizen, although other types of processes also exist (G2G, G2B). User satisfaction measurements are often used to measure the 'quality of a process', while also for measuring the quality of a process several other indicators can be used (e.g. number of complaints). Another way to define quality is to consider quality as the degree to which the actual product or service attributes and properties conform to underlying product specifications.

Table 3 provides an overview of the relevance of each of these 3 main dimensions for measuring and analysing the performance of location-enabled business processes:

Table 3. Three key indicators and their relevance to location-enabled processes

Key indicators	**Relevance in different processes**
Flow time	*Building permits:* Period of time between the application and the issuance of a building permit (and other types of permit) *Address registration:* Period of time between the request for a new address and the inclusion of this new address into the national address register
Cost	*Flood mapping:* Resources needed to create a map of recently flooded areas *Animal transport:* Resources needed for spatio-temporal monitoring of a single animal transport
Quality	*Business register:* Correctness, completeness and up-to-dateness of the national register of private companies *Creation of spatial development plans:* Extent to which new spatial development plans are aligned with the objectives of other policy domains and take into account the views and needs of different stakeholders

Performance analysis and management deals with improving processes with respect to time, cost or quality. The assessment of process performance should build further on the model of the process that has been made in the mapping phase. Once a map or description of an existing process is available, information on the time and costs in the flow of information and activities and on the quality of the process should be added to the original process model. This means the process model will be extended with performance data, on the flow time, cost and quality.

Measuring the performance of a process is not an end in itself but should provide a basis for actions for improving performance and optimising the process. Process optimisation means that changes or adjustments to a process are made in order to get better results. The goal of developing and implementing a spatially enabled process is to improve the quality of the process and to reduce the process flow time and total costs of the process through the integration of spatial data and services in one or more process steps.

4 Selecting a use case for the study

4.1 Use case selection criteria

There are many e-Government processes, but not all these processes are equally 'ready' to be location-enabled. This will depend on particular factors, including the degree of maturity of the process in different Member States. A process in one Member State may already be very well developed regarding the integration of location information compared another Member State. This is due to national and sub-national policies, institutional settings and many other factors. When defining the criteria, it is therefore important not only to take into account the (technical) characteristics of the process, but also those organisational and institutional boundary conditions. It should be stressed that in the use cases the aim is not to develop any infrastructure, application or SDI component[5], but rather to integrate what is already offered through e.g. INSPIRE or national SDIs. Table 4 provides an overview of the proposed criteria for defining and selecting possible use cases.

Table 4. Criteria for selecting use cases

Criteria	**Comments**
1. A use case should focus on the integration of location information and services in e-Government processes	Key is the selection of e-Government processes in which location information and services are only used to a limited extent to support a particular part of the process. The chosen process should not be relatively simple. G2C, G2B or G2G interactions should be considered.
2. Use cases should cover Member States as well as European processes, if possible, a mixture of both	Many administrative and decision-making e-Government processes apply at different administrative levels and some at European level.
3. The use cases should preferably focus on the re-use of existing INSPIRE/SDI web services, rather than developing such services from scratch	The use cases should look for existing applications which are using copies of spatial data sets or for specific functionalities within applications that can be replaced by existing INSPIRE/SDI web services. Use of open source platforms is recommended.
4. Use cases should have the characteristics of a system 'demonstrator' rather than a 'descriptive' study	While the demonstrator must not deliver an operational system, it must clearly show how integration of location information and services from different sources works in practice. The target audience is policy makers and end-users. The demonstrator can involve either modification of an existing application or integration in a new application under development.
5. Use cases should be developed together with stakeholders from the GI and e-Government communities	The use cases should involve process owner(s), data/service providers (where relevant), as well as end-users in case a G2C or G2B application is developed. User requirements for the applications/services should be clearly described and documented. The process should be mapped clearly and understood in order to define the places in the process where the use of location information could be enhanced.
6. Use cases should be kept small and 'easy-to-implement' without the need of extensive	The approach for the use cases should be kept pragmatic. The aim should be to find existing initiatives in which the integration of location information and services is already foreseen. Work involved should be kept to a minimum to prove a concept that can later be implemented.

5 Although the set-up of one or more SDI components, such as web map services, is not excluded.

Criteria	Comments
resources	

Source: Based on Vandenbrouke et al, 2014

Ideally the use case should allow comparing two situations: i.e. 1) the process without the use/integration of certain SDI components (ex-ante situation) and 2) the process with the SDI component(s) embedded (ex-post). However, depending on the situation, this might not entirely be feasible, e.g. because the ex-ante situation existed some time ago, and some work is already ongoing to implement location enabling components without measuring the performance of the process prior to this implementation (see also section 3).

4.2 Examples of potential use cases

From analysis done in preparation of the EULF Blueprint, four potential use cases were confirmed during a working meeting with the JRC (09/09/2015)[6]. To indicate to readers, the types of process that may be considered for this type of assessment, these potential use cases are outlined below.

Potential Use Case 1

Process: Monitoring traffic accidents in Flanders

Process owner(s): Department of Mobility and Public Works (MOW) of the Flemish Government, supported by the Policy Research Centre on Traffic Safety

Policy Area: Transport and Mobility

Legal basis:

- Flemish Decree of 17 June 2011 concerning the management of traffic safety of the road infrastructure (B.S. 2012-04-19);
- Directive 2015/413 of the European Parliament and of the Council of 11 March 2015 and Directive 2011/82/EU of the European Parliament and of the Council of 25 October 2011 facilitating the cross-border exchange of information on road safety related traffic offences;
- Commission Recommendation of 6 April 2004 on enforcement in the field of road safety;
- Council Decision 93/704/EC of 30 November 1993 on the creation of a Community road accidents database.

Abstract:

Flanders (and Belgium as a whole) has an above average number of deaths in traffic accidents compared with the European average. In 2014, there were 400 deaths on Flemish roads, while in 2015 the figure only decreased slightly to 390. The Flemish Government has declared traffic safety as one of its priority policy areas. A traffic safety plan was drafted to reduce the number of accidents and victims, and to take specific measures to protect those most vulnerable such as pedestrians and cyclists. Measures are variable: from creating awareness, organising education programmes in schools and better training for car drivers, to stricter control and interventions on the roads in order to influence the behaviour of all actors in traffic situations. But traffic safety is also influenced by other factors such as the quality of the road infrastructure, visibility at crossings, speed limitations, interaction of different traffic modes, etc.

[6] For pragmatic reasons, i.e. the knowledge of and the accessibility to the process (owners), most of the examples are from Flanders, Belgium. However, the approach can be applied anywhere and the use cases will probably look quite similar in other countries.

In 2012, the Flemish Government set-up a supporting policy centre to monitor and assess traffic safety, aiming to collect the necessary information and continuously analyse how traffic safety is evolving. The traffic safety monitoring process put in place not only involves Flemish stakeholders, but also federal and European stakeholders: local and federal police, provinces, the department of Mobility and Public Works, the federal Statistical Office, DG MOVE, etc. The process consists of several sub-processes: 1) registration of traffic accidents with all their characteristics (including location) which provides input to legal (where applicable) and insurance processes; 2) assessment of the traffic accident information including the location of 'black points and zones' (locations with high risks) in view of potential measures such as re-engineering of road crossings and 3) delivery of traffic safety information to the CARE[7] database of DG MOVE for European policy purposes.

Use of location information:

Location information is used to locate all accidents with casualties or with important damage (very small accidents are not registered unless there is a dispute). Location information is also used for the analysis of the traffic accidents. However, in almost all phases of the (sub-)process(es), there is no use of geospatial web services.

Potential use of location information:

Besides the use of geospatial web services, there are a lot of traffic related data available on the Internet, pointing to the potential use of semantic web technologies such as linked data.

Project:

A project monitoring traffic accidents ran between 2012 and early 2016 on which the use case could be built.

Potential Use Case 2

Process: Spatial Monitor Flanders

Process owner(s): The Department of Spatial Policy of the Flemish Government, supported by the Policy Research Centre on Spatial Development

Policy Area: Urban and spatial planning

Legal basis:

Flemish Codex for Spatial Planning - Decree of 18 November 2011 for changing the Flemish Codex for Spatial Planning and of the Decree of 10 March 2006 regarding the creation of the strategic advice board Spatial Planning - Immovable Heritage concerning the advising councils (B.S. 16/12/2011)

Abstract:

Flanders, as with many other regions in Europe, is very densely populated and many sectors (agriculture, environment, industry, logistics, etc.) aim to use the same land. Therefore, a thorough land use planning and monitoring process is necessary. Several strategic options drive the Flemish spatial policy: spatial efficiency and effectiveness of land use (through re-use and non-fragmentation) and spatial quality (e.g. providing enough free space). Several challenges were identified: to define urban systems on a human scale; to define enough green and blue (water) areas; to create urban networks with a critical mass including (international) 'top-spots'; to maintain dynamic landscapes; to keep enough space for food, water and biodiversity, and to keep performant logistical networks.

The objective of the spatial monitor is to make available a series of scientific and policy relevant indicators to support the preparation, monitoring and evaluation of the spatial policy in Flanders and to underpin societal discussions and choices that must be made to answer the spatial and urban planning challenges of the future. The indicators are accessible via a portal which represents geographical indicators and assesses the policy objectives. All the components of the portal, the metadata catalogue, the view and download services are offered through a Content Management System.

[7] http://ec.europa.eu/transport/road_safety/specialist/statistics_en#

Use of location information:

Some use of geospatial web services, extensive use of geospatial data (maybe too well developed already to 'measure' the difference with/without)

Potential use of location information:

Use of more geospatial web services of the Flemish SDI and also of linked data technology (a lot of information, e.g. on the housing market is available as linked data on the web and could enrich the basic information).

Project:

A project on spatial monitoring ran between 2012 and June 2016 as part of the supporting centre for spatial planning, on which a use case could be built.

Potential Use Case 3

Process: Monitoring Animal Transport in Europe

Process owner(s): EC DG SANTE

Policy Area: Health and food safety

Legal Basis:

Commission Decision 2003/24/EC of 30 December 2002 concerning the development of an integrated computerised veterinary system, followed by Commission Decision 2003/623/EC of 19 August 2003 concerning the development of an integrated computerised veterinary system known as TRACES;

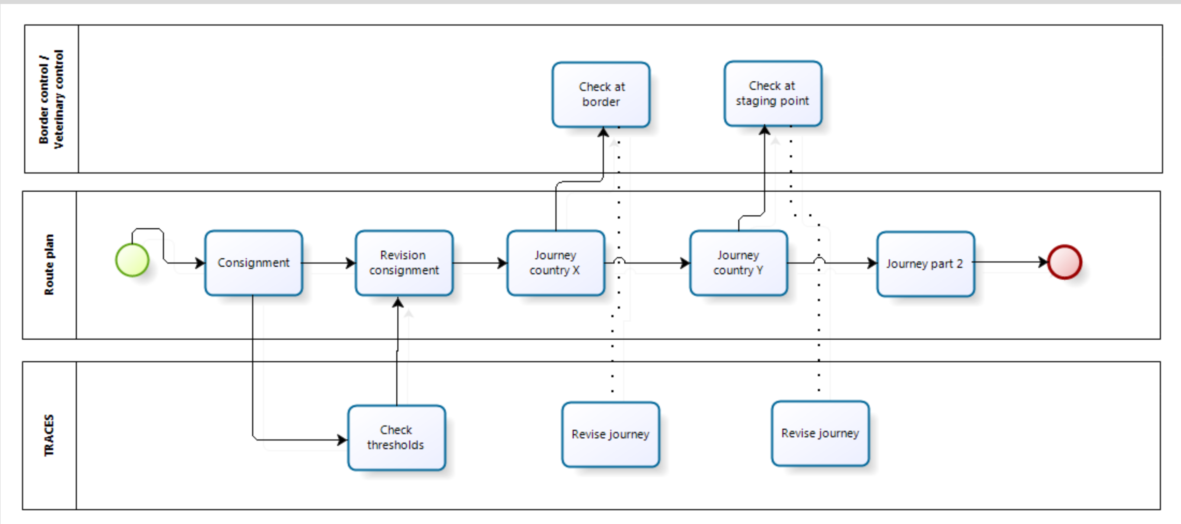
Commission Decision 2004/292/EC on the introduction of the TRACES system and amending Decision 92/486/EEC making TRACES compulsory for all Member States from 1 January 2005;

Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97.

Abstract:

Around 4 million cattle, 33 million pigs, 3 million sheep and 1.25 billion poultry animals are transported annually between the Member States of the EU and EFTA in more than 350,000 animal movements (figures for 2014). Besides animals, products of animal origin, feed and food of non-animal origin, as well as plants, seeds and propagating material are exchanged between European countries or imported from outside Europe. In order to protect the health of consumers and the health and welfare of the animals, all movements of animals and goods throughout the EU are traced by an e-Government service called TRACES (TRAde Control and Expert System), set-up in 2004.

Figure 6. The animal transport monitoring process



TRACES is a multilingual online management tool of the EC for all sanitary requirements on intra-EU trade and import of animals, semen and embryo, food, feed and plants. The main objective of TRACES is to digitise and guide the entire certification process and all linked procedures such as sanitary and border controls. About 30,000 users from more than 80 countries worldwide - competent authorities, as well as businesses - use TRACES by digitising, managing and exchanging all the necessary information and hence simplifying and accelerating the trading process. The possibility to trace all the movements of animals and goods contributes to the reduction of the impact of disease outbreaks and brings a quick response to any sanitary alert, for the better protection of consumers, livestock and plants. TRACES also promotes better cooperation between the competent authorities as well as between the traders and between the traders and their competent authorities.

When a decision is taken on a consignment, the parties involved gain access to the official documents and receive alert notifications in case of a problem with the consignment. TRACES enables speedy detection of fake certificates and therefore contributes to the enhancement of trust for its partners. All harmonised export certificates to the EU are available in the last updated version and translated into all EU official languages. Users can access all information 24 hours a day, 7 days a week, free of charge (but only if they are a concerned party). TRACES involves stakeholders from different sectors such as farmers as 'producers' of the animals and goods, transport companies, veterinary inspectors, customs for the border inspections and EU officials. It is an example of a cross-sector (agriculture, transport, health, security) and cross-border e-Government service.

Use of location information:

Limited use of geospatial information (only in a limited part of the process, i.e. to check the estimated travel time), no use of geospatial web services.

Potential use of location information:

Potential use of geospatial information by different stakeholders in the process such as the veterinary experts, border customs.

Project:

No operational project running to improve the integration of geospatial information in the process.

Potential Use Case 4

Process: Managing Flood Areas in Flanders

Process owner(s): Flemish Environment Agency (VMM)

Policy Area: Integrated Water Policy

Legal basis:

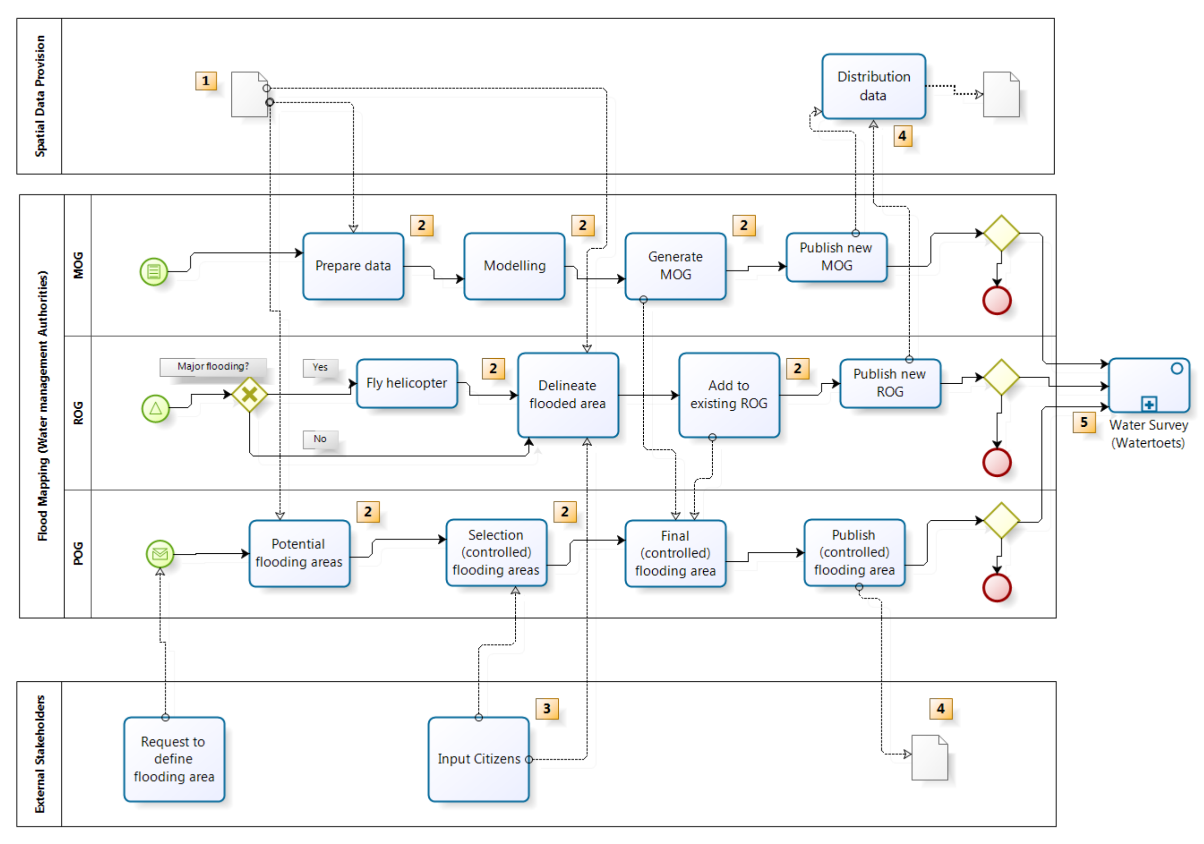
- Decree Integral Water Policy of 19 July 2013 of the Flemish Government which amended previous versions of the same decree: the first version of the decree transposed the Water Framework Directive (2003) and the second version integrated relevant aspects of the Flood Directive (2010);
- Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, known as the Flood Directive;
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, known as the Water Framework Directive (WFD)

Abstract:

The integrated water policy of the Flemish Government follows a holistic approach for monitoring and managing water systems. This includes the organisational, technical and scientific aspects of water quality and quantity as part of those complex water systems. It takes into account environmental, as well as socio-economic aspects of water. Monitoring and management of excessive water (potentially) causing floods is a process that uses spatial data intensively and is part of the whole integrated water policy cycle.

The flood management process involves different types of flood mapping sub-processes including: recently flooded areas (ROG) by mapping actually flooded areas and keeping flood history records; delineation of potential flood areas (POG) serving as water buffer areas in case of excessive rainfall; and modelled flood areas (MOG) which define the areas flooded under particular weather and other conditions (e.g. as a result of infrastructure works). The outputs of these different flood mapping sub-processes are various maps used in other processes, such as the water survey which is a sub-process that is applied as part of the building permit process.

Figure 7. The flood mapping process



The Flemish Environment Agency (VMM) is developing a series of 'Next-Generation' e-Water-Services to support the flood modelling sub-process, with a set of flexible (modelling) tools in the fields of hydrometry, hydrology and hydraulics. The resulting tools will become part of the Flemish Water Data Infrastructure (WDI), a framework of water data, models, tools and users that are interactively connected in order to use the data in an efficient and flexible way. The objective is that the water data and tools are accessed from a wide variety of locations, at a wide variety of scales, and integrated to meet specific needs. The WDI will comprise web-services such as "web map services", "sensor observation services", "models as a service", etc. The e-Water services are expected to improve the flood modelling process significantly as well as the other flood mapping sub-processes and related processes.

Use of location information:

The flood management process already makes extensive use of geospatial data, but only makes limited use of geospatial web services.

Potential use of location information:

Intensified use of OGC web services including WMS, Sensor Web Enablement, Web Processing Services (WPS) and the application of service chaining and orchestration techniques.

Project:

A project in 2015/2016 explored how a WDI for Flanders can be organised, what technical infrastructure was required, and investigated and tested the state of the art in web enabled modelling.

4.3 Selected use case: Monitoring Traffic Safety

Based on discussions with JRC, one use case was selected to be investigated in more detail, i.e. the traffic safety monitoring process. This was done based on the criteria explained in section 4.1. Table 5 provides an overview of the criteria applied to the traffic accident monitoring use case.

Table 5. Application of the selection criteria for the traffic accident monitoring use case

Criteria	Comments
1. A use case should focus on the integration of location information and services in e-Government processes	The traffic safety monitoring process is a promising case for various reasons: • The traffic accident registration sub-process already makes use of location information to register traffic accidents: i.e. base maps to locate the accident; • In the registration sub-process the location of the accident is kept as a new spatial feature; • In the sub-process of assessing traffic accidents, location information is analysed and processed to better understand the causes of the accidents and to take measures to avoid future accidents; • Information on the characteristics and location of accidents is exchanged between different actors of the process.
2. Use cases should cover Member States as well as European processes, if possible a mixture of both	The process spans different levels of authority: • The local police is the key partner for registering traffic accidents (at least for serious accidents in which there are fatalities and/or there is significant damage); • Federal authorities such as the federal police (registration and consolidation), the statistical office (processing traffic accident statistics), etc.; • Regional authorities and provinces that are responsible for the transport and mobility policy; • Europe which manages the CARE database to monitor major accidents on European roads; Moreover, the use case involves different sectors of public administration: police (Ministry of Interior), statistics, and mobility and public works.
3. The use cases should preferably focus on the re-use of existing INSPIRE/SDI web services, rather than developing such services from scratch	Although location information is already used in the process and its sub-processes, the use of SDI and INSPIRE components is relatively weak and could become part of the work within the use case: • The reference maps used for the registration of local accidents are often still replicated in local environments instead of using a web map service; • Sharing of aggregated information on accidents such as maps on the characteristics of traffic accidents at municipal level were embedded before within applications, but might be shared in this use case as web map services; • Linked data technology could be tested in view of enriching basic traffic information with other information found on the web to get

Criteria	Comments
	better insights in the causes of the accidents.
4. Use cases should have the characteristics of a system 'demonstrator' rather than a 'descriptive' study	The process and its sub-processes are operational. Between 2012 and early 2016, a policy support centre was in place with some room to test new approaches and technologies. • Testing of the use of web map services: embedding existing services and deploying new ones; • Testing of linked data technology.
5. Use cases should be developed together with stakeholders from the GI and e-Government communities	The Department for Mobility and Public Works is the process owner and has the ambition to improve and modernise the traffic safety monitoring process. • Traffic safety is one of the priority policy areas of the Flemish Government with the aim to reduce drastically the number of fatalities due to traffic accidents; • The policy support centre is focused on investigating and testing new approaches to monitor traffic safety using an advanced mechanism of indicators and web mapping technology.
6. Use cases should be kept small and 'easy-to-implement' without the need of extensive resources	The fact that a policy support centre is operational facilitates proposals for 'small' improvements and testing of new approaches that were already foreseen (e.g. testing linked data). • The EULF use case does not jeopardise the regular work of the centre, but rather reinforces it; • Particular points of attention that are important for the EULF and ELISE, such as estimating the added value of integration of location information and location-based services can easily be added to the ongoing activities.

5 Detailed analysis of the traffic safety monitoring process

Section 5 provides a detailed analysis of the traffic safety monitoring process. Firstly, it describes the Traffic Safety Policy Support Centre in Flanders that manages the traffic safety assessment sub-process and is the driver of the whole monitoring process. It also discusses the general aspects of the traffic safety monitoring process, including the constituent sub-processes (registration of traffic accidents and assessment of traffic safety) and its related processes. Next, it maps the two major sub-processes using BPMN and highlights the actors, the major (spatial) data flows, the process steps and outcomes. Finally, the process is assessed in terms of its spatial enablement and there is a focus on issues related to process performance.

5.1 The Traffic Safety Policy Research Centre

The Traffic Safety Policy Research Centre was established in 2001 by the Flemish Government to provide a scientific basis for policy making in the field of transport and mobility and traffic safety. The goal was to understand anticipated social developments and challenges in order to take proactive measures to reduce the number of traffic accidents and victims. Other centres were established by the Flemish Government to support different policy priorities[8].

The Traffic Safety Policy Research Centre was set-up as a consortium of specialised entities from three major organisations: the University of Hasselt (IMOB – Transportation Research Institute), the University of Leuven (SADL – Spatial Applications Division Leuven; ETE - Energy, Transport and Environment; ICB – Centre for Industrial Management, Traffic and Infrastructure) and VITO - the Flemish Institute for Technological Research. The specific goals assigned for traffic safety were: data collection, short term research on various policy matters, fundamental scientific research focusing on traffic safety of its citizens and providing policy support. In order to attain tangible results, there was a sub-division into five work areas relating to:

1. Traffic Safety Monitoring based on data and indicators - Analysis and dissemination of data and indicators concerning traffic safety and its underlying factors through a road safety monitoring system and a yearly road safety report.
2. Risk analysis - Computation of the relative safety level at various locations based on analysis of registered data. Network safety management and analysing road crash patterns by using collision diagrams.
3. Human behaviour in relation to system components and vehicle environment - Evaluation of the road system (driver, environment, vehicle) as a whole with regard to road accidents and exploration of innovative solutions for each of the three dimensions of the road system.
4. Development of road safety measures - Focus on usefulness of education and engineering strategies that might intrinsically motivate drivers to behave safely. Investigation of influence on behaviour using three approaches: simulator-based training, in-vehicle technology, and road design and infrastructure.
5. Ranking and evaluation of measures - Evaluation of traffic safety policies and providing a ranking for publicly acceptable measures to meet traffic safety targets ensuring best possible use of available resources.

5.2 Overview of the Traffic Safety Monitoring process

The Traffic Safety Monitoring process consists of several sub-processes and there are also several related processes. Figure 8 provides an overview of the sub-processes and related processes.

Registration of traffic accidents (operational level)

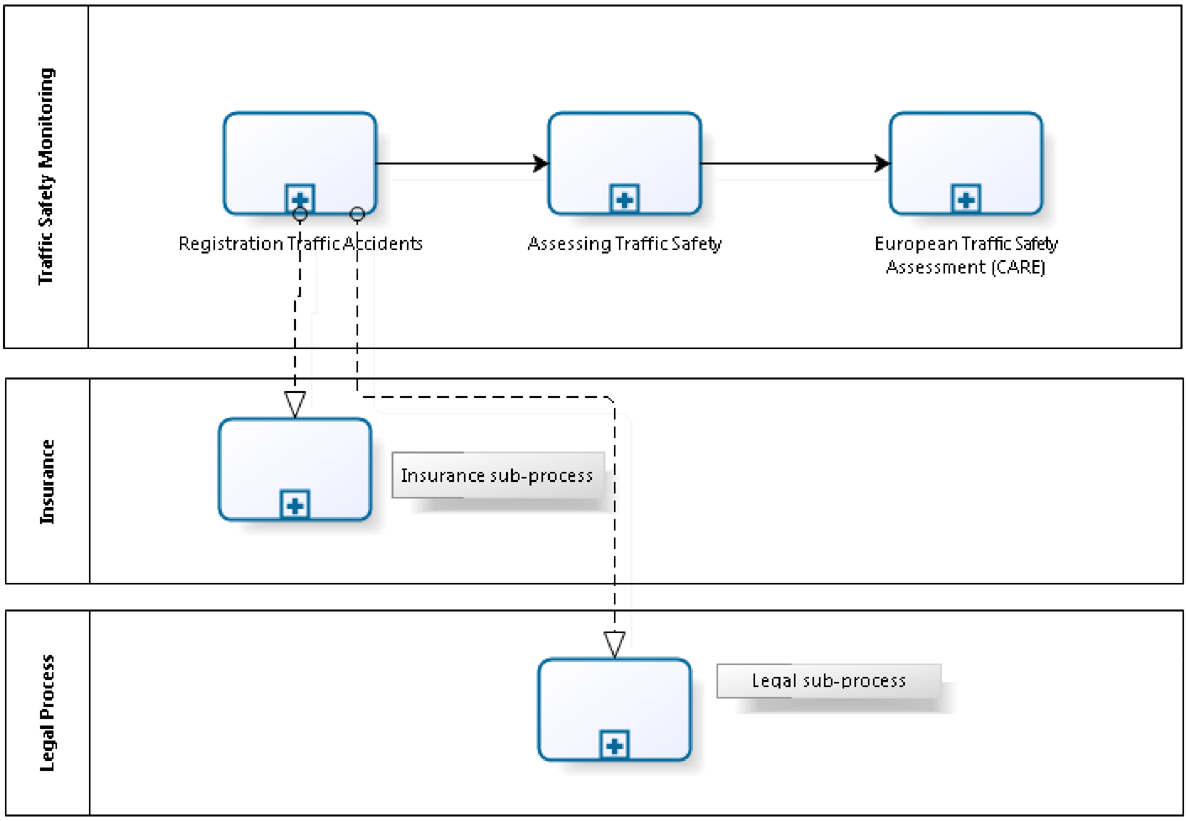
The basic sub-process is the process of registering all the relevant traffic accidents that occur in practice. This is an operational process that focuses on the collection of all the relevant information in the field each time an accident occurs. It is an event driven process. It is this process that feeds the traffic accidents assessment sub-process. This sub-process is described in detail in section 5.3.1.

8 Since 2016, the policy centres were integrated in the public administrations and other mechanisms were put in place to conduct applied research in different fields.

Assessment of traffic accidents (policy level)

The core policy process is the assessment sub-process in which all the information is processed in different ways in order to evaluate traffic accidents as they occurred over a certain period of time, to better understand them and to formulate policy measures to reduce their number and their negative impact. This sub-process is described in detail in section 5.3.2.

Figure 8. Overview of the traffic safety monitoring process



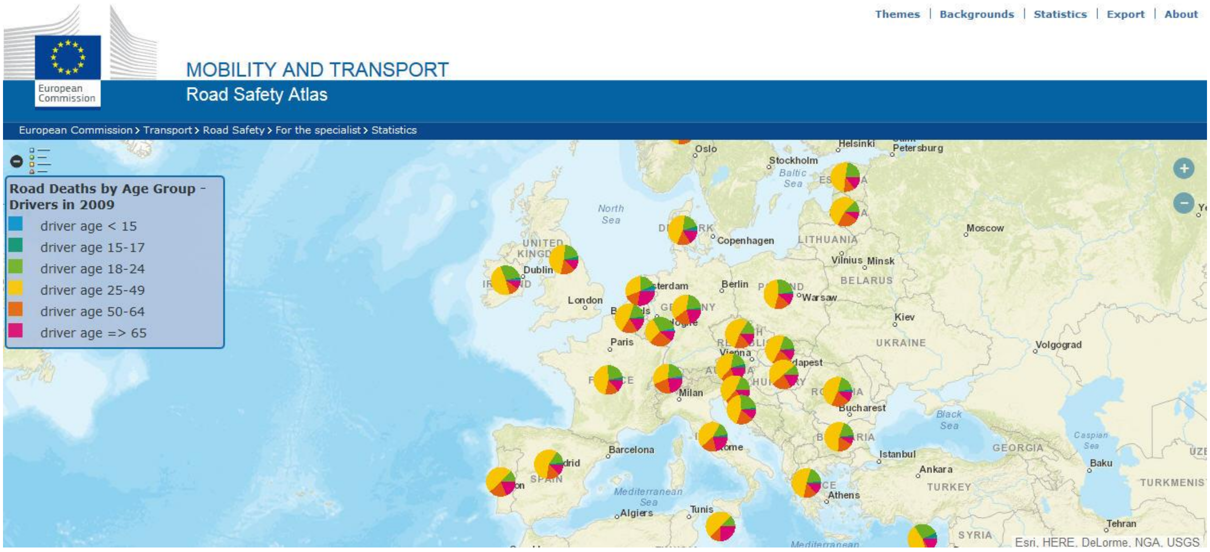
European traffic safety assessment (policy level)

The national and sub-national traffic safety processes also feed into the European traffic safety assessment process. DG MOVE initiated the Road Safety Programme and specific actions in the field of road safety. One of the achievements of the Road Safety Programme is the development of the CARE system (CARE - Community database on Accidents on the Road in Europe) according to Council Decision 93/704/EC of 30 November 1993.

The purpose of the CARE system is to provide a tool which makes it possible to identify and quantify road safety problems on European roads, evaluate the efficiency of road safety measures taken by Member States, determine the relevance of Community actions and facilitate the exchange of experience in this field. CARE is maintained in order to provide reliable and usable data. New data series on accidents are provided each year by Member States and are loaded and validated into the CARE system. The system is in production and is used by Commission staff and experts in Member States for reporting.

One of the location-enabled services is a traffic safety atlas with harmonised statistics from Member States (see Figure 9). This sub-process which is a data sharing and publication process is not analysed or described further in this report.

Figure 9. Road Safety Atlas



Two other processes exist which are closely linked to the traffic safety monitoring process (especially the registration of traffic accidents): the traffic accident insurance process and the traffic accident legal process. Neither of these are described further in this use case report.

Insurance process

Each traffic accident – including those that are not disputed and have no victims - is documented, and insurance companies from all parties involved get this full documentation. They are users of the information from the traffic accidents registration process, rather than contributors. They might also be interested in the traffic safety assessments as an end-user.

Legal process

When an accident involves heavy injuries/deaths and/or serious disputes (which can't be solved between the parties involved), then a police report is sent to the court with all the information on the accident including its location (usually in the form of sketches). This might then lead to a legal case in which, besides the people involved in the accident, the police, the insurance companies, as well as witnesses might also be involved.

It should be noticed that the traffic safety monitoring process is also related or might influence other processes: e.g. the traffic monitoring process in case an accident has an impact on the traffic in the form of traffic jams. These processes are not analysed further in the context of this use case.

5.3 Step 1 - Mapping the process

In this first step, we analyse the two major sub-processes which together form the traffic safety monitoring process: the registration of traffic accidents and the traffic safety assessment process. For each of the processes, we describe the actors, process steps, required input and the resulting outputs.

5.3.1 Registration of traffic accidents

The process of traffic accident registration involves **several stakeholders** and is event-driven, i.e. each time an accident occurs with serious injuries/deaths the process is initiated (see Figure 10).

The general procedure for the registration of traffic accidents by the **local police** involves three main steps. The first step is the on-scene registration of the traffic accident by a police officer. Depending on the location of the accident, a local or a federal police officer is involved. This registration is, in almost all cases, still done on paper with the collection of complementary data such as basic sketches, manoeuvre diagrams, interrogations, etc. The location is specified in terms of the address closest to where the accident happened, or a kilometre post in case of numbered roads[9]. The second step consists of loading these data in the Integrated System for the Local Police (ISLP) database and to perform the actual, more precise geo-

[9] Only occasionally a precise x,y coordinate is known.

localisation of the accident when possible. The third and final step is completing the minutes based on the information from the localisation process in order to pass the minutes on to the Central Database of the Federal Police.

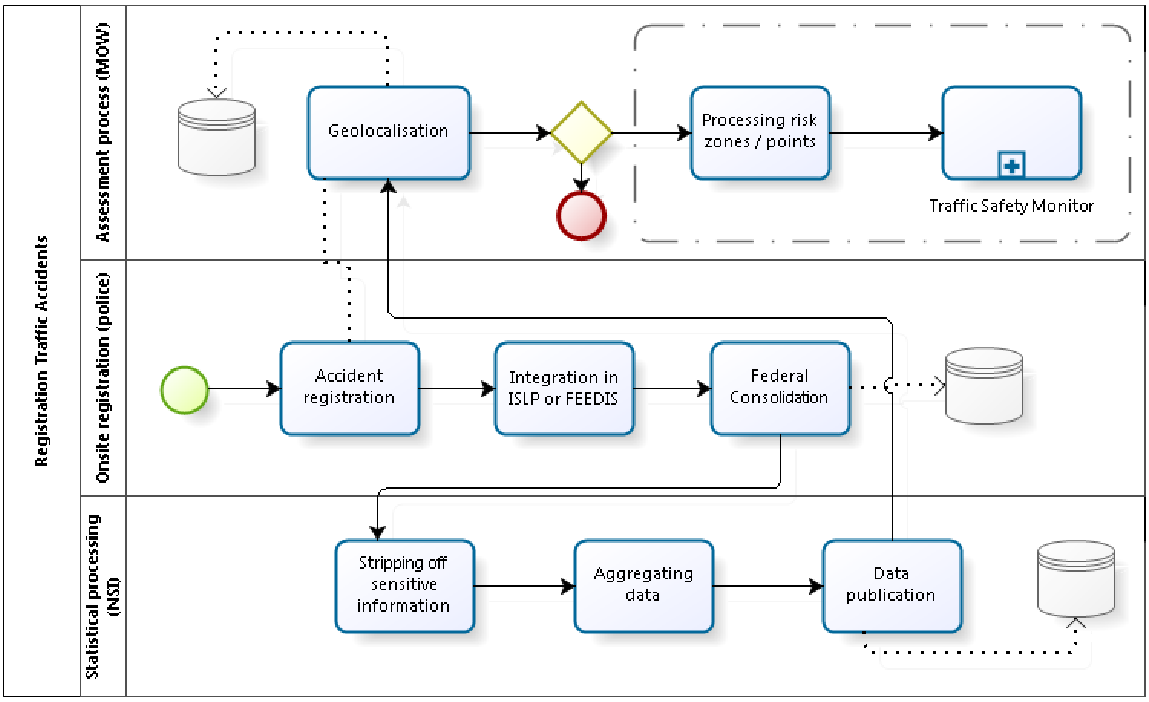
The highway patrols of the **Federal Police** are responsible for registering of accidents on state highways. The location in this case is registered by means of the information about the closest kilometre post (at a numbered road). The location information on the accident minute is then entered into the Feeding Information System (FEEDIS) and transferred to the Central Database of the Federal Police as well. The Directorate of Operational Police Information manages the Central Database of the Police and is responsible for the localisation of traffic accidents in order to perform strategic analysis.

ADSEI, the **Federal Statistical Office** receives the data from the Federal Police and in case of fatalities within 30 days after the accident, additional information is provided by the Courts. ADSEI performs numerical statistical analysis on the traffic accident data and strips 'sensitive' information from the data such as personal data and sometimes even the location of the accident if this would allow identification of this personal information[10]. It should be noted that ADSEI processes the data for accidents covering a full year. This means they 'collect' accidents over one year and process all the accidents that occurred in the previous year in one go.

The localisation of traffic accidents within the **Department of Mobility and Public Works** (MOW) is situated in the division of Mobility and Traffic Safety. The data input for the localisation procedure is mainly performed by the **provinces** who act on behalf of MOW. They will collect missing location information from ADSEI, the local and Federal Police and AGIV. It should be noted that the Department of MOW works together with the agency for Roads and Traffic to maintain an up-to-date road network.

The localisation of traffic accidents is used as supporting information in order to enhance potential policy measures. However, it is not always possible to find the information needed to perform a correct geocoding. In this case, the Department of Mobility and Public Works sends the data with inaccurate location information back to the respective provinces for collecting additional information. If the localisation is not accurate enough (50m detail is required), the province sends the record back to the local police zone responsible for the accident registration with the request to provide the correct information concerning the traffic accident location.

Figure 10. BPMN diagram of the traffic accidents registration sub-process



[10] This due to the very strict privacy laws in Belgium.

Some police zones return a paper copy of a map with an ink indication of the accident location; some police zones return x-y coordinates and some police zones answer with information coming from a dedicated GIS application in a standard GIS file format (e.g. SHP). Once updated, the data are sent back to the Department of Mobility and Public Works. Figure 10 provides an overview of the major data flows and actors, with more details mentioned in the text (the complete figure would provide a picture which is too cluttered).

Various **spatial data sets** are used during the traffic accidents registration process:

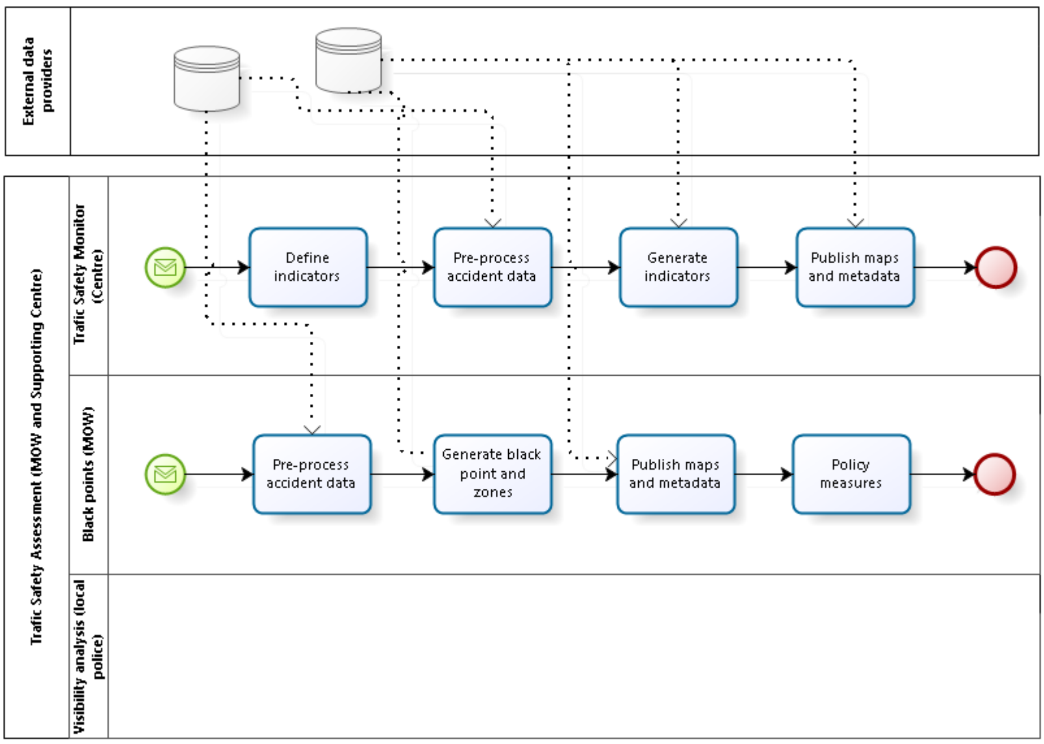
- During field registration no spatial data sets or GIS applications are used but sketches locating the accident are made;
- For registration in the office, police officers usually use detailed large-scale maps (e.g. GRB), addresses (e.g. CRAB) and road networks to locate the accident more precisely;
- The statistical office uses geospatial techniques to aggregate the data;
- MOW and the provinces also use (a local copy of the) data from the Flemish SDI (GRB and other data) to support the geocoding;
- None of the stakeholders use existing location-based web services (e.g. background maps) although this is changing at the time of writing this report.

The **outputs** of the traffic accident registration process are multi-fold: 1) a consolidated accident database used by the federal police for follow-up of the individual accidents when needed, and for strategic analysis; 2) a processed version of this database with some of the information filtered and/or aggregated managed by ADSEI; and 3) an accident database with geo-localised information managed and further used by MOW for policy purposes (see next section).

5.3.2 Assessing traffic safety

Assessing traffic safety is part of the policy tasks of MOW and the Policy Research Centre activities make use of the results of the traffic accident registration sub-process. These activities consist of – among others - the development of traffic safety indicators, the generation of black-points (and zone) maps, as well as conducting of detailed visibility analysis in order to decide whether to re-engineer road-crossings, etc. Figure 11 provides a general BPMN schema for two of them: the safety monitor and the black points mapping.

Figure 11. Business Process Modelling and Notation (BPMN) schema of the Traffic Safety Assessment process



Monitoring indicators for road safety

To *monitor the status of road safety* and to support policy development in Flanders, the Road Safety Monitor was developed (Tirry and Steenberghen, 2013). The objective of the Road Safety Monitor is to support the accessibility, quality and the interoperability of spatial indicators for road safety. It also plays an important role in the distribution of data and information to internal and external stakeholders (Tirry and Steenberghen, 2013). A number of indicators are necessary to understand the state of affairs in the field of traffic safety and to prepare policy recommendations. Being both a spatial and temporal phenomenon, to better understand the current situation and take precaution and measures for the future, there is a need for an in-depth analysis of the current status and trends over the past years.

The first phase of the Accident Monitoring Process in the Road Safety Monitor starts with the provision of accident data. The accident data for the calculation of the indicators are received by the Policy research Centre for Traffic Safety from the **Department of Mobility and Public Works** (MOW) – who is the process owner - as a file via mail or other electronic transfer system. However, before providing the accident data, an agreement needs to be signed with the **federal government** because of the sensitive nature of the information. Because of the privacy issues, information can be published only at an aggregated level.

The road safety monitor also makes use of external spatial data provided by the **Agency for Geographic Information in Flanders** (AGIV). The agency is responsible for coordinating the development of the components of the Spatial Data Infrastructure and INSPIRE in Flanders. The most important spatial data sets are the administrative boundaries and the road network, but other data are used as well.

The second part of the process is triggered when the data are received. The data is uploaded into an Access database of the **Centre** at the beginning of the process. Then, the set of indicators are defined based on the given accident data such as total number of deaths, sum of accidents with pedestrians, with cyclists etc. After the decision is made about which indicators will be developed, the next step is the pre-processing of the accident data. The data are studied in detail to check for any inconsistencies and whether there are any changes in data structure in comparison with previous years. When there are issues, they should be solved before further processing of the data. Then, a set of queries are run for the creation of the road safety indicators. The indicators are calculated as a 3 years average, which smooths out the anomalies that occur in some years or specific peak periods that might give a wrong idea about the trends of the accidents.

The indicators are then categorised into various themes such as policy-related, risk areas and thematic areas. All the road accident indicators are aggregated at municipal or province level. Some of the examples of indicators are:

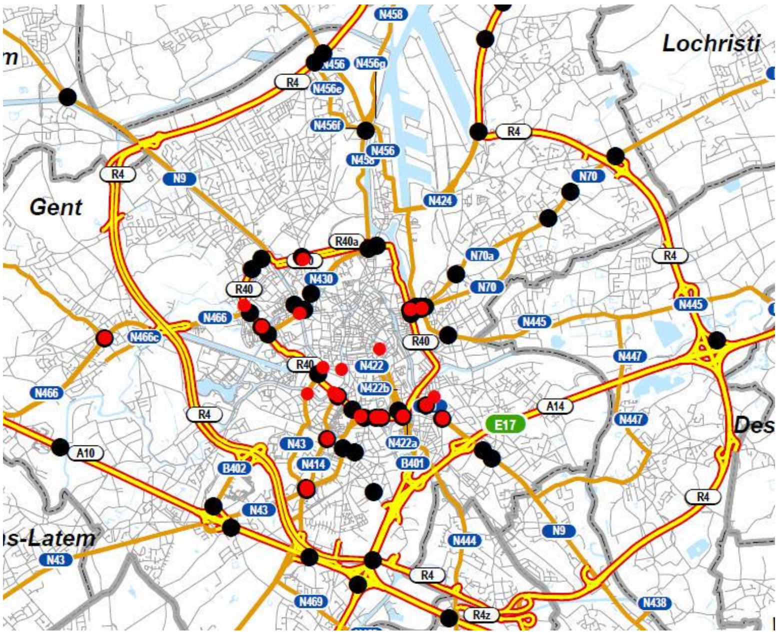
- Deaths for the years 2005-2007, 2006-2008, 2007-2008
- Risk of accidents 2005-2007, 2006-2008, 2007-2008
- Accidents with pedestrian, cyclist, mopeds, motorcyclists, 2005-2007, 2006-2008, 2007-2008
- Accidents under the influence of alcohol 2005-2007, 2006-2008, 2007-2008
- Accidents at cross-points, roundabouts and continuous sections 2005-2007, 2006-2008, 2007-2008

In the use case, the external geospatial data were accessed through OGC web services (see section 5.3.2). Both maps and metadata are made available to all the users of the Traffic Safety Monitor through the traffic safety geoportal and published also as OGC web services as well (see also section 5.3.2).

Black points mapping

In a similar way, black points are generated as a key instrument for making policy decisions regarding traffic safety (see figure 12 for an example). These data sets are generated from the traffic accident database originating from the federal police and via the different steps in the registration process resulting in a geo-localised, multi-year accidents database.

Figure 12. Sample of a black points map around Ghent



Also, here, in a first step, the accident database received from the federal police and ADSEI needs to be pre-processed to check on inconsistencies and changes over time. This step might take some time (see section 5.3). Then, the individual statistics are aggregated, e.g. accidents occurring at the crossing of two roads might have a slightly different location, but the 'black point' will be the exact crossing of the centre lines of the road. Or accidents occurring in a small zone (road segment) might be aggregated as well, etc. An overview map of these black points is published on the governmental web site but the data are not allowed to be distributed due to the same privacy rules and laws. The black points map is used to make governmental decisions, especially related to public works that might be conducted to improve the underlying infrastructure where most of the accidents occur.

5.4 Step 2 – Assessing the process

In this second step, the objective is to evaluate the use of location information and location-enabled web services in the traffic safety monitoring process, and eventually to identify where in the sub-process new added value e-Government services (applications) might be developed. We make the assessment for the two sub-processes, the registration of traffic accidents and the assessment of traffic safety. Especially for the second sub-process, some geospatial web services were integrated and set-up and new techniques were tested (linked data). We end this section with some final considerations on process performance regarding the spatial enablement of the entire traffic safety monitoring process.

5.4.1 Registration of traffic accidents

Before discussing where the process could be better spatially enabled, some general considerations should be made regarding the organisation of the traffic accident registration sub-process and how this might impact process performance.

1) The overall registration process (from beginning to end) takes a significant amount of time. The throughput or flow time is estimated at 2 years minimum, but often it is around 3 years. This means that the data available for policy purposes are out-of-date when they reach the policy stakeholders (see section 5.3.2). However, the initial registration itself, in the field, and even the initial localisation and inputting into the respective systems of the police are relatively smooth and fast.

2) The 'slow-down' of the process occurs during specific activities in the process which make the traffic accident data unavailable for a long period of time. This happens at the time the data are delivered to ADSEI. The data are grouped before being delivered to and processed by ADSEI since there is not a dynamic / permanent process, processing single accidents, but rather a batch process. Also, the processing itself takes time. The same happens when the data arrive at MOW and the provinces. The process to 'fix' the data takes around 6 months annually.

3) Belgian privacy laws and rules mean that data management does not occur in optimal circumstances and much work has to be redone. Probably the privacy concerns can be managed within the process in another way in order to respect the laws and rules, but at the same time avoiding jeopardising the process (speed).

4) The order in which the data are processed does not seem to be entirely logical. In fact, ADSEI might be considered as one of the (key) users of the data at the end of the chain, rather than at the middle of it. MOW and the provinces could get the data earlier in the process (in parallel), directly from the federal police, and could then process the data according their needs with respect for the privacy laws and rules.

Figure 13 provides the same BPMN scheme of the traffic accidents registration sub-process as figure 10, but this time with four places indicated where location information could be better integrated and used.

1) Data collection - A significant change would be to automate the collection of information on the accidents in the field. Police officers could make use of tablets or other mobile devices to collect information about accidents making use of GPS (or in the future Galileo) technology to locate the precise location of the accident, to sketch and annotate, to fill-in forms and directly write the information into the central database of the police, etc.

2) Address register – During the process, several address databases are used. This leads to miss-matching and difficulties in the localisation of certain accidents. The use of one central address register (for the whole of Belgium!) would avoid this problem. Work is on its way to harmonise and streamline addresses, but the real situation is still very mixed.

3) Use of OGC web services - For the processing and aggregation of the data at ADSEI, OGC web services could be used for reference data such as administrative boundaries, the road network, etc. Currently local geospatial data sets are used which require regular updates.

4) Geo-localisation - In the phase of geo-localising the accident data by MOW and the provinces, more OGC web services could be used, enabling harmonisation in the way the localisation is done (same underground reference data such as the large scale reference database - GRB). Moreover, an option would be to offer geo-localisation as an e-Government service that could be re-used in other processes.

Figure 13. Places in the accident registration sub-process where integration of location information could be improved

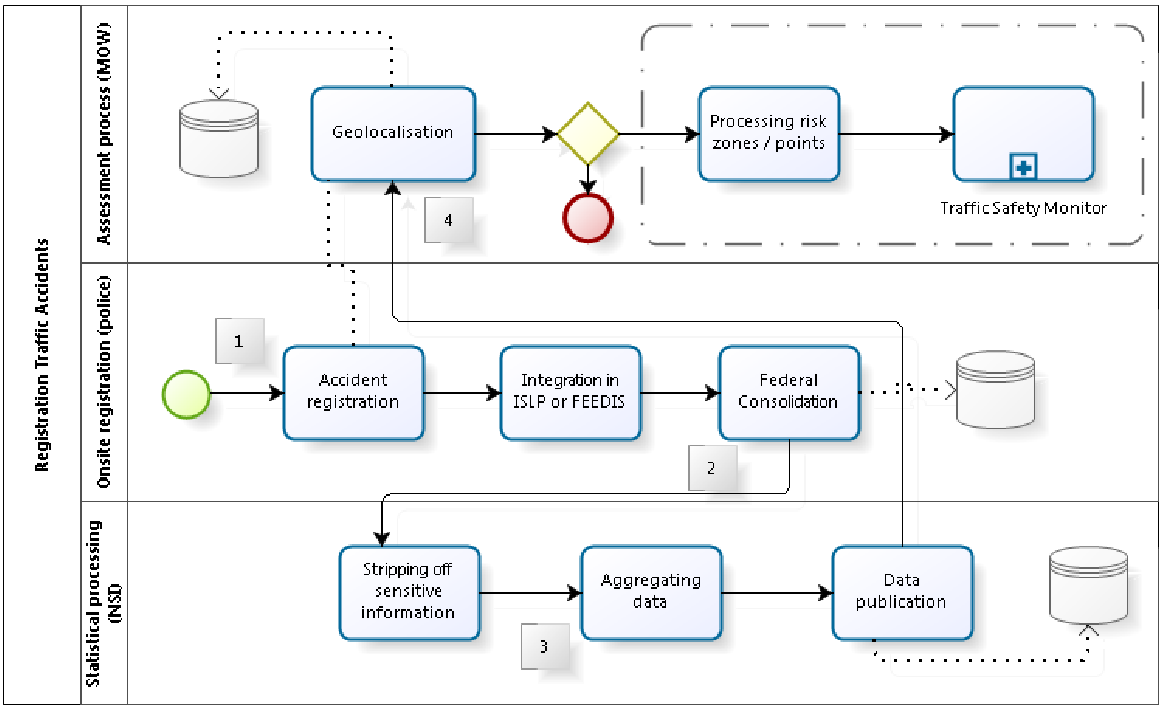


Table 6 provides an overview of the estimated impact on process performance in terms of flow time, cost and quality. The impact is expressed in broad relative terms but could of course be refined.

Table 6. Estimated impact on process performance of further location enablement of the traffic safety registration sub-process

	(Flow) Time	Cost	Quality
Accident registration app	*Very high*	*High*	*Medium to high*
Harmonised address register	*Medium*	*Medium*	*High*
Use of OGC web services	*Low to medium*	*Very low*	*Medium*
Geo-localisation service	*Medium*	*Medium*	*Low*

Since the possible (required) actions were relatively complex and time-consuming, and also required agreement with many stakeholders, none of the described improvements were tested in this use case.

5.4.2 The accidents monitor (as part of the traffic safety assessment sub-process)

Before discussing where the process could be better spatially enabled, some general considerations should be made regarding the organisation of the traffic safety assessment sub-process and how this might impact process performance.

1) The traffic safety assessment sub-process consists of several parallel activities (or sub-processes) that deliver specific assessment information to the traffic safety policy stakeholders. However, the requirements for this stakeholder group are dynamic: i.e. the required indicators or the way they must be calculated can change; the way black points are processed might need revision; particular geospatial analysis might be asked for, etc. This needs to be taken into account when developing specific e-Government services for this process.
2) In the assessment sub-process, the time aspect is very important, requiring some stability in the way information is collected, but this must also be reflected in the tools and platform(s) used, and the way the traffic safety information is represented.
3) The overall performance of the assessment sub-process is highly influenced by the performance of the registration sub-process. It seems that a lot of pre-processing is required due to non-harmonised data structures (models/specifications) and the fact that they seem to change over time. Moreover, since data protection is not embedded in the process – e.g. by using secure access mechanisms – separate agreements must be signed by all the stakeholders involved with each cycle in the data gathering process, i.e. annually. This slows down the whole process yearly by at least one month (but usually it takes more time).

The objective of the Traffic Safety Monitor was to initiate and promote an interactive user community where data analysis techniques and results can be developed, applied, updated, discussed and shared. Thus, a web platform was chosen where indicators relating to traffic safety were published as maps along with metadata. These geospatial indicators are important for governments to monitor and support spatial planning policy and decision making. In addition to developing additional indicators as a map, the work also centred on a user-friendly tool making use of GIS to support policy making.

Figure 14 provides the same BPMN schema of the traffic accidents assessment sub-process, as Figure 11, but this time with four places indicated in the process where location information could be better integrated and used, as well as where in the process Linked Data technology could enrich the information base (5).

1) Quality Assurance service - During the pre-processing activity the data are investigated using different kinds of tools including geospatial and statistical tools, and additional spatial data layers. The activity corresponds to a quality control assurance procedure which could eventually be automated and offered as a back-office G2G service, which could also inform the relevant stakeholders of the traffic accidents registration process of shortcomings/errors.
2) Use of OGC web services - For generating the indicators, several geospatial data sets are used from AGIV. This could be done by accessing them via OGC web services. Similarly, when publishing the indicators, OGC web services could be used.

3) Service supporting the generation of indicators - Generating the indicators is a fixed process for each indicator. Once the indicators are defined and once the calculation method is fixed, they can be generated automatically. In the longer term this activity could be offered as a web processing service.

4) Publication of OGC web services – In the past, publication of the traffic safety information happened in a static manner through statistics and static maps. In this use case, the resulting indicators are published as a web mapping service. Unfortunately, downloading of the information in the form of a web feature service is not allowed for the same privacy rules and regulations mentioned before. Also, metadata on the indicators are published along with the services.

5) Use of Linked Data - Much information on traffic and traffic safety is available through the web; different communities are active. Therefore, the use of semantic web technologies such as linked data might be a way to link the base information from traffic safety monitoring to this information to bring new insights.

Figure 14. Places in the safety monitor sub-process where the integration of location information could be improved

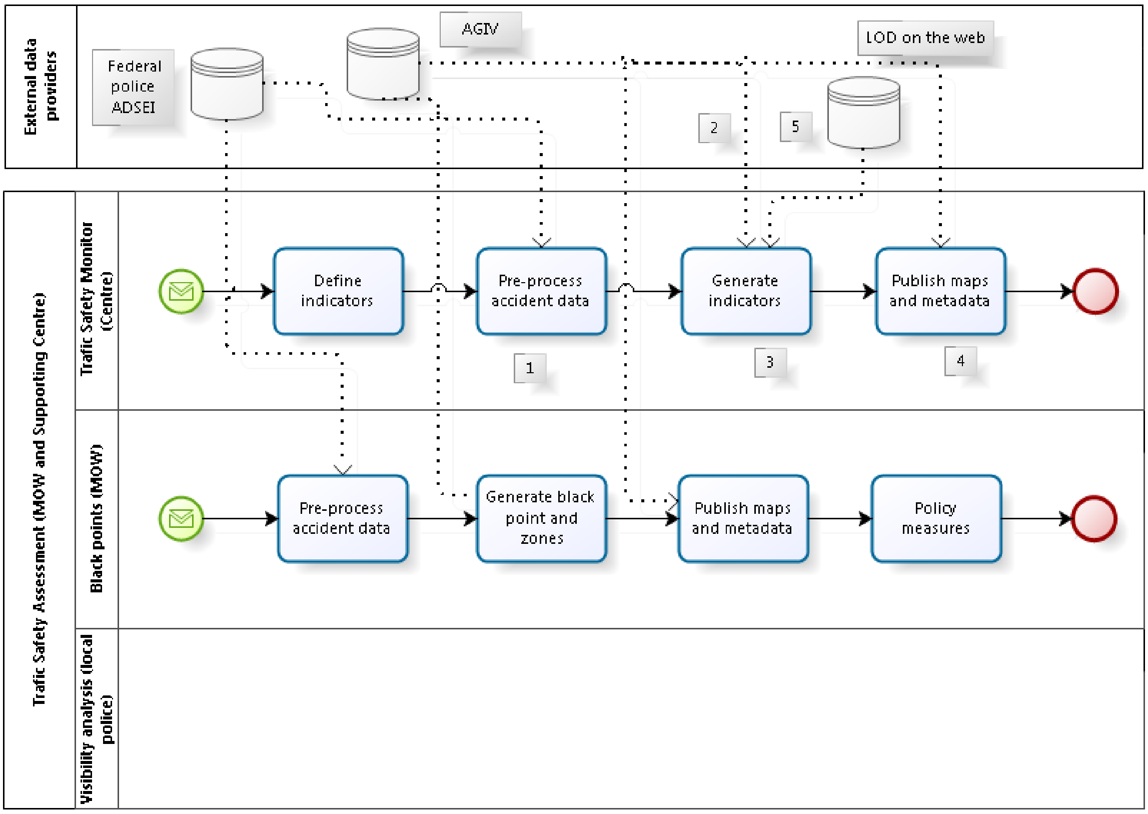


Table 7 provides an overview of the estimated impact on process performance in terms of flow time, costs and quality. The impact is expressed in terms of major categories but could of course be refined.

Table 7. Estimated impact on process performance of further location enablement of the accident monitor sub-process

	(Flow) Time	**Cost**	**Quality**
Quality Assurance service	*High*	*Medium*	*High*
Use of OGC web services	*Medium*	*Very Low*	*Medium*
Service for generating indicators	*High*	*Medium*	*High*
Publication of OGC web services	*Low*	*Low*	*High*
Use of Linked Data	*Unknown*	*High*	*Unknown*

In the context of this use case, three aspects were worked on: the use of OGC web services, the publication of OGC web services and the testing of linked data as a method to enrich the baseline information.

The publication and use of OGC web services

The website of the traffic safety monitor is built as a Content Management System (CMS) based on Drupal. This allows easy building and editing using models rather than extensive coding. Drupal makes use of Open Layers and OGC standard Web services (WMS) to visualise the maps. The focus was not only on reuse but also on reproducing the indicators so that users are able to recalculate the indicators themselves. Therefore, the metadata template is extensive, providing information about how the indicator is calculated. The monitor not only published the geospatial indicators that were developed by the Centre itself but also from other stakeholders. In the geoportal, WMS services from other organisations such as AGIV were embedded. Some of the examples of geospatial indicators on road safety are the number of accidents with cars, death due to accidents, the number of positive alcohol tests etc. The use of existing WMS enabled the latest data to be available without having to take local copies.

The Road Safety Monitor publishes the accident indicators through Web Map Services (WMS). This allows other organisations to embed it in their own application or portal (e.g. the provinces). There is also a possibility of providing Web Feature Services (WFS) but for the time being it was not implemented due to the aforementioned privacy issues. In the Road Safety Monitor design, GeoServer is used for the WMS and WFS services. Along with maps, metadata also form an essential component of the monitor. A standard metadata template is created where the non-spatial information such as creator, temporal information (date of publishing/updating), reference, data quality are stored along with spatial metadata: Spatial coverage (Flanders), spatial representation (vector/grid), Coordinate Reference System (EPSG code).

The updating of the indicators is one of the key issues that needs to be solved. The processing of the contract and receiving the accident data takes almost a year. It is impossible to even get the data from the Ministry of Mobility and Public works, as they need to do their own processing and correction. In 2015, the latest data obtained were data from 2012. Another challenge is the changing data structure, the addition of new categories, for example: 5 classes for the type of road were added in 2012 while previously there were only 3 classes. This makes it impossible to make an exact replication of some of the indicators for 2012.

The use of Linked Open Data

One of the problems that the project tried to address was the interoperability issues in cross-domain and cross-sectoral research. In recent years, a policy framework to provide government data as 'Open Data' was developed in Flanders which means that more and more data become available through the web. The web is the preferred medium when it comes to information and data sharing. Better integration and interoperability of data through the World Wide Web is only possible when everyone agrees on the standards for data representation and sharing. Linked Open Data (LOD) is one such method of publishing structured data using standard Web technologies. The work on LOD was tried out as a proof of concept for standardisation of metadata and data.

The exploitation of the World Wide Web as a platform for the integration of data and information to make government data available and accessible is considered as key to getting started with Open Data. The Semantic Web as a concept was first mentioned by Tim Berners-Lee (2000). It allows data to be shared and reused across different platforms using the standards and a set of principles. The term 'Semantic' means that there is an agreement on the meaning of an object or entity. For example, if we talk about an entity or object named 'road', it should have an explicit definition that everyone understands in the same way. The 'Semantic Web' is a vision on technology in which computers are capable of understanding the exact meaning of data, making machines intelligent to process and link the datasets.

'Linked Data' is a set of principles that guides the achievement of the vision of the Semantic Web. 'Linked Data' is used in this context as a method for the publication of data in such a standardised and structured way that the data becomes linkable. Linked data builds upon standard web technologies, like Hypertext Transfer Protocol (HTTP) and a Uniform Resource Identifier (URI). Instead of making webpages readable in a traditional way, pages are extended in such a way that they become machine-readable.

Berners-Lee suggested a "5 star" deployment scheme for Linked Data[11] (**Error! Reference source not found.**). This 5 Star Linked Data system is cumulative, meaning that each additional star presumes the data

[11] http://5stardata.info/en/

meets the criteria of the previous step(s). To reach the fifth star phase, Berners-Lee defined four design principles of Linked Open Data (Berners-Lee, 2000):

1) Use Uniform Resource Identifiers (URIs) to name the data entities;
2) Use Hypertext Transfer Protocol (HTTP) URIs, so the information can be looked up on the web and description of the particular entities can be retrieved ("dereferenced");
3) Provide useful information using open standards like the Resource Description Framework (RDF), SPARQL Protocol and RDF Query Language (SPARQL etc. to encode the information and query it;
4) Provide links to related URIs (other information), so people can discover more.

Thus, the primary focus of Linked data is on publication, discovery, interoperability, sharing and interlinking of the data, with use of the open standards. The Linked Open Data concept didn't exist when the INSPIRE Directive implementing rules were designed. There is a good overlap between the two but with some subtle differences:

- The focus of linked data is explicitly on the web while INSPIRE, in principle, is not limited to the networks of the Internet on which spatial data is made available.
- The fourth principle of linked data goes beyond publishing, encouraging people to add links to other related data. INSPIRE limits itself to publication of existing data sets and excludes collection of new data.
- Linked data is based on semantic web technologies and SDIs are mostly based on web services sending XML messages via HTTP.

Figure 15. The "5 star" deployment scheme of Linked Data by Berners-Lee. Source: http://5stardata.info/en/

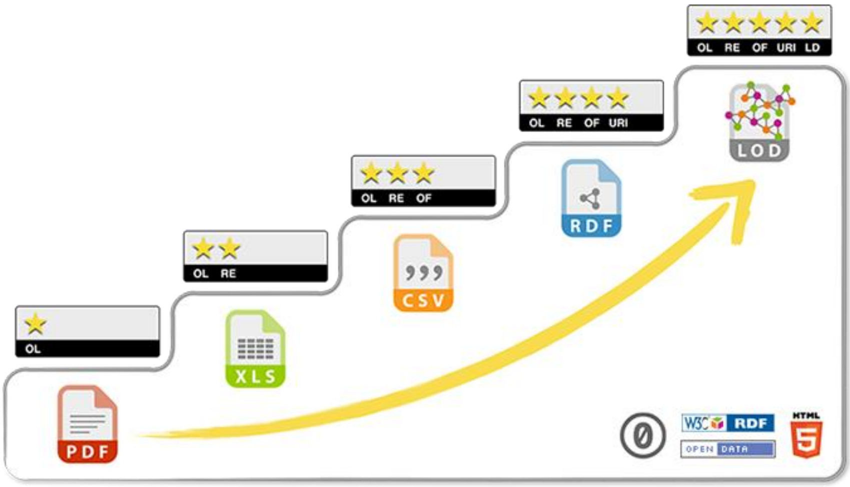
☆ Data is available on the Web, in whatever format.

☆☆ Data is available as machine-readable structured data, (i.e., not a scanned image).

☆☆☆ Data is available in a non-proprietary format, (i.e. CSV, not Microsoft Excel).

☆☆☆☆ Data is published using open standards from the W3C (RDF and SPARQL).

☆☆☆☆☆ Data is all of the above and links to other Linked (Open) Data.



In the traffic safety monitor, the linked open data case was implemented as a possibility to standardise metadata and link data to other datasets or indicators to give more insight about traffic safety. The focus lies at the development of a business process for the semantic exchange of spatial data and metadata using linked open data principles, as publishing five star linked data needs new workflows. This business process benefits from describing spatial indicators in a structured way as well as unlocking and presenting them in a coherent way. To ensure exchangeability of indicators through semantic interoperability, a first step was the development of a semantic exchange model using Linked Open Data principles for the Road Safety Monitor. The full workflow for publishing Road Safety monitoring data as linked data is described in Annex 1. Also, the metadata for the indicators were prepared as linked open data according to the DCAT specification, with an extension to host specific requirements for indicators. The last step, the linking of the published road safety data to other transport and mobility data on the web, could not be finalised during this use case because of the limited resources and time constraints to prepare the information (some of it was not yet in linked data format).

With the enormous potential, there are still considerable challenges, drawbacks and possible hurdles in realising the full potential of Linked Data (Bechhofer et al., 2013; Lopez et al., 2010). Linked Data principles are built on a stack of standards and technologies. This makes it a long learning process for developers to understand the complexity of the logic behind the Semantic Web. It is even more difficult for end-users to benefit from Linked Open Data unless there are user-friendly interface solutions that conceal the complexity. Also, the process of finding and querying the distributed semantic data available online is difficult and not optimal (Bechhofer et al., 2013; Lopez et al., 2010). To ensure the reusability of data, metadata is crucially important as it provides information about provenance, quality, credit and methodology. Other underexplored issues relate to the identification and management of broken links (Hart and Dolbear, 2013). The assessment of data quality is yet another issue to be solved. There is no automated method to know if the links are logically consistent. Also, the misuse of Linked data or misrepresentation of information within Linked data may direct semantic search engines or Semantic Web applications to a spammer's data or website (Hart and Dolbear, 2013). The trust issues could be minimised only if the user can view and explore metadata.

Moreover, the geospatial semantic web can offer more intelligence to spatial reasoning and increase the benefit of linked open data with geospatial information. It still is at the initial stage of development however, facing several challenges in its implementation. A second issue with the geospatial semantic web is that different types of software tend to use their own vocabularies for representing geometries. This makes it more difficult to understand and use them. For example, GeoSPARQL, an OGC standard, is only used by a few tools.

5.4.3 Process performance analysis to the use case

The three main performance indicators as defined in section 3.2.2 can also be applied in the process of monitoring traffic safety. As was described earlier in this report, the process can be divided into two main sub-processes: the registration of traffic accidents and the assessment of traffic safety. Table 8 shows how each of the three performance indicators can be measured in the context of these two sub-processes. Also, within each of these sub-processes, the indicators can be applied on individual process steps, to assess the performance of each of these steps. This especially facilitates identifying bottlenecks in the process, i.e. process steps in which the performance of the process is particularly low, or in which the process is even temporary stopped.

Table 8. Application of the key indicators to the selected use case

Performance Indicator	Registration of accidents	Assessment of traffic safety
Flow time	Period of time between the occurrence of a traffic accident, and the inclusion of the accident in the central traffic accident database	Period of time between the access to the traffic accident database and the release of the results of the assessment process
Cost	Total cost of the resources spent on the creation of a central traffic accident database	Total cost of the resources spent on assessing traffic safety using the central traffic accident database
Quality	Correctness, completeness, up-to-dateness and re-usability of the central traffic accident database	Quality of the results of the assessment process

An interesting way of analysing, assessing and describing the performance of existing processes (or sub-processes) is by comparing them to the performance of the optimal process. To illustrate this, Table 10 provides a summary of the performance of the current traffic accident registration process in Flanders, and how a more performant traffic accident process could operate. The table shows how time, cost and quality are useful indicators for describing the performance of processes.

The total flow time of the process is generally considered as one of the main weaknesses of the registration process. Between the occurrence of an accident and the registration on the spot of this accident by a police officer, it can sometimes take more than three years before the accident is included in the central traffic accident database. This is mainly due to the fact that the process is organised in a strongly sequential manner, i.e. some process steps are only initiated after the previous step is fully completed for several cases. This makes the amount of waiting time for some process steps significantly higher.

Even without detailed information on the costs associated with the creation of a central traffic accident database, some evidence is available on the amount of resources spent in the creation of the database. Besides, the local police who are in charge of the registration of traffic accidents on local roads, four more public authorities - at three different administrative levels – are involved in the creation of an entry in the traffic accident database: the federal policy, the Directorate-General for Statistics and Economic Information (ADSEI), the provinces and the Flemish department for Mobility and Public Works. Each of these organisations is responsible for a particular process step. Also, interesting to note is that the work done by the provinces, i.e. the localisation of the accidents for their territory is fully financed by the Flemish government.

Table 9. Comparison of current performance of the traffic accident registration process and optimal performance

Performance indicator	Optimal process	Process Flanders
Flow time	After registration on the spot by the local police zone, a traffic accident is immediately uploaded to the central database of traffic accidents	In some cases, it takes more than 3 years before a traffic accident is included in the central traffic accident database.
Cost	No further processing activities are needed after the registration of the traffic accident by the local police.	After registration of the accident by the local police, four more public organisations spend resources on the processing of the individual accidents into one single traffic accident database.
Quality	A complete, correct and up-to-date traffic accident database is available to all stakeholders (with respect for privacy regulations).	The central traffic accident database is outdated, does not include all traffic accidents, and is not available to the public.

With regard to the quality of the process, and of the product in particular, some important observations can be made. An important problem in the traffic accident registration is the under-registration of accidents. Only accidents with injuries or death are included in the database, data on accidents with material damage are missing. Moreover, the database of traffic accidents in Flanders is not accessible online by the general public. A third quality issue – or weakness – is also related to the time dimension. As of 2015, the most recent data on traffic accidents in Flanders are data related to accidents in 2012.

The goal of developing and implementing spatially enabled processes is to improve the quality of the process and to reduce the process flow time and total cost of the process through the integration of spatial data and services in one or more process steps as was demonstrated in the previous sections. Several examples can be given of how the use of spatial data and services has improved the time, cost and/or quality of the traffic accidents registration process:

- Availability of an up-to-date detailed large-scale reference map improves the quality of the 'on-the-spot' registration ('drawing') of an individual accident, as data on the surrounding of the accident (road characteristics, traffic signs, etc.) should not be registered manually;
- Availability of a reference address database means that the majority of all traffic accidents in Flanders could be localised automatically, without intervention of an operator (time and cost savings);
- Direct exchange of traffic accident data, including information on the location of the accident, between the local police zones and the Flemish Department of Mobility could dramatically decrease the flow time of the process.

6 Conclusions and recommendations

The general methodology for improving the use of location information in e-government processes described in this document and illustrated through the traffic safety use case is recommended as an approach for Member State public administrations to adopt in their e-government improvement programmes. The proposed methodology has two steps:: first the detailed mapping of the process by means of the Business Process Model and Notation (BPMN) standard; second the assessment of the process in terms of where location information could play a more prominent role, as well as in terms of estimating the impact on process performance. For estimating process performance, three indicators are defined: flow time, cost and quality.

The traffic safety process, used for illustration, consists of several sub-processes and related processes. The most important ones were analysed in more detail: the traffic accident registration and traffic safety assessment sub-processes. Both sub-processes were described in detail using the BPMN standard in terms of actors, input, process activities and outputs, with particular attention given to the use of location information and the data flows throughout the different process steps. Subsequently, the process was assessed in terms of where in the process the use of location information and location-based services could be improved and the impact that could have on process performance.

The integration of existing OGC web services in the traffic safety monitor proved to be an easy way to make the use of geospatial data in the process more effective. Also the publication of the indicator maps as OGC web services was very straightforward and provided added value, mainly for other stakeholders that can re-use them in their own processes (e.g. provinces). Several potential e-Government services were identified as well. Due to time and resource constraints these could not be implemented as part of the use case. Finally, the importance of focusing on a harmonised approach for data gathering, in this case the traffic accidents information, cannot be overestimated. Harmonised data have a major impact on performance further along the process, e.g. because of the possibility of avoiding extensive re-engineering of data structures. Additionally, in this particular case, initial tests were also made to enrich the information of the traffic safety monitor with other transport and mobility data on the web using linked data technologies. Due to the same time and resource constraints, this topic could only be handled partially.

The work on the traffic safety monitoring use case points to some recommendations for Member State public administrations in the analysis of their use cases:

1) A use case should be defined as simply as possible. Even if the process itself may be very complex, it is recommended to avoid testing and demonstrating too many aspects of how location enablement could enhance the process.
2) The fact of having an existing operational project in which there is some 'freedom' for testing is crucial. Do not set-up an entirely new project. This would take too much time and would also require too much organisational effort.
3) It is recommended to allow enough time during the use case to work directly with the process owner, but also with broader stakeholders. It is therefore suggested not only to choose cases in which not too many stakeholders are partners, but also to develop the use case over six months instead of very short/quick use cases of e.g. three months.
4) Use cases should be very well documented from the beginning of the work. Developing BPMN schemas, conducting interviews, integrating and testing location-based components in processes is a very intensive and iterative process.
5) The integration of performance measurement techniques is only possible if they are embedded and supported by the actors in the process. Moreover, it is preferable that the measurement can be organised ex-ante and ex-post, something which could not be done in this use case. However, this requires additional time which might not be available. Alternatively, the process owner can be asked to estimate the difference between the new situation (with geospatial components added) and the situation as it existed before (without those geospatial components added).

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List of abbreviations and definitions

ADSEI	The Federal Statistical Office in Flanders
AGIV	The Agency for Geographic Information in Flanders
B2B	Business to Business
B2C	Business to Citizen
BPMN	Business Process Model and Notation
C2C	Citizen to Citizen
CARE	Community Database on Road Accidents
CMS	Content Management System
CRAB	Central Address Reference Register in Flanders
CSV	A comma-separated values file is a delimited text file that uses a comma to separate values
DG MOVE	Directorate-General for Mobility and Transport
DG SANTE	Directorate-General for Health and Food Safety
EFTA	European Free Trade Association
ELISE	European Location Interoperability Solutions for E-government
ETE	University of Leuven Energy, Transport and Environment Division
EU	European Union
EULF	European Union Location Framework
EPSG	The International Association of Oil and Gas Producers Geodetic Parameter Dataset – a structured dataset of coordinate reference systems and coordinate transformations
FEEDIS	Feeding Information System of the Federal Police in Flanders
G2B	Government to Business
G2C	Government to Citizen
G2G	Government to Government
GeoSPARQL	An OGC geographic query language for RDF data
GI	Geographic information or geospatial information
GIS	Geographic information system or geospatial information system
GRB	Large scale base maps of the Flemish municipalities
HTTP	Hypertext Transfer Protocol

ICB	University of Leuven Centre for Industrial Management, Traffic and Infrastructure
ICT	Information and Communication Technologies
IMOB	University of Hasselt Transportation and Research Institute
INSPIRE	Infrastructure for Spatial Information in the European Community
ISA	Interoperability Solutions for European Public Administrations
ISA^2	Interoperability Solutions for Public Administrations, Businesses and Citizens
ISLP	Integrated System for the Local Police in Flanders
JRC	Joint Research Centre
LOD	Linked Open Data
MOG	Gemodelleerde Overstromingsgebieden – Modelled Flood Areas
MOW	Flemish Government Department of Mobility and Works
OGC	Open Geospatial Consortium
OMG	Object Management Group
POG	Potentiële Overstromingsgebieden – Potential Flood Areas
R&D	Research and Development
RDF	Resource Description Framework
ROG	Recente Overstromingsgebieden – Recently Flooded Areas
SADL	University of Leuven Spatial Applications Division
SDI	Spatial Data Infrastructure
SHP	A file extension for a Shapefile shape format used in geographical information systems (GIS) software
SPARQL	An RDF query language for databases
TRACES	Trade Control and Expert System for animal transport
URI	Uniform Resource Identifier, used to identify a resource on a network
VITO	Flemish Institute for Technological Research
VMM	Flemish Environment Agency
W3C	World Wide Web Consortium
WDI	Water Data Infrastructure
WFS	Web Feature Services

WMS	Web Mapping Services
WMTS	Web Mapping Tile Service
WPS	Web Processing Services
XML	eXtensible Markup Language

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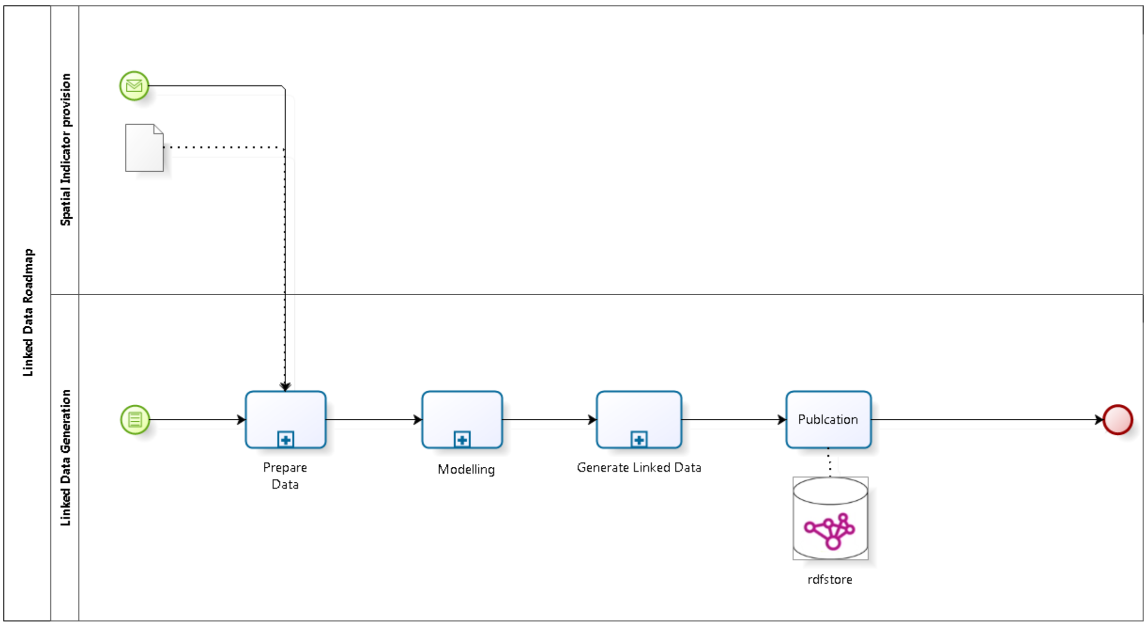
Annexes

Annex 1. Linked Data publication process

We provide a standardised workflow for publishing road safety related data as Linked Data (**Error! Reference source not found.**). The simplified and comprehensive method behind this workflow is mainly based on best practices from the W3C Linked Data Cookbook[12], the LINKVIT project[13], and the work by Hart and Dolbear (2013) and Heather and Bizer (2011). The process of Linked Data publication is divided into six phases (**Error! Reference source not found.**) that are represented as BPMN diagrams:

- Phase 1: Prepare data
    - **a.** Data selection and cleaning.
- Phase 2: Modelling
    - **a.** Define naming space
    - **b.** Ontology Design
- Phase 3: Linked Data Generation/RDF creation
    - **a.** Mapping to generate RDF
    - **b.** RDF file generation
    - **c.** Add Metadata
- Phase 4: Linked Data Publication
- Phase 5: Exploitation of Linked data
- Phase 6: Link to External Datasets

Figure 16. Business process model for the publication of Linked Open Data



[12] http://www.w3.org/2011/gld/wiki/Linked_Data_Cookbook
[13] http://www.linkvit.eu/en/

Figure 17. BPMN schema of Phase 1 'prepare data' of the standard workflow for publishing Linked Data

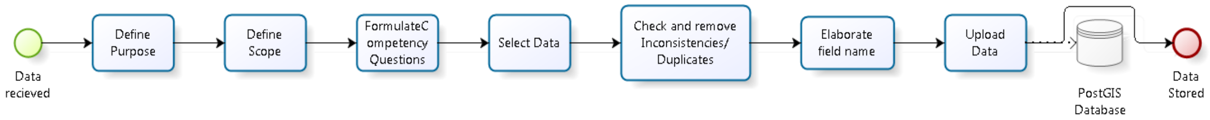


Figure 18. BPMN schema of Phase 2 'modelling' of the standard workflow for publishing Linked Data

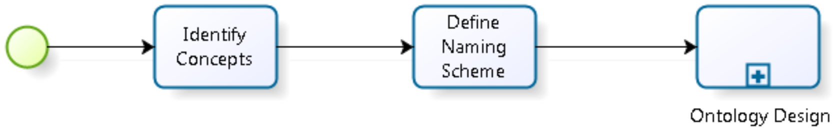


Figure 19. BPMN schema of the sub-process 'Ontology design', part of the standard workflow for publishing Linked Data

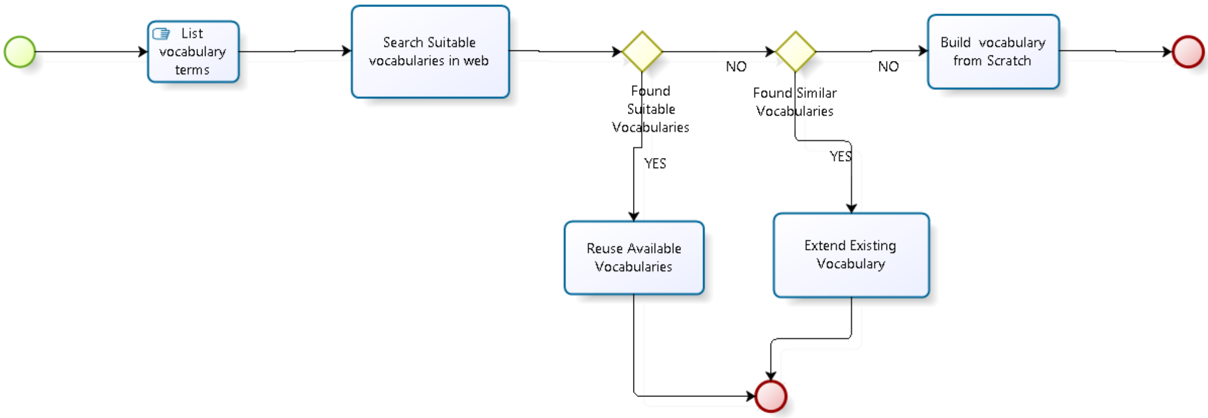
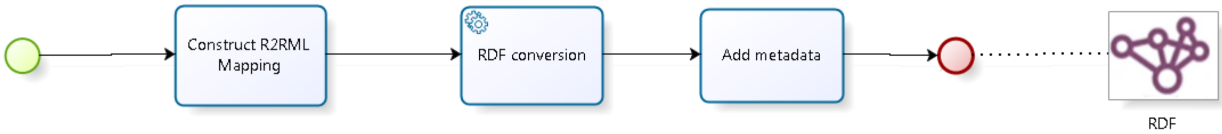


Figure 20. BPMN schema of Phase 4, modelling, of the standard workflow for publishing Linked Data



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