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## **Business cases**

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## About IMPETUS

IMPETUS (Intelligent Management of Processes, Ethics and Technology for Urban Safety) is a Horizon 2020 Research and Innovation project that provides city authorities with new means to improve the security of public spaces in smart cities, and so help protect citizens. It delivers an advanced, technology-based solution that helps operational personnel, based on data gathered from multiple sources, to work closely with each other and with state-of-the-art tools to detect threats and make well-informed decisions about how to deal with them.

IMPETUS provides a solution that brings together:

- *Technology*: leverage the power of Internet of Things, Artificial Intelligence and Big Data to provide powerful tools that help operational personnel manage physical and cyber security in smart cities.
- *Ethics*: Balance potentially conflicting needs to collect, transform and share large amounts of data with the imperative of ensuring protection of data privacy and respect for other ethical concerns - all in the context of ensuring benefits to society.
- *Processes*: Define the steps that operational personnel must take, and the assessments they need to make, for effective decision making and coordination - fully aligned with their individual context and the powerful support offered by the technology.

Technological results are complemented by a set of *practitioner's guides* providing guidelines, documentation and training materials in the areas of operations, ethical/legal issues and cybersecurity.

IMPETUS places great emphasis on taking full and proper account of ethical and legal issues. This is reflected in the way project work is carried out, the nature of the project's results and the restrictions imposed on their use, and the inclusion of external advisors on these issues in project management.

The cities of Oslo (Norway) and Padova (Italy) have been selected as the site of practical trials of the IMPETUS solution during the project lifetime, but the longer-term goal is to achieve adoption much more widely.

The work is carried out by a consortium of 17 partners from 11 different EU Member States and Associated Countries. It brings together 5 research institutions, 7 specialist industrial and SME companies, 3 NGOs and 2 local government authorities (the trial sites). The consortium is complemented by the Community of Safe and Secure Cities (COSSEC) – a group established by the project to provide feedback on the IMPETUS solution as it is being developed and tested.

The project started in September 2020 with a planned duration of 30 months.

## For more information

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## Executive Summary

This deliverable aims at providing a reference point for prospect cities that may be interested in the adoption and implementation of the IMPETUS solution and provide a foundation to evaluate the relative costs and benefits. To be as effective as possible, it was decided to adopt the perspective of the two pilot cities, Oslo and Padova. With a city-centred (rather than a tool-centred) approach, prospect cities (i.e., the ultimate beneficiaries of the solution) can better relate to the project and the different implications of the implementation of IMPETUS can be more effectively conveyed.

The analysis is structured following the EU “Guide to Cost-Benefit Analysis of Investment Projects” framework, which has been adapted to the scope of our analysis and the amount and accuracy of data currently available. Some limitations encountered have made it necessary to adopt some assumptions to carry out the analysis. These limitations mainly refer to the lack of real statistical and financial data regarding tools and crimes, the social and non-monetary nature that characterizes this subject, and the consequent difficulty in quantifying such socially complex phenomena.

Assumptions were based on the literature, identifying a series of crime clusters and associated statistics and connecting the IMPETUS tools with the related crime clusters affected by them. Two different scenarios were considered when estimating the gains of adopting a smart security solution: a more conservative one with an 8% fatalities reduction and a 15% crime reduction, and a more optimistic one, in line with the estimations of the literature, with a 10% fatalities reduction and a 30% crime reduction.

Thus, tangible cost reductions per year are estimated to be €13 to €24 million for Padova, and €9 to €18 million for Oslo. Considering also intangible costs, the potential savings are estimated to be €53 to €85 million for Padova, and €34 to €66 million for Oslo.

To provide the basis for our cost-effectiveness analysis, estimates of time of implementation and investment needed to get IMPETUS into effect are then calculated, based on inputs gathered from partners responsible for each tool. Since some tools are not yet at a market-ready technology level (TRL <9), and some tools will be available via different methods (e.g., purchase, subscription fee) these estimates are still approximate. Overall, the time needed for the platform and the tools to be operational at this time of the project is quantifiable as 12-18 months, while costs required are estimated at around to €1 million.

Based on this, mature IMPETUS technologies will be potentially highly cost-effective in reducing direct and indirect costs associated with the different crime clusters.

A qualitative risk assessment is then presented, performed by mapping the main adverse events that a municipality might encounter when implementing IMPETUS in its public security operations, together with a mitigation/prevention strategy to help prospect cities avoid the risk materialising. The main risks associated with a city using IMPETUS are mostly operational, like an inadequate preliminary analysis of the privacy requirements, an ineffective information and communication strategy towards the public, non-flexible procedures, inadequate infrastructures, etc. This means they can be tackled by prospect cities by some specific targeted initiatives and effectively counteracted.



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# 1 About this deliverable

## 1.1 Why would I want to read this deliverable?

This document describes the methodologies used to assess the IMPETUS business case from the point of view of a city interested in adopting the IMPETUS toolkit. It provides a general overview of what the IMPETUS solution offers and a foundation to evaluate its related costs and benefits.

In order to be as effective as possible, the perspectives of the two pilot cities, Oslo and Padova, were used to write this deliverable.

## 1.2 Intended readership/users

The deliverable is intended for potential adopters of the IMPETUS solutions, other technology providers related to security in smart cities, and all readers interested in understanding the potential benefits and costs related to different solutions for urban safety.

## 1.3 Other deliverables that may be of interest

This deliverable provides inputs to D9.4 “Exploitation Plan – final”. However, that is a confidential deliverable, so further information cannot be provided here in this public deliverable.



## 2 Methodology

### 2.1 The Business Cases

After a rigorous discussion over the scope of analysis of the business cases, it has been decided to consider the two pilot cities as the object of the analysis instead of having business cases focusing on the tools part of the IMPETUS platform.

The rationale underlying the choice of addressing the cities is taking advantage of a perspective allowing:

- better assessment of non-monetary costs and benefit of implementing the platform
- easier communication of the perks of the platform to other cities
- more accurate data collection during the demos and from the Pilots
- same point of view of the final decider (local government) in the platform implementation.

Focusing on the cities allows us to align costs and benefits to the final beneficiaries of the platform: the citizens. Undoubtedly, services related to safety and security raise concerns about the balance between the increase in protection and the loss in privacy. Moreover, the actual equilibrium should be sought between the perception of safety and the feeling of being controlled.

The impact of these feelings is hard to be estimated if taking the perspective of a security tool manufacturer. In fact, the manufacturer will only capture those drivers and barriers impacting directly on sales. Clearly, similar considerations are valid for other non-monetary costs and benefits.

Secondly, being European cities the first potential adopters of the IMPETUS platform, presenting the business cases as analysis on the impact of implementing the tools in daily routine provides an intuitive marketing tool when benefits overcome costs. It would be indeed easier for a local government to take decisions looking at a practice already validated and reviewed in other cities with similar needs and challenges.

For all these reasons, the scope of the business cases are the cities of Oslo and Padova whose municipalities are members of the IMPETUS consortium and, in these settings, the implementation of the different tools has been analysed.

### 2.2 The Cost-Benefit Analysis

The Cost-Benefit Analysis (CBA) methodology has been chosen to present the two business cases related to the pilot cities of Oslo and Padua. The main driver of this decision is the possibility of considering non-monetary costs and benefits too. In fact, having the two pilot cities as the object of the business cases required a methodology able to integrate a broad economic analysis in addition to a more direct financial one.

The CBA is an analytical tool for judging the economic advantages or disadvantages of an investment decision by assessing its costs and benefits in order to assess the welfare change attributable to it. To carry out the CBA, guidelines provided by the European Commission have been followed. In particular, the “Guide to Cost-Benefit Analysis of Investment Projects” has been considered as the main reference.

Even if the objective of the guide is offering practical guidance on major project appraisals, as embodied in the cohesion policy legislation for 2014-2020, the document can be seen primarily as a contribution to a shared European-wide evaluation culture in the field of project appraisal. Moreover, a strong methodology is provided together with a language accessible also to non-experts in the field of economic and financial valuation.

The analytical framework of CBA relies on five pillars:

- Opportunity cost
- Long-term perspective
- Calculation of economic performance indicators expressed in monetary terms
- Microeconomic approach
- Incremental approach.



**Opportunity cost:** a cost equal to potential gain lost for not choosing an option with respect to another. When there are more than two alternatives, the best one is to be considered. In fact, every decision implies some sacrifices (e.g., building a new fountain in the middle of a square comports losing parking slots).

**Long-term perspective:** solutions for municipalities are usually designed to be long-lasting; for this reason, a time horizon of no less than 10 years is usually adopted. However, given the high technological content of the IMPETUS integrated solution and the fast-paced market evolution, a time horizon of 5 years will be considered in this document.

**Calculation of economic performance indicators expressed in monetary terms:** the main goal of the CBA is comparing costs and benefits, which is possible only by having both of them expressed in the same measure units. All the costs and benefits are therefore expressed in monetary terms through a quantification of the financial burden (or relief) associated with impacts of the project under evaluation.

**Microeconomic approach:** it is important to focus only on the direct effects of projects and avoid considering effects on secondary markets or to macroeconomic indicators (GDP, employment, local growth, etc.). The main reasons are the risk of double counting costs/benefits and the risk of including effects that only partially originate from the project and thus overestimate the total impact.

**Incremental approach:** as for the opportunity cost principle, the CBA always considers the existence of at least one alternative to the project implementation: not to do anything. This counterfactual scenario is defined as what would happen in the absence of the project and it is called Business As Usual (BAU). All the considerations and computations related to economic and financial indicators are to be made only to the incremental cashflows, which are the difference between the under-evaluation scenario and the BAU.

The EU framework of the CBA is structured in seven steps:

1. Description of the Context
2. Definition of objectives
3. Identification of the project
4. Technical feasibility
5. Financial Analysis
6. Economic Analysis
7. Risk Assessment.

The framework which has been reported here is the approach provided by the European Commission for major projects appraisal. For our analysis, however, such a detailed and thorough evaluation of every aspect of the project is neither a viable option nor a useful one. Further, for some of these seven points, accurate and reliable data is not available at the time of writing. As will be outlined in the next sections, the European Commission's "Guide to Cost-Benefit Analysis of Investment Projects" has been used as a framework to follow. However, for some of the parts of the analysis, slight adaptations according to our scope and to data availability have been made, as will be defined below.

### 2.2.1 Description of the context

This is to be a paragraph dedicated to the social, economic, political and institutional context in which the project is being implemented. The key features to be described relate to:

- the socio-economic conditions of the country/region that are relevant for the project, including e.g., demographic dynamics, expected GDP growth, labour market conditions, unemployment trends, etc.;
- the policy and institutional aspects, including existing economic policies and development plans, organisation and management of services to be provided/developed by the project, as well as capacity and quality of the institutions involved;
- the current infrastructure endowment and service provision, including indicators/data on coverage and quality of services provided, current operating costs and tariffs/fees/charges paid by users, if any.





In this document, this paragraph is intended to be a brief introduction to the pilot cities as a description of the context where the platform has been implemented. This is presented in Section 3 below.

### 2.2.2 Definition of objectives

Given the context, this part defines the needs and the issues to be addressed by the project. As far as possible, objectives should be quantified through indicators and targeted. They may relate to, for example, improvement of output quality, better accessibility to services, increase in existing capacity, etc.

### 2.2.3 Identification of the Project

In this paragraph the project is clearly identified through the description of:

- the physical elements and activities that will be implemented to provide a given good or service, and to achieve a well-defined set of objectives, consisting of a self-sufficient unit of analysis;
- the body responsible for implementation (often referred to as ‘project promoter’ or ‘beneficiary’), including its technical, financial and institutional capacities analysed; and
- the impact area, the final beneficiaries and all relevant stakeholders (‘who has standing?’).

### 2.2.4 Technical feasibility

Technical feasibility is not strictly part of the CBA but it is important to properly assess costs and benefits of the project. The assessment mainly focuses on

- demand (current and potential);
- technical design, cost estimates and implementation schedule.

In fact, according to the EU Commission guidelines, option analysis and environment and climate change considerations should be done too. However, given the purpose of this deliverable and the scope of implementation of the IMPETUS platform, they are not going to be considered within these business cases.

### 2.2.5 Economic Analysis

According to the EU’s CBA framework, performing a Financial Analysis entails using the Discounted Cash Flow (DCF) method. At this time, calculating Discounted Cash Flows or Net Present Value is not a viable option for the scope of our analysis, because for many of the tools under development and the IMPETUS solution overall, accurate data regarding cash outflows and inflows is still unknown. One of the most important rules of financial estimation models is that the final calculation is only as reliable as its underlying assumptions. Given the impossibility of having reliable assumptions and estimations at the current time, performing a financial analysis would be of little use if not outright impossible.

Further, due to the nature of the technology that we are developing, costs and returns that need to be investigated do not pertain to the mere monetary sphere, but instead involve a large share of social, non-monetary, public safety-related advantages that are difficult to quantify and predict at this time.

What has been done, in this sense, is a wide economic analysis of the potential adoption of the IMPETUS solution based on data and scenarios offered by the academic and empirical literature. The approach selected, which will be explained in detail later in the document, has been the following:

- Based on academic and empirical literature, assign a unit cost to different types of crimes.
- Gather (when available) or estimate (where not available) crime data for the same crime categories for the cities of Oslo and Padova.
- Based on evidence from the literature, build a scenario of crime reduction prompted by the adoption of smart technologies for urban safety like the IMPETUS platform.
- Calculate potential savings that Oslo and Padova could achieve thanks to the adoption of the IMPETUS solution.



### 2.2.6 Risk Assessment

Risk assessment may be conducted either in a qualitative or in a quantitative way depending on the possibility of consistently identifying the probability function associated to the risk. A qualitative risk analysis identifies and describes the main causes of distress for the project, moreover the risks are usually classified according to their expected impact and their likeliness to occur. A quantitative risk analysis has pretty much the same goal as a qualitative one (identifying and classifying risks), but it takes into consideration the probabilistic behaviour of the determinants of the risk in order to properly estimate the expected impact on the eNPV (economic Net Present Value) of the project. In fact, both methodologies require then to set up strategies for prevention and mitigation, the last step of the analysis, to help understand which corrective actions are the right ones and what it takes to implement them. Given the current state of the project, a qualitative risk assessment has been carried out.



## 3 Description of the context

### 3.1 Oslo

Oslo is the capital of Norway and the country's largest city with almost 700,000 inhabitants. The GDP (Gross Domestic Product) of the Oslo County is almost 56 billion euros, while the GDP per capita is about € 84,000. Given its position and a well-developed public transportation system of underground and overground trains, buses, trams, and boats, it is a very accessible city and Norway's hub for national and international travel. Oslo has a very young and technology friendly population. The age group 25-35 will increase by 40% next ten years and it is talented and educated. The Oslo Region is Norway's main location for knowledge-based industries and services. In fact, advanced technology and expertise are also found within fields such as life sciences, information and communication technologies (ICT), energy and environmental technologies and creative industries.

As in the rest of Norway, in Oslo security services are performed by four organizations:

- The Police Security Service (PST), which investigates and prevents serious offences that threaten national security;
- The Norwegian Intelligence Service (NIS), which warns of external threats to Norway, supports the armed forces, and assists in decision-making processes;
- The Norwegian National Security Authority (NSM), which prevents threats to national security, and detects, alerts and coordinates responses to serious ICT attacks;
- The Directorate for Civil Protection and Emergency Planning (DSB), which maintains an overview of risks and vulnerabilities in Norwegian society.

The principles incorporated into Oslo's contingency and emergency planning system are four:

1. Responsibility: in contingency situations the responsibility should lie where it normally does;
2. Likeness: efforts should be organized as close to normal as possible;
3. Closeness: incidents should be handled at the lowest possible organizational level, the one most close to the incident;
4. Cooperation: organizations should cooperate and combine efforts to best solve emergencies.

Oslo is a relatively safe city and crime levels have been declining on a yearly basis over the last 18 years, before stabilizing over the last few years. More common types of crimes in public spaces relate to the sale of drugs, shoplifting and violence. Crimes related to profiteering are by far the most reported ones. Violent crimes have been increasing over several years. Threats, violence and robbery have seen an increase in incidents involving a knife as a weapon. Causes seem to be related to both economic conditions and group identity. In fact, ideologically and politically motivated violence is the main public-facing threat in 2020 and in particular, individuals within right-wing extremist and radical Islamist organizations are seen as most capable of planning and executing attacks. However, the murder rate is low and demonstrations are generally so peaceful that police are generally unarmed.

Regarding cybersecurity, there are no indications that the Oslo Municipality has been exposed as result of a directed threat actor, while the majority of incidents are malware-related, with continuous untargeted attacks. The majority of them are automatically contained by the municipal safety tools.

Car accidents occur regularly with different degrees of severity. Moreover, Oslo has various locations where containers or reservoirs with hazardous materials are stored, presenting a risk of explosions or gas clouds.

### 3.2 Padova

Padova is one of the main cities in the Veneto Region, in northeast Italy. The municipality of Padova accounts for more than 200 thousand inhabitants while the whole province is populated by almost one million people. The GDP per capita is about € 25.200 euro and thus it's one of the richest cities in the region and in 2020 it has been ranked 4<sup>th</sup> among Italian cities for quality of life. On the other hand, Padova is one of the most polluted cities in Europe in terms of PM10, and the city ranks 3<sup>rd</sup> in Europe for costs related to health issues due to pollution.



Padova is mainly known for its university, which is among the oldest in the world and every year hosts about 60,000 students and 5,000 professors and researchers. For this reason, Padova is a young and vibrant city with many people coming from abroad.

As in the rest of Italy, Padova has four main security organizations:

- The National Police (Polizia di Stato): responsible for control and security in the streets; control of travellers and goods in airports, harbours and stations; crime investigations; fighting against drug trafficking; security and public order in big events or demonstrations; scientific police activities; and cyber-crimes investigations;
- The Carabinieri Corp (Arma dei Carabinieri): responsible for public security and order; environmental police activities; military police activities; missions abroad and security of diplomatic representatives; and territory control;
- The Finance Guard (Guardia di Finanza): responsible for currency, tax and financial crimes;
- The Local Police (Polizia Municipale): responsible for public security, fighting drug trafficking, minors' protection, preventing crimes against Padova and environment, fighting illegal trade, public heritage protection, and antiterrorism.

Padova is among the 30% safest cities in Italy, with a declining trend in crimes reported that stopped only in 2020 when, due to the pandemic and economic instability, a surge in violence, narcotics and profiteering crimes was observed. Among crimes, those related to profiteering are by far the most common, followed by vandalism and violence.

Because of its university, in the '70s Padova was the scene of many ideological and political terrorist attacks. Overall, between 1977 and 1979 in the city there were 708 acts of subversive violence. Nowadays, terrorism is more likely to be associated with religious and political extremism, and Padova is not perceived as a high-risk target. However, this perception may be misleading, as Padova has one of the most important Christian sanctuaries (St. Anthony's church) and there is no reason to believe it could not be attacked.



## 4 Definition of objectives

The objectives for the implementation of the IMPETUS solution in Oslo and Padova will be considered the same, and they will be the objectives of the project as a whole. As a matter of fact, it is not possible, at the time of writing this deliverable, to differentiate the objectives of the application of the IMPETUS solution for the two different cities.

Since the goal of IMPETUS on the most general level is to increase urban safety, the objective of the application of the toolkit both in Padova and Oslo will consist of achieving a higher level of urban safety. In order to determine whether the output of the project makes for a fruitful investment, however, the goal of “higher level of urban safety” is not good enough for a potentially interested stakeholder. Indeed, when evaluating an investment opportunity, quantifiable indicators and parameters are the preferred means to assess the attractiveness of a project. Therefore, since “higher level of urban safety” could also be defined as “lower level of crimes in the city”, the target of the implementation of the IMPETUS toolkit in Oslo and Padova will consist of achieving lower levels of crimes in the years after its implementation. To be more specific, a list of 13 types of offences will be considered as a representation of the majority of crimes that a society faces. These types of offences are taken from the academic paper “The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation” by McCollister et al. (2010), which is among the most cited sources in crime-related academic literature. This is the paper that will be used as the point of reference for the economic calculations later on in the deliverable, as it will be explained in Chapter 7.

The list of the types of offences with a brief explanation, as presented in the paper, is reported below.

Type of Offense	Definition
Murder	The killing of one human being by another, through either a willful act (nonnegligent manslaughter) or negligence (negligent manslaughter).
Rape/Sexual Assault	Forced sexual intercourse (vaginal, anal, or oral penetration) involving psychological coercion and physical force, as well as attacks or attempted attacks generally involving unwanted sexual contact between victim and offender.
Aggravated Assault	Attack or attempted attack with a weapon, regardless of whether or not an injury occurred, and attack without a weapon when serious injury results.
Robbery	Completed or attempted theft, directly from an individual, of property or cash by force or threat of force, with or without a weapon, and with or without injury.
Arson	The unlawful and intentional damage, or attempt to damage, any personal property by fire or incendiary device.
Motor Vehicle Theft	Stealing or unauthorized seizure of a motor vehicle, including attempted thefts.
Stolen Property	The reception, purchase, retail, possession, concealment, or transportation of any property with the knowledge that it has been unlawfully taken.
Household Burglary	Unlawful/forcible entry or attempted entry into a residence, usually involving theft.



Type of Offense	Definition
Embezzlement	The unlawful misappropriation for profit of money, property, or some other article of value entrusted to the care, custody, or control of the offender.
Forgery and Counterfeiting	The unauthorized altering, copying, or imitation of an article with the intent to deceive or defraud by passing off the copy as the original or the selling, buying, or possession of an altered, copied, or imitated article with the intent to deceive or defraud.
Fraud	The intentional perversion of the truth for the purpose of inducing another person or entity to part with something of value or to surrender a legal right.
Vandalism	The willful destruction or damage of real or personal property without the consent of the owner or the individual in custody or control of it.
Larceny/Theft	Completed or attempted theft of property or cash without personal contact, including theft or attempted theft of property or cash directly from the victim without force or threat of force, purse snatching, and pocket picking.

**Table 1: Types of Offence**

The objective of the implementation of IMPETUS in Oslo and Padova is therefore the reduction of the cities' overall crime rate. At a general level it can be stated that both in Oslo and in Padova, total crime rate has decreased in the period between 2015-2019, albeit some differences among the various types of offences. As it will be explained later, not every type of offence will be directly targeted by the IMPETUS tools. Even so, the objective of the implementation of IMPETUS in Oslo and Padova will consist in the improvement of the trend the overall crime rate, as the adoption of such a solution can affect indirectly also the types of offence not directly targeted by one (or more) of the tools.

## 5 Identification of the project

The IMPETUS project stems from the need and desire to keep cities simultaneously safe and liveable, in a period of increasing attacks on soft targets and city centres in EU member States. The project seeks to improve the effectiveness of the response of cities to security threats in public spaces, by addressing three main aspects of urban security in smart cities: technologies, ethics and processes. More specifically, the project is developing and integrating tools and processes underlying the capacity of cities to manage both physical security and cyber security, leveraging the power of IoT, artificial intelligence and big data analysis. Moreover, caution will be placed on the ethical side of things, as the main goal is the benefit of society, which will be pursued by balancing potentially conflicting needs to collect, transform and share large amounts of data with the protection of data privacy and ethical constraints. From the process point of view, what IMPETUS develops will be integrated and supportive of the daily, operational needs of the different stakeholders involved in the public security chain, stakeholders including law enforcement bodies, municipalities, etc.

The solutions developed within the project make use of a large amount of data, coming from an interconnected city grid of sensors, such as cameras or environmental sensors. These devices offer great help in managing various aspect of the public security sphere in a city. For instance, they help to better manage traffic and public transit, to control pollution, to enhance policing, crowd control, and even to monitor public sentiment. While these make for the positive side of things, smart cities technologies can also be exploited maliciously, and they can represent a risk for municipalities. Indeed, they increase the risk of unethical use of personal data, while also increasing the attack surface of a city, as multiple interconnected IT systems control key infrastructures such as transportation, energy, water distribution, etc. To address the growing security and ethical threats to smart cities, the project will develop an integrated toolkit that covers the complete physical and cybersecurity value chain, e.g., detection, simulation & analysis, and intervention.

Stakeholders involved in the implementation of IMPETUS are multiple and different in nature. Two main categories of stakeholders can be identified for the implementation of IMPETUS in Padova and Oslo:

- end-users;
- security and emergency management organisations.

End-users are mainly Security Operations Centre (SOC) operators, who will be the ones to operate the IMPETUS platform. Security and emergency management organisations are local and/or public institutions involved in the handling of public security operations.

A comprehensive list of local stakeholders for Oslo and Padova follows below:

### OSL Main local stakeholders:

- Local Authorities (City Council)
- Local Authorities (City Government)
- Public Administration - Executives
- Public Administration – IT System management
- Public Administration – Personnel (IT System excluded)
- SOC operators (Municipal fire service and rescue agency, The Public transport companies, Harbour authorities)
- Other municipal SOC operators
- Other Authorities
- Media
- Citizens
- Private SOC operators (private agencies, commercial CCTV's systems supervisors, etc.)

### CPAD Main local stakeholders:

- Local Authorities (Mayor and City Council)
- Local Police – SOC operators



- Local Police – SOC supervisors
- Local Police – Commander and Officials
- Public Administration - Executives
- Public Administration – IT System management
- Public Administration – Personnel (IT System excluded)
- Other SOC operators (other Police forces, Fire Services, First Aid, Civil Protection, etc.)
- Other Authorities (other Police forces, Fire Services, First Aid, Civil Protection, etc.)
- Media
- Citizens
- Private SOC operators (private agencies, commercial CCTVs systems supervisors, etc.)

The degree of involvement of the various stakeholders will vary. Depending on their role, some of them will need to be specifically trained for the utilization of the tools provided by IMPETUS (mainly end-users, i.e., SOC operators), some of them will need to be informed about the project and its implication in the various aspects of the city life (e.g., citizens), while other will need to be prepared for the impact it will have on their daily life and work (e.g., Public Administration).



## 6 Technical feasibility

The demand behind the implementation of the IMPETUS solution, for the most part, goes beyond the single city or municipality. Instead, it should be seen as a general need and issue of the European Union and its Member States, as the intent of the project is to make the output as widespread as possible across the continent. That is why the demand supporting the application of the project's toolkit in Oslo and Padova will be the common one that supported the development of project in the first place, and that can be tracked in the EU's funding programme behind IMPETUS.

Even though the levels of security enjoyed by European citizens are high compared to other parts of the world, a level of vulnerability is always present in a context of ever-increasing globalisation. Security threats that society has to deal with in present times are growing in scale and sophistication, ranging from "traditional" crime, terrorism, illegal trafficking and mass emergencies due to natural or man-made disasters, to cyberspace-targeted threats with attacks arising from different sources. Indeed, cyber-attacks can lead to the disruption of critical infrastructure and services (e.g., energy, aviation and other transport, water and food supply, health, finance or telecommunications), while simultaneously damaging the trust of citizens in ICT systems and causing financial losses and the loss of business opportunities for private and public entities.

The project, thus, responds to the ever-present need of increased public safety and security in a period of evolving threats. These threats, while representing a danger at different levels in the life of citizens, also entail an important economic challenge given the share that Europe has of the global market. As previously stated, the potential negative effect that some of these threats can have on services, networks or businesses calls for the implementation of adequate security solutions in order to protect and preserve the economy and European manufacturing competitiveness. In this context, IMPETUS can represent the right solution.

The set of tools that IMPETUS is developing is applied at a city level. Each municipality needs to assess whether the solution is needed in their own context, however it is difficult to imagine that a higher level of public safety would be something that gets overlooked if the investment is advantageous. Of course, each city has its own requirements and critical points to assess, and in this sense, the modularity of the IMPETUS solution might come in handy. If we look at the specific cases in question, i.e., Oslo and Padova, both cities have the highest share of crime in the Profiteering cluster, even though the trend is decreasing both in the Norwegian and in the Italian city. In this sense, the preventive action of some of tools could assist in impeding profiteering crimes.

As far as time and costs of implementation are concerned, these are very difficult to estimate at this time. A number of tools at the end of the project will not be ready for commercialization (TRL <9) and this results in cost estimates that are quite approximate. In order to provide at least order of magnitude estimates with the knowledge and data available at this point of the project, partners were asked to give estimates, even if quite rough for certain tools, of time and costs required to implement their tools and make them actionable in the scenario of a prospect city interested in the adoption of the IMPETUS solution.

As far as estimating costs is concerned, the following procedure has been followed. A spreadsheet was created to gather input from KER Responsibles regarding implementation cost for their tool.

For each KER, two Phases were devised:

- Acquisition costs, referring to the one-time costs that the buyer pays when purchasing the tool;
- Recurring annual costs, referring to the costs that incur yearly to keep the tool in use (e.g., license fee, maintenance, training, etc...).

For each of the two phases, three cost categories were formulated:

- Supplier, referring to the costs that the buyer pays directly to the supplier of the result (e.g., proce for hardware, software license, training, consultancy, etc...)
- Third Party, referring to costs that the buyer pays to someone else than the supplier (e.g., price for extra hardware needed to make the tool functional)
- Internal, referring to costs that the buyer faces as a result of adopting the result (e.g., extra staff costs needed to use the result, training needed, etc...)



To calculate an annual cost of ownership for each KER, the estimates of the Acquisition Costs were divided by 5, under the assumption that the tools would be operating for 5 years. The total annual cost of ownership for each KER would then be the Acquisition Costs (Supplier, Third Party, Internal) divided by 5 + the Recurring Annual Costs. Since this information would necessarily be very difficult to estimate precisely due to a number of reasons (e.g., for some tools costs are already defined as they are already commercialized, while some of them are still under development, some of the tools will be available via a service/subscription basis, etc...), Partners were asked to provide a “low” and “high” range for each of these inputs required.

The structure would then look like this:

	Acquisition costs												Recurring annual costs						Total Annual Costs											
	One-time/purchase payment						Annual equivalent (spread over years)						Supplier		Third party		Internal		Supplier		Third party		Internal		TOTAL costs					
	Supplier		Third party		Internal		Supplier		Third party		Internal		Supplier		Third party		Internal		Supplier		Third party		Internal		TOTAL costs					
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High				
KER 1	A	B	C	D	E	F	A/5	B/5	C/5	D/5	E/5	F/5	a	b	c	d	e	f	A/5+a	B/5+b	C/5+c	D/5+d	E/5+e	F/5+f	A/5+a	B/5+b	+ C/5+c	+ D/5+d	+ E/5+e	+ F/5+f

**Table 2: Structure for KER costs calculation**

As a final estimate, we used the “high” range for all fields, in order to keep a prudent attitude as advised in business planning. Further, since this is a public deliverable, only the total annual costs for all tools will be reported in the table below. This is because the information relating to single KER costs is potentially commercially sensitive, and therefore it will not be published.

Following this procedure, the total annual costs for the entirety of the IMPETUS solution is the following:

	Acquisition costs	Recurring Annual costs	Total Annual Costs
Supplier	115 600	360,000	<b>475 600</b>
Third Party	194,000	48,000	<b>242,000</b>
Internal	135 400	171,000	<b>306 400</b>
	<b>445 000</b>	<b>579,000</b>	<b>1 024 000</b>

**Table 3: Total KER costs**

We can estimate, then, that the costs associated with adopting the entirety of the results of the IMPETUS project (considering the “high” range of partners inputs) will be around €1 million per year, and it will take around 12-18 months to make it operation for the first time. The way the IMPETUS solution has been developed, however, is that prospect cities could also choose a subset of the tools developed within IMPETUS, depending on which they deem more relevant for their own needs and for the city’s characteristics. In Chapter 7 we will compare this costs estimate with potential savings deriving from the adoption of IMPETUS results.

## 7 Economic analysis

Performing a comprehensive financial and economic analysis is not a viable option at the time of writing this deliverable, due to the lack of accurate data regarding cash outflows and inflows for the different tools and the IMPETUS solution overall, and regarding what a prospect city can expect from the adoption of the IMPETUS solution. Also, due to the nature of the technology that we are developing, costs and returns that need to be investigated do not pertain only to the monetary sphere, but instead involve a large share of social, non-monetary, public safety-related advantages that are difficult to quantify and predict at this time. As mentioned before, one of the most important rules of financial estimation models is that the final calculation is only as reliable as its underlying assumptions. Given the impossibility of making reliable assumptions and estimations at the current time, performing a financial analysis would be of little use if not outright impossible.

What can be done, however, is an economic analysis of the potential adoption of the IMPETUS solution based on data and scenarios offered by the academic and empirical literature. The approach selected has been to assign a cost to different types of crimes, imagining a scenario of crime reduction induced by the adoption of smart technologies for urban safety like the IMPETUS platform, and finally calculating potential savings that a municipality could achieve thanks to the adoption of the IMPETUS solution.

The first step was to perform a comprehensive literature review on the topic of crime costs. The main takeaway after performing this task was understanding how this topic bears an inherent variability, uncertainty and unfathomable nature. A number of authoritative and official sources, nonetheless, have published material trying to quantitatively determine the cost that crime has on society. Not unexpectedly, each publication has its own peculiarities, whether it be different calculation methods or a classification of crimes by different clusters. In order to maintain a degree of comparability, we decided to use the academic paper “The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation” by McCollister et al. (2010) as our point of reference, which is among the most cited sources in crime-related academic literature. The study presents a comprehensive review of crime-costing literature followed by its own estimations. One common key point highlighted in all the different publications on the topic, which we will stress here as well, is the differentiation between tangible costs and intangible costs related to crime offences. The tangible costs, as intuitively one might foresee, mainly deal with medical expenses, cash losses, property theft or damage, lost earnings because of injury and other victimization-related consequences. The intangible costs, on the other hand, are related to indirect losses suffered by crime victims, including pain and suffering, decreased quality of life, and psychological distress. To calculate these costs a different approach is needed: more specifically, the most common one is the “jury compensation method” developed by Cohen (1988), which uses jury award data from personal injury trials to measure the equivalent dollar value of the pain and suffering and psychological distress suffered by the victim of a criminal offense. In short, intangible costs are based on the difference between the jury’s total award and the direct economic loss to the victim. Total costs of crime, finally, is the sum between tangible costs and intangible costs (plus some minor adjustments in the calculation formula that are out of the scope for this analysis, and that in some cases lead to total costs slightly differing from the mathematical sum of the two components).

As the development of the IMPETUS solution is targeted primarily to public authorities whose concerns are not merely economic, but social as well (primarily, even), we believe it is important to focus not only on economic, tangible costs but on indirect, intangible, social costs as well. Certainly, the reasons that might lead a municipality to implement IMPETUS in its urban safety operations will not be to merely get a financial return on its investment. If anything, reducing crime penetration and getting a social return on its investment will be the driving force behind the decision. For this reason, we will take a look at both scenarios: tangible costs only and total costs after that.

After assigning a unit cost for different crime types, a potential scenario of crime reduction thanks to the adoption of the IMPETUS solution was needed in order to estimate the potential savings that a prospect city could achieve. To provide a solid basis to this estimation, a 2018 report from the McKinsey Global Institute named “Smart Cities: Digital Solutions for A More Liveable Future” was used. This report encompasses the topic of smart cities in depth, analysing dozens of technology applications and their consequent changes in various quality-of-life indicators. Clearly, forecasting reduction of crimes thanks to the adoption of smart technologies necessarily leads us to estimates rather than predictions. Given the innate variability of the topic, what we strived to do was



to build the most reliable and realistic estimates we could. Using this report from a world-renowned institute of research as the basis for our estimates allowed us to provide realistic (rather than real, which we could not possibly do) figures on the impact that the adoption of IMPETUS solutions could have on crime rate reduction. In the report, the McKinsey's Institute for Business and Economics Research found that the use of data and smart technologies by cities in different domains result in improved quality of life in different aspects of the public life. As far as our topic of interest is concerned, i.e., urban safety, MGI estimated that the utilization of smart technologies and applications by a city can result in an average reduction of 8-10% in fatalities, 30-40% in crime incidents and 20-35% in emergency response time. The two main takeaways that we will use to build our analysis are therefore the 8-10% reduction of fatalities (in relation to murder cases) and 30-40% reduction of crime incidents (in relation to all other types of offence) that a municipality adopting smart technologies like IMPETUS could attain. However, since preserving a conservative attitude is a good habit in business, we decided to create two different scenarios:

- a more conservative one, hypothesizing an 8% fatalities reduction and a 15% crime reduction;
- a more optimistic one, in line with the estimations of the paper, hypothesizing a 10% fatalities reduction and a 30% crime reduction.

The crime categories and their relative unit costs<sup>1</sup> are the following:

Type of Offence	Tangible Cost	Intangible Cost	Total Cost <sup>2</sup>
Murder	\$1,285,146	\$8,442,000	\$8,982,907
Rape/Sexual Assault	\$41,252	\$199,642	\$240,776
Aggravated Assault	\$19,472	\$95,023	\$107,020
Robbery	\$21,373	\$22,575	\$42,310
Arson	\$16,429	\$5,133	\$21,103
Motor Vehicle Theft	\$10,534	\$262	\$10,772
Stolen Property	\$7,974	N/A	\$7,974
Household Burglary	\$6,169	\$321	\$6,462
Embezzlement	\$5,480	N/A	\$5,480
Forgery and Counterfeiting	\$5,265	N/A	\$5,265
Fraud	\$5,032	N/A	\$5,032
Vandalism	\$4,860	N/A	\$4,860
Larceny/Theft	\$3,523	\$10	\$3,532

**Table 4: Unit Costs per Type of Offence (McCollister, French, & Fang, 2011)**

When N/A is shown in the intangible costs' column, it means that these costs are not available or not applicable for the relative type of crime.

To estimate potential savings for a city adopting the IMPETUS solution, crime numbers are necessary. However, crime numbers per type of offence aren't always publicly available information or information that is easy to find. Further, the classifications by which data is gathered differs from country to country. For the case in question, we tried to recover crime statistics per type of offence based on the declared crimes in Oslo and Padova in order to calculate a rough estimation of potential tangible and overall social savings that the two pilot cities could expect with the adoption of the IMPETUS platform with the data that is currently available.

For Padova, it was possible to recover exact numbers per type of offence through the National Institute of Statistics, which provides this information at a city level.

For Oslo, on the other hand, only national Norwegian data was available with the same level of detail, as exact crime numbers at a city level are aggregated at bigger, more general crime clusters which did not serve our

<sup>1</sup> Values in 2008 USD, as reported in (McCollister, French, & Fang, 2011)

<sup>2</sup> As reported in the paper, a share of the tangible cost is excluded from the total costs calculation because it is already accounted for in the calculation of the intangible costs (Total Cost is therefore not just an addition of the previous columns)



purpose. What was done, then, was divide national numbers by the number of Norway's inhabitants and then multiplying for the Oslo's inhabitants, to obtain a rough estimation of Oslo crime numbers per type of offence.

These crime numbers per type of offence were then grouped together to obtain an approximate estimation of crime numbers for the same categories of crime for which we know the costs. These numbers for year 2019 for both Oslo and Padova are presented in the table below.

Type of Offence	Oslo (2019)	Padova (2019)
Murder	7	40
Rape/Sexual Assault	861	81
Aggravated Assault	1,636	1,133
Robbery	151	378
Arson	88	24
Motor Vehicle Theft	493	444
Stolen Property	304	215
Household Burglary	384	22
Embezzlement	167	35
Forgery and Counterfeiting	213	45
Fraud	2,684	3,017
Vandalism	2,253	4,293
Larceny/Theft	11,574	16,151

**Table 5: Crime statistics per Type of Offence for Oslo and Padova**

The final step before estimating the savings that IMPETUS might bring to a city is to investigate the impacts that the tools might have on the different types of offences. The 13 different types of offences used as reference cover a large part of crime types that societies face. IMPETUS, however, is not designed to counteract every single existing type of offence. Therefore, the assumption that each type of offence would see a reduction in number of cases thanks to the adoption of IMPETUS would be unrealistic. Based on the nature and scope of the different IMPETUS tools, then, only selected types of offence will be taken into account, based on the fact that they will be the ones directly affected by the IMPETUS tools. The rationale behind this choice was to make the analysis as realistic and as tailored to the IMPETUS project as possible. Indeed, if we included every type of offence in the calculation of potential savings, we would have obtained even larger savings and our case would have been even stronger. However, we deemed this way of proceeding a bit too simplistic. We preferred instead to consider only those crimes on which an IMPETUS exploitable result has a direct outcome. For this reason, and as an example, "arson" is not considered as a type of offence directly affected by IMPETUS because no single tool has the prevention of arson in its scope of use. On the other hand, the Firearm Detector tool could have a direct influence in reducing cases of murders, as shootings are one of the most relevant causes of this type of offence. For this reason, "murder" has been considered as a type of offence directly affected by IMPETUS. Finally, it might be worth noting that the IMPETUS tools indirectly assist in reducing and preventing other types of crime, even though not specifically designed for those cases. For calculation purposes this has not been considered, but it would consist in any case in a positive externality.

As mentioned before, we tried to make the analysis as reliable and as realistic as we could, and that is why we chose this approach. Thus, the types of offence considered in the analysis are:





Type of Offense directly affected by IMPETUS	Definition
Murder	The killing of one human being by another, through either a willful act (nonnegligent manslaughter) or negligence (negligent manslaughter).
Aggravated Assault	Attack or attempted attack with a weapon, regardless of whether or not an injury occurred, and attack without a weapon when serious injury results.
Robbery	Completed or attempted theft, directly from an individual, of property or cash by force or threat of force, with or without a weapon, and with or without injury.
Fraud	The intentional perversion of the truth for the purpose of inducing another person or entity to part with something of value or to surrender a legal right.
Vandalism	The willful destruction or damage of real or personal property without the consent of the owner or the individual in custody or control of it.

**Table 6: Types of Offence affected by IMPETUS**

With the data and assumptions provided until now, we can now calculate potential yearly savings for Padova and Oslo according to the two scenarios of crime reduction that we mentioned before, the more conservative one of 8% fatalities reduction and 15% crime reduction, and the more optimistic one of 10% fatalities reduction and 30% crime reduction.

First, we proceed to calculate tangible costs reduction according to the calculations below:

<b>Oslo</b>			
Type of Offense	2019 estimated tangible costs	Conservative scenario	Optimistic scenario
Murder	€ 8,725,916.44	€ 8,027,843.12	€ 7,853,324.80
Aggravated Assault	€ 30,899,709.84	€ 26,264,753.36	€ 21,629,796.88
Robbery	€ 3,130,422.63	€ 2,660,859.23	€ 2,191,295.84
Fraud	€ 13,100,373.71	€ 11,135,317.66	€ 9,170,261.60
Vandalism	€ 10,620,818.86	€ 9,027,696.03	€ 7,434,573.20
Total tangible costs	€ 66,477,241.47	€ 57,116,469.40	€ 48,279,252.32
<b>Potential savings</b>		<b>€ 9,360,772.07</b>	<b>€ 18,197,989.15</b>

**Table 7: Potential Tangible Costs Savings per year for Oslo**

<b>Padova</b>			
Type of Offense	2019 estimated tangible costs	Conservative scenario	Optimistic scenario
Murder	€ 49,862,379.65	€ 45,873,389.28	€ 44,876,141.69
Aggravated Assault	€ 21,399,371.18	€ 18,189,465.50	€ 14,979,559.82
Robbery	€ 7,836,422.21	€ 6,660,958.87	€ 5,485,495.54
Fraud	€ 14,725,718.14	€ 12,516,860.42	€ 10,308,002.70
Vandalism	€ 20,237,539.00	€ 17,201,908.15	€ 14,166,277.30
Total tangible costs	€ 114,061,430.18	€ 100,442,582.23	€ 89,815,477.05
<b>Potential savings</b>		<b>€ 13,618,847.95</b>	<b>€ 24,245,953.12</b>

**Table 8: Potential Tangible Costs Savings per year for Padova**

Tangible cost reductions, as we can see from the tables above, are higher for Padova (€13 to €24 million) than for Oslo (€9 to €18 million). This is due to the fact that crimes reported for these categories are higher in the Italian city than in the Norwegian capital. In addition, the factor that influences the total savings the most is the number of murders, as it bears the highest unit cost of all the types of offence. Indeed, Padova reported almost 6x the number of murders compared to Oslo, and the tangible cost of murder alone is almost 9x higher than the sum of all the other types of offence combined. This alone can give an idea of how costly a murder is for an administration.

If we consider total costs, on the other hand, meaning costs that are not immediately measurable and entail indirect losses suffered by crime victims, including pain and suffering, decreased quality of life, and psychological distress, potential yearly savings would amount to even higher numbers, in the region of €34 to €66 million for Oslo and €53 to €85 million for Padova, as outlined by the tables below.

<b>Oslo</b>			
Type of Offense	2019 estimated total costs	Conservative scenario	Optimistic scenario
Murder	€ 60,992,366.52	€ 56,112,977.20	€ 54,893,129.87
Aggravated Assault	€ 169,827,801.28	€ 144,353,631.09	€ 118,879,460.90
Robbery	€ 6,196,985.98	€ 5,267,438.08	€ 4,337,890.19
Fraud	€ 13,100,373.71	€ 11,135,317.66	€ 9,170,261.60
Vandalism	€ 10,620,818.86	€ 9,027,696.03	€ 7,434,573.20
Total costs	€ 260,738,346.36	€ 225,897,060.06	€ 194,715,315.75
<b>Potential savings</b>		<b>€ 34,841,286.30</b>	<b>€ 66,023,030.60</b>

**Table 9: Potential Total Costs Savings per year for Oslo**

<b>Padova</b>			
Type of Offense	2019 estimated total costs	Conservative scenario	Optimistic scenario
Murder	€ 348,527,808.69	€ 320,645,584.00	€ 313,675,027.82
Aggravated Assault	€ 117,613,018.86	€ 99,971,066.03	€ 82,329,113.20
Robbery	€ 15,512,984.77	€ 13,186,037.05	€ 10,859,089.34
Fraud	€ 14,725,718.14	€ 12,516,860.42	€ 10,308,002.70
Vandalism	€ 20,237,539.00	€ 17,201,908.15	€ 14,166,277.30
Total costs	€ 516,617,069.46	€ 463,521,455.65	€ 431,337,510.36
<b>Potential savings</b>		<b>€ 53,095,613.81</b>	<b>€ 85,279,559.10</b>

**Table 10: Potential Total Costs Savings per year for Padova**

Even more than before, when only the tangible costs were taken into account, the higher number of murders reported in Padova affects the difference in estimated total savings forecasted for the two cities, as unit total cost for murder is 19x the sum of all the other types of offence combined.

The key takeaway from this analysis is that the magnitude of potential benefits, both tangible and intangible, is far superior to the costs associated with adopting the results of the IMPETUS project. As shown in Table 3, the total annual costs for the entirety of the IMPETUS solution settles at around €1 million. If we assume that a prospect city would elect to implement only a subset of the tools developed within the project, implementation costs would be even lower. In any case, as stated above, these numbers should not be used by prospect cities to



extract a mere quantitative prediction, but they should be adapted to the local context and tailored to the conditions and characteristics that different municipalities are aware of. Irrespective to different social contexts, however, any prospect city can expect a positive balance between costs and benefit from the adoption of the IMPETUS solution according to data and assumptions presented here.



## 8 Risk assessment

The qualitative risk assessment matrix has been built following the ensuing structure, which follows the structure provided by the European Union in the “Guide to Cost-Benefit Analysis of Investment Projects”:

- **Adverse event** that the project may face;
- **Causes** underpinning each adverse event;
- **Effects** generated on the project;
- **Probability** of occurrence for each adverse event;
- **Severity** of the effect generated by the adverse event materialising;
- **Risk level** as a combination of Probability and Severity;
- **Prevention and/or mitigation measures** foreseen.

The probability of each adverse event materialising has been assigned according to the following classification:

Probability	Meaning
A	Very unlikely (0-10% probability)
B	Unlikely (10-33% probability)
C	About as likely as not (33–66% probability)
D	Likely (66–90% probability)
E	Very likely (90–100% probability)

**Table 11: Risk Probability**

The severity of each adverse event has been assigned according to the following classification:

Severity	Meaning
I	No relevant effect on social welfare, even without remedial actions.
II	Minor loss of the social welfare generated by the project, minimally affecting the project long run effects- However, remedial or corrective actions are needed.
III	Moderate: social welfare loss generated by the project, mostly financial damage, even in the medium-long run. Remedial actions may correct the problem.
IV	Critical: High social welfare loss generated by the project; the occurrence of the risk causes a loss of the primary function(s) of the project. Remedial actions, even large in scope, are not enough to avoid serious damage.
V	Catastrophic: Project failure that may result in serious or even total loss of the project functions. Main project effects in the medium-long term do not materialise.

**Table 12: Risk Severity**



Following what can be considered a standard technique in risk models, a risk level was assigned to each adverse event. The risk level is the combination of the two previous classifications of Probability and Severity, and it is outlined as follows:

Severity Probability	I	II	III	IV	V
A	Low	Low	Low	Low	Moderate
B	Low	Low	Moderate	Moderate	High
C	Low	Moderate	Moderate	High	High
D	Low	Moderate	High	Very High	Very High
E	Moderate	High	Very High	Very High	Very High

Risk level	Colour
Low	Light Green
Moderate	Yellow
High	Orange
Unacceptable	Red

**Table 13: Risk Level matrix**

As a result, the following is the qualitative risk assessment matrix has been developed. The process followed was to draft a broad list of adverse events in two brainstorming sessions and later to select the ones that were deemed more relevant and applicable. The adverse events envisaged stem from the scenario of the adoption of the IMPETUS solution from a municipality. The assumption here is therefore that the tools are tested and at a marketable level (TRL 9). This is the reason why, for example, a circumstance like the failure to function by the solution was not considered as a potential adverse event.

Adverse event	Causes	Effects	Probability	Severity	Risk level	Prevention/mitigation measures
Minimum privacy requirements not respected	Inadequate design of platform and tools; inadequate preliminary analysis by the municipality	Lawsuits against the city, judiciary removal of the platform	B	III	Moderate	Thorough analysis of local/national privacy norms to ensure full compliance
Privacy breach perceived by citizens	Ineffective information and communication campaigns	Citizens' distrust towards city administration; potential protests; decreasing political consensus	D	II	Moderate	Widespread, clear dissemination and information campaigns



Adverse event	Causes	Effects	Probability	Severity	Risk level	Prevention/mitigation measures
Value added brought by IMPETUS not perceived by citizens	Ineffective information and communication strategy; low digital maturity by a share of population	Citizens' distrust towards city administration; decreasing political consensus	C	I	Low	Communication, awareness-raising campaigns and practical demonstrations of use and outcomes
Difficult integration with pre-existing systems and procedures	Resistance to change by operators; consolidated and inflexible procedures; inadequate infrastructures	Lower-than-expected impact on crime rates, sub-optimal exploitation of IMPETUS potential	B	III	Moderate	Set up of an implementation plan to study mutual adaptability; training and involvement of end-users in the process

**Table 14: Risk Assessment**

The first adverse event identified is the case of minimum privacy requirements set by local and/or national regulations not respected by the IMPETUS platform and tools. An inadequate analysis by the prospect municipality of how the IMPETUS solution works and whether or not it is compliant with local regulations (which clearly differ from country to country) might lead to this risk materialising. If this is the case, lawsuits could be initiated against the administration and against the use of IMPETUS, leading to potential sanctions and the forced removal of the platform. The actual risk of this event materialising can be seen as quite remote, as privacy and ethics is something that the Consortium is well aware of, and that is always at the top of the importance list when proceeding with the development of the tools and the platform. This means that resulting tools and related practitioners guides will most certainly meet all the relevant minimum privacy and ethics requirements. Additionally, a thorough analysis of local/national privacy norms to ensure that IMPETUS is fully compliant is something that is expected by a city which is evaluating the adoption of the platform.

Even if privacy requirements are respected by the solution, it can be the case that the population of a city perceives this use of smart technologies for urban safety purposes as too invasive with respect to privacy and data protection. As something similar was observed in different aspects of public life in recent years, anti-system, conspiracy-theorists, or simply people that are wary and distrustful against everything that is new, could represent a loud minority that can negatively influence the judgement of other people and media resonance. Even if this can be effectively fought with a clear and effective information and communication strategy, it is something that can be expected with a relatively high probability.

Something that should also be taken care of by an effective and widespread information campaign is the definition and explanation of the value added that IMPETUS brings in the sphere of urban safety for the city. Even if this wouldn't generate serious or practical consequences for the purposes of the use of IMPETUS, having the population's consensus is always something that a city administration strives for. Besides information and communication campaigns, it might be useful to perform or broadcast practical demonstration of the tools at work.

Implementing IMPETUS in the safety procedures of a city entails integrating the new technologies with existing procedures, systems and *modus operandi* of operators. These procedures are likely old, standard, codified processes that are likely to get modified or adapted due to the integration of IMPETUS. Further, operations are run by people that need to get trained and need to somewhat change their standard way of working. Resistance to change by law enforcement workers can play a role here as IMPETUS inherently brings changes. However, these changes bring advantages for the city, from the population to the operators, and these need to be clearly conveyed during the training process before the implementation. An effective integration of IMPETUS with the



municipality's existing procedures and infrastructures are essential to avoid a sub-optimal exploitation of the tools.



## 9 Conclusions and future work

### 9.1 Conclusions

Based on the analysis that was carried out, some points can be highlighted as the main takeaways of this work.

First and foremost, it has been shown that Oslo and Padova could potentially obtain large tangible and intangible savings from the adoption of IMPETUS. Based on crime statistics calculated for the two cities and on the reduction of crime rate attributable to the adoption of smart technologies as presented in the literature, the implementation of the IMPETUS solution has revealed itself as highly cost-effective. As mentioned in the document and as will be further explained in the next section, a margin of error still exists both for the foreseen costs of implementation (some tools are still under development and it is difficult to quantify costs at this time) and for the envisaged savings that cities could obtain (due to the inherent variability of the subject and the actual success that the solution will have, which can only be estimated in advance). This uncertainty however does not change the fact that IMPETUS is expected to be highly cost-effective, as calculated savings are many times higher than expected costs. Further, the area of social, non-monetary benefits is another selling point for the solution, given the fact that reducing crime rate directly helps cities to reduce the so-called ‘intangible costs’, and IMPETUS helps in doing just that.

The outcome of this analysis should help other cities that are looking to integrate smart safety procedures like IMPETUS in their operations to get a better idea of the advantages that the adoption of such a solution could bring. The IMPETUS business case has been built adopting the perspective of the two pilot cities, Oslo and Padova, for this very reason: helping the ultimate beneficiaries of the solution (i.e., other cities) assessing the technology’s cost-effectiveness.

Further, drawing from the risk assessment matrix, it turns out that, hypothesizing a market-ready technology level, the primary risks and related root causes associated with the implementation of IMPETUS are mainly operational (e.g., inadequate preliminary analysis by the municipality regarding minimum privacy requirements, ineffective information and communication strategy towards the public, consolidated and/or non-flexible procedures and/or operators, inadequate infrastructures, etc.). This clearly entails some effort from prospect cities in order to avoid or minimise these, however it also means that these risks are all addressable with some specific targeted activities, such as a pre-emptive analysis of local/national privacy norms to ensure full compliance, comprehensive communication and information campaigns, training and involvement of operators and end-users during the process.

### 9.2 Limitations

This analysis has been based on a series of assumptions that were necessary because some data or information needed for a more detailed analysis are not yet available. The assumptions have been listed and motivated throughout the document but are also summarised in this final chapter. Clearly, assumptions pose somewhat of a limitation in the reliability of quantitative information, since actual future events could differ from the ones foreseen in this document. The importance of motivating and giving references to the basis used to generate the assumptions, as it was done for this document, is that it is essential for interested readers not only to assess the quality of the data, but also to understand it more thoroughly and potentially utilize it as a foundation to make their own calculation with the knowledge of context-specific factors that only they can be aware of.

The analysis was built around the Cost-Benefit Analysis framework provided by the European Commission because it was deemed as a good instrument to build a business case for the adoption of the IMPETUS solution by a prospect city. Some adaptations compared to the official guide were needed, however, in order to bypass some data regarding selected tools that is not available at this point in time, and that would have been necessary to thoroughly carry out some of the points of the analysis. Specifically, performing a comprehensive financial and economic analysis was not a viable option at the time of writing this deliverable, due to the lack of accurate data regarding cash outflows and inflows of the different tools and the IMPETUS solution overall, and the consequent lack of accurate data regarding financial expectations of prospect cities adopting the IMPETUS solution. Further, due to the nature and scope of the technology we are developing, costs and returns that need to be examined include a significant portion of social, non-financial, public safety-related benefits that are



currently impossible to measure and estimate. Since one of the most important rules of financial estimation models is that the final calculation is only as reliable as its underlying assumptions, performing a financial analysis would not have resulted in an appreciably significant outcome. What has been done, however was to perform an economic analysis based on information and scenarios provided by the academic and empirical literature.

In particular, as explained thoroughly in Chapter 7, the method chosen was to associate different types of offence to a unitary cost based on academic literature. The types of offences that would be directly affected by one (or more) of the IMPETUS tools were then selected. Finally, two crime rates scenarios for the pilot cities resulting from the adoption of the IMPETUS solution were envisaged, but keeping a more conservative approach compared to what is reported in empiric literature. The process resulted in estimations of potential savings Oslo and Padova could attain as a result of implementing the IMPETUS solution based on these assumptions. The purpose of this approach was to create a reference framework to prospect cities and provide an order of magnitude to make them aware of the impact and the importance of these kinds of tools.

As specified in the document, prospect cities evaluating the adoption of the IMPETUS solution surely need to contextualize the approach used depending on their characteristics and local specificities. What we found out during our research, however, is that local security-related information is oftentimes restricted. That's why we chose to present a reference framework to prospect cities that are encouraged to contextualize it with local information that only they are in possession of. As a matter of fact, within IMPETUS, specific information concerning the two pilot cities were gathered by the Partners. This information however was classified as sensitive information not to be disclosed in a public deliverable such as this one. Therefore, the approach used for Padova and Oslo in this deliverable has been the same one that would have been used with other prospect cities, that is by tailoring data with information publicly available.

The costs for each type of offence were based on a 2011 paper from (McCollister, French, & Fang). This choice was based on the fact that we wanted a reliable and consistent source of data. Assigning unit costs to different types of crime is a difficult task that has been very seldom performed in the literature, and most of the time crime related information is classified as sensitive information. The paper used in the deliverable, which is one of the most cited in the crime-related literature, is the most comprehensive one found after thorough research. Moreover, since crime unit costs differ depending on the method of calculation and data sources used to calculate them, it was important to use a single data source as our basis of calculation to guarantee consistency and reliability.

Clearly, the resulting numbers of the analysis should not be taken as a pinpoint-accurate, quantitatively precise prediction of monetary savings. Rather, they should be useful to understand how the IMPETUS solution could affect crime rates and the magnitude of related potential tangible and intangible savings accruable. The final number will then depend on a number of conditions that cannot be precisely determined in advance, but that were substituted by informed and motivated assumptions in order to help readers to form their own opinion.

### 9.3 Possible future work

To conclude this document, some actions and aspects will be listed that, when they become available, will make the overall analysis more accurate and that address some of the limitations presented above.

In order to have more precise information regarding time and costs needed for the implementation of the IMPETUS solution by a prospect city, all tools should be in a position of advanced technological development and potentially have some data accruing from real use cases. This point will probably be reached in the near future and, when realistic, field-tested data will be available, it will be possible to significantly reduce the variability from this aspect.

Clearly, when tools will reach a market-ready level of technology and data will be gathered from real use cases, more accurate data on the reduction of crime rate and related savings will be available too, thus making the final quantitative estimates more accurate and telling.

Further, the relation between tools and crime clusters directly affected by them could be better investigated, both in terms of the types of offence that each tool combats and the degree to which each type of offence is reduced. For this purpose, having a set of high-TRL solutions with defined and assessed functionalities is crucial. Also,



municipalities are surely equipped with some specific security data and information needed to tailor the analysis to their local context. Most of security-related data, however, is classified as sensitive information and would not be allowed to be reported in public documents like the present deliverable. A suggestion for potential adopters would then be to create structured templates to gather data and create before-after scenarios, in case of real test cases or pilot cases during possible follow-up projects.

Overall, to deepen the understanding of the effect that tools have on different types of offence, ideally all tools would need to be technologically mature, as this would make it viable to have more reliable data coming from their practical use. For cities, this would enable creation of clear before-after scenarios to evaluate cost-effectiveness based on their local context. Finally, for developers and involved stakeholders, it would make it possible to run specific live exercises aimed at the collection of tool-specific, statistical data on the effect of the solutions (e.g., time saving from alarm to intervention, number of credential breaches avoided before and after implementing the cyber tools, etc).










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