Identity Management in PUbLic SErvices

D4.4 Economic Benefits of the IMPULSE Approach – V2

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Executive summary

This Deliverable 4.4 updates and expands Deliverable 4.3, which began the analysis of the potential economic impact that deployment of the IMPULSE eID solution might yield in specific pilot use cases. The Deliverable first reviews the relevant literature on the economics of digital identity and digital government. It then analyses the expected impact of IMPULSE in the pilot use cases explored in the project, providing quantitative estimates where feasible. Compared to Deliverable 4.3, *Economic Benefits of the IMPULSE Approach, Version 1*, this version considerably expands the analysis of the pilots in Peshtera, Aarhus and Ertzaintza, by: (1) analysing new and additional data provided by the pilots and by the large-scale survey (N = 740) of potential IMPULSE users conducted in Work Package 4.1, (2) estimating and considering likely future changes to population sizes in the projections and estimations of possible future economic effects of IMPULSE, (3) examining the potential and economic impact of scaling up each of these use cases to the national level (i.e., to all of Bulgaria, Denmark and Spain, respectively), and (4) for Peshtera: considering a wider application of IMPULSE than foreseen in the current piloting. Furthermore, it (5) corrects an error in Deliverable 4.3 that was only noticed after submission, namely the use of wage/salary data instead of labour cost data (i.e., including employers' tax and insurance contributions) for certain estimations. These and other estimates are now made using labour cost data. Finally drawing on the task 4.1 survey data, this Deliverable includes (6) an additional chapter on possible economic impacts of IMPULSE in the private sector. The literature review from Deliverable 4.3 and the analyses of the Reykjavik, Gijon and Infocamere use cases are reproduced, as there was little to add to these and providing them greatly facilitates understanding the analysis presented here.

The general conclusion of the economic analysis presented here continues to be that in some, though not all, use cases, IMPULSE can increase the efficiency and ease of public service provision. Where this is the case, the public administrations should enjoy modest monetary savings, largely by reducing the amount of labour (time) required to complete various administrative tasks. For citizens and residents, the main direct economic benefit of IMPULSE are time savings. Depending on the context and use case, the system may cut the time required for citizens to obtain a particular service by an hour or more. These findings are broadly in line with the extant literature, which predicts that in advanced economies, basic digital identity solutions (i.e., those that mainly offer authentication services) like IMPULSE should mainly yield modest efficiency gains. Similar conclusions apply to the private sector impacts. These are harder to assess, as the IMPULSE project did not include private-sector use cases. Thus, the analysis had to remain largely qualitative. There is reason to expect that IMPULSE could reduce administrative, compliance and security costs connected to confirming customers' identity and resetting lost passwords. It is also likely that IMPULSE could modestly increase the consumption of online services. Larger economic gains from the implementation of digital identities are possible, but they depend on (i) making large numbers of different public and private sector use cases available via the digital identity; (ii) adding "advanced" functionalities to the digital identity system, in particular a digital wallet and/or qualified electronic signature functionality.

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Abbreviations and acronyms

BGN	Bulgarian lev
DKK	Danish Krone
DSGV	Deutscher Sparkassen- und Giroverband
EC	European Commission
EU	European Union
EEA	European Economic Area
eID	electronic identity
GDP	Gross Domestic Product
ICT	Information and Communication Technologies
NIST	National Institute of Standards and Technology
OECD	Organisation for Economic Cooperation and Development
QES	Qualified Electronic Signature
SSI	Self-Sovereign Identity
TUM	Technische Universität München
VC	Verifiable Credential
ZKP	Zero Knowledge Proof

1 Introduction

This report expands and updates the analysis of the potential economic impact that deployment of the IMPULSE eID solution might yield, which was begun in Deliverable 4.3. The main question this Deliverable tries to answer is, what are the likely (socio-) economic effects that the IMPULSE eID solution might have, if implemented "for real" in the six Pilot Use Cases developed within the IMPULSE project, as well as beyond. To answer this question, the Deliverable employs a mix of approaches, including a review of the extant literature on the economics of electronic identity and digital government, and quantitative estimations and analysis of the possible effects of IMPULSE in the Pilot Use Cases based on interviews with the case owners and original data collected from their organisations. Due to the variety of approaches used, the Deliverable does not include a separate chapter on methodology. Instead, a separate methodology section is included in each chapter, where relevant.

The text is organised as follows. Chapter 2 frames the following analysis through a discussion of some key underlying concepts. Chapter 3 then presents the review of the literature. Chapter 4 examines economic impacts of IMPULSE in the Pilot Cases under different scenarios. Chapter 5 turns to possible economic impacts in the private sector. Chapter 6 concludes.

2 Conceptual considerations and detailed research questions

IMPULSE is an **eID solution** that is currently being tried in various **digital government** use cases. The main function of IMPULSE in its current instantiation is **authentication/log-in** through biometric means (facial recognition), though **digital wallet** and **digital signature** functionalities are likely to be added in the future. IMPULSE belongs to the class of **self-sovereign identity** (SSI) solutions. To properly understand what effects IMPULSE in its current and future forms may and may *not* have, it is important to properly understand the distinctions between these concepts. The purpose of this chapter is to lay these out.

2.1 How IMPULSE works

A full description of how IMPULSE works is beyond the remit of this Deliverable, and basic familiarity of the reader with the functionality of IMPULSE is assumed.[1] In a nutshell, however, IMPULSE works as an App on the user's smartphone, through which the user can create digital (electronic) identities for herself, to register and authenticate to online services. To do so, the user accesses the website of the online service, clicks "Sign up with IMPULSE" (or a similar link, possibly in QR-code form), which opens up the IMPULSE application on her smartphone. She next takes a photo of each side of her identity document (e.g. state identity card, passport) as well as a photo of her face (selfie), and uploads these to the IMPULSE enterprise server via the app. IMPULSE then uses artificial intelligence to check that the selfie and the user's photo on her identity document match, and that the identity document is not fraudulent. Information about the user required by the online service (e.g. name, date of birth, etc.) is automatically extracted from the card or entered manually by the user, if not contained on her identity document (e.g. personal hobbies). The IMPULSE system creates a digital identity for the online service in question, and stores this in the secure element on the user's smartphone. This digital identity contains biometric information (a "biometric profile") derived from the selfie to enable the user to authenticate herself via facial recognition. The photographs are erased from the system. To log in to the online service, the user then simply accesses the service website, selects "Log in with IMPULSE" (or similar), which opens the IMPULSE app on her smartphone. She selects the digital identity for the service, and again takes a photo of her face. IMPULSE checks that the photo and the biometric profile contained in the digital identity match. If they match, she is authenticated and logged in to the service. The photograph she just took is again erased.

[1] For detailed technical discussion of the IMPULSE solution, see Deliverables 5.1–5.4 of the IMPULSE project. The following video provides a basic overview of how IMPULSE works from the user perspective: https://www.youtube.com/watch?v=P3j-xJK5fXA

2.2 Digital government, electronic identity, authentication, digital wallet and digital signature, SSI

At its most basic, **digital government** refers to "the production and delivery of [government] information and services … [by] using a range of information and communication technologies" (Fountain 2004). Beyond this basic understanding, as the full potential of digital technology and digital processes have gradually come to be recognised, "digital government" has increasingly come to be understood as constituting a fundamental shift in how public services are delivered and what they even consist of, towards a more data-driven, accountable, transparent and more interactive and demand-/needs-oriented mode of administration and service delivery (World Bank n.d.; OECD 2019).[2] There is good reason to believe that achieving comprehensive "digital government" in this more ambitious sense will yield substantial economic benefits, including efficiency savings, higher growth, employment and company creation, as well as increased use of public services. Most of the use cases explored in the IMPULSE pilots can be considered instances of "digital government". What economic effect the digitisation of discrete government tasks and processes yields, will of course depend on the details of the use case, and it is possible that the full economic potential can only be reached as broad swaths of public administration are digitized, not just individual use cases.

An **electronic identity**, **eID**, or **digital identity**[3] is an electronic/digital means for entities (citizens, businesses, machines, etc.) to prove who they say they are, via a digital channel (European Commission n.d.; White et al. 2019). A digital identity thus includes a subset of attributes about the entity (e.g. name, date of birth) that uniquely identify it within a given set of other entities (Gritzalis and Lambrinoudakis 2008), with the composition of this subset varying by use case. Digital identity is a key building block for the realisation of digital government (Vassil 2016; White et al. 2019); however, by itself it is *not* digital government, and providing citizens or companies with digital identities alone will not achieve the economic (or social and political) benefits digital government promises.

As both McKinsey (White et al. 2019) and Echikson (2020) note, it is helpful to distinguish between "basic" digital identity, which enables only authentication (see next), and "advanced" digital identity, which allows additional information about the individual to be electronically stored in the eID or automatically linked to it (e.g. via digital wallets, see below). The IMPULSE solution at present is a tool to provide people only with a basic digital identity, but planned future developments (e.g. wallet functionality) would turn it into an advanced eID.

Authentication, or, from the user's perspective, **Log-In**, is the act of verifying that a user is indeed who they claim to be, including verifying that the attributes they claim are true. It is a common prerequisite for allowing a user access to certain services or resources (NIST n.d.). Many different authentication technologies for eIDs exist today; e.g. password and username, smartcard or USB stick and PIN, or biometrics (finger print, iris scan, facial or voice recognition). Broadly speaking, password/username is likely the most commonly used authentication technology today. Smartcards seem to be mainly still used in legacy systems and are often gradually being supplanted with newer technology. Biometric systems are increasingly common. IMPULSE uses facial recognition to authenticate users. As further discussed in Chapter 4, the technologies currently deployed in the Pilot use cases include smartcards, USB sticks, usernames and passwords, or purely analog means of authentication (e.g. appearing in person with one's physical identity card). One question for IMPULSE is whether different authentication technologies have qualitatively or quantitatively distinct economic (as well as social and political) impacts.

[2] Scholars sometimes distinguish between "e-government" – the introduction of information and communication technology (ICT) to carry out tasks previously performed by analog means, but without changing the nature of the tasks or the organisation of the processes themselves (what I called the "basic" understanding of digital government above) – and "digital government" proper; that is, the transformation of the tasks and processes of public administration themselves to take advantage of the full potentials of digital technology (OECD 2019: p. 148).

[3] For sake of linguistic variation, this text uses the three terms electronic identity, eID and digital identity interchangeably.

Digital or **electronic signature** is a function included in some electronic identity systems that enables the user to provide a legally-binding signature on electronic documents (sometimes also referred to as a "qualified electronic signature" or QES). The IMPULSE system currently does not include a QES function. Including it would require further technical development as well as legal-regulatory certification. The ability to provide legally-binding digital signatures is likely crucial to enable many higher-value use cases in both the public and private sector (e.g. taking on mortgages, applying for various permits). That IMPULSE currently still lacks this functionality must be borne in mind when assessing its potential economic impacts.

Digital wallets are applications (or functions within larger applications) within which users can store certain types of information, such as payment information, credentials or certificates, including electronic versions of physical documents like driver's licenses or university records. Modern digital identity systems increasingly include digital wallets, allowing users to digitally present and prove their possession of diverse certificates and credentials. The current instantiation of the IMPULSE system does not include a digital wallet, but development of one is planned for the future. Nor do the current pilot use cases require a wallet. Again, to assess the full possible impact of IMPULSE, the implications of its current lack of a wallet function, and the opportunities offered by its future inclusion, must be considered.

Self-sovereign identity (SSI) is one family of digital identity technologies, to which also IMPULSE belongs. The main idea of SSI is that the user is to be put in complete control of her data. This is accomplished by storing the data (e.g. an identity credential or a certificate like an electronic driving license) only on the user's own device (e.g. a smartphone), usually in a digital wallet.[4] The user can then decide in a "sovereign" fashion, to whom to give access to the data. The SSI model of identity management is distinct from centralised, federated and "user centric" identity management models, which currently still predominate. While in SSI the user's data is stored only on the user device (and with any service providers the user chooses to give access to the data to), in centralised as well as federated/"user centric" systems, the identity provider remains in possession of the user's data (centralised system) and is able to track which services the user authenticates to (federated and user centric models).[5] One question for the economic assessment of IMPULSE is whether, as an SSI system, it has qualitatively different economic implications to other kinds of eID systems.

2.3 Research questions

The above discussion implies that IMPULSE may unleash economic effects through two pathways: (i) by enabling digital government, (ii) by enabling digital transactions in the private sector. The IMPULSE project explores these effects through the six pilot cases. Research questions 1 and 2 are thus:

1) What are the specific economic effects of using IMPULSE in the pilot cases and in the private sector?
2) How large are the economic effects in the pilot cases and the private sector?

The architecture of IMPULSE (SSI, with biometrics for authentication and Wallet and QES functionalities potentially available in future) raises further research questions:

3) Does the use of biometrics for authentication give IMPULSE distinct economic effects, compared to other authentication technologies?
4) What economic effects could adding a Digital Wallet and QES functionality to IMPULSE have? What are the economic effects of their current lack?
5) Does being an SSI solution give IMPULSE particular economic effects, that other eID architectures will necessarily lack?

[4] For security reasons, the data is usually only stored in an encrypted format, and/or in a secure element on the device.
[5] For detailed discussion of the differences between these various approaches to identity management see Strüker et al. (2021). For details on the IMPULSE system's architecture see Deliverables 5.1 – 5.4.

3 Review of the Literature

To better understand the possible effects of IMPULSE and eID systems in general, we reviewed the relevant literature.

3.1 Method

To identify relevant literature for both the economic (Deliverables 4.3 and 4.4) and the social and political impact assessments (Deliverable 4.1), we first searched the "Economics" and "Social Sciences" sections of the SCOPUS journal database for articles with any of the following keywords in their titles or abstracts:

> *Digital identity OR electronic identity OR eID OR digital personal identity OR digital government OR e-government OR self sovereign OR sovereign identity OR SSI*

This returned 362 documents (journal articles) from the "Economics" section, and 427 from the "Social Sciences" section (including a large number of duplicates between the two searches). The abstracts of these articles were then read to identify articles potentially relevant to the research questions at hand. This yielded about ~60 papers, which we studied. While these numbers appear to suggest that a large scholarly literature on the economic and social/political impacts of digital identity as well as on questions of acceptance exists, this is not in fact so. Many papers had only tangential relevance (e.g. technical papers proposing novel eID or digital government schemes), and/or were mainly conceptual and included no empirical data on the questions of interest. Therefore, when reading the papers, we also followed up their footnotes to identify further papers and relevant "grey literature". Indeed, the grey literature – mostly practically-oriented reports from international organisations or consultancies – often proved the most helpful. This review summarises the main points of relevance.

3.2 Results

It is helpful to discuss the economic impacts of digital identity on the public and the private sector separately, and then deal with the narrower questions of the economic effects of different authentication technologies, digital wallets, signatures and "self sovereign identity" architectures.

3.2.1 Economic impacts of digital identity in the public sector

The World Bank "Identification for Development"-Project and the consulting company McKinsey have produced the most systematic recent studies of the impact of (digital) identity on the public sector (World Bank 2018a, 2018b; White et al. 2019). Both find that the impact of providing citizens and businesses with digital identities can be substantial, though making specific quantitative estimates is difficult. McKinsey (White et al. 2019) does try to calculate what the aggregate economic impact across both the public and private sector would be for seven "focus countries"[6], were digital identity to be widely adopted by their populations. The estimates range from 3 to 13 percent of GDP by 2030 depending on country, with the higher ranges found in Global South countries. The Bank, conversely, refrains from country- or even sector-specific quantitative estimates, noting the "scarcity of publicly available data" and unresolved "methodological challenges … with quantifying and attributing the effects of [identity] systems" (World Bank 2018a: p. vi). Instead, the focus is on identifying causal mechanisms through which economic effects take place. More broadly, the World Bank (2018a) cautions that observed effects and effect sizes are highly dependent on country characteristics, including:

- Share of the population that has (no) form of official identification (e.g. state identity card)
- Size of the informal sector of the economy
- Prevalence and scale of tax evasion
- Prevalence and scale of fraud, corruption and errors in public services provision and public employment (e.g. ghost workers, deceased pensions claimants still on the books; benefits fraud)

[6] Brazil, China, Ethiopia, India, Nigeria, United Kingdom and United States.

- Role (if any) of intermediary actors (e.g. local businesses, churches, NGOs, local leaders) in mediating access to public services and state-citizen interactions
- Availability of internet access and ICT
- General development and wage level.

Generally speaking, (positive) economic effects of providing citizens with digital identity are larger in countries where a significant share of the population still lacks official identification, where the informal sector is large, existing public population and benefits registers are error-prone, non-state intermediaries play important roles in public service/benefits provision, and tax evasion, fraud and corruption are more prevalent (World Bank 2018a; White et al. 2019). Conversely, lower levels of internet and ICT availability as well as higher wage and development levels push up the costs of building and rolling out digital identity systems.

The literature points to three main mechanisms through which positive economic effects for the public sector are achieved: formalisation, reduction of fraud, corruption and errors, and efficiency savings.

3.2.1.1 Formalisation: public sector effects

This refers to bringing people and business activities into the formal sector. Lack of a legal (officially recognised) identity is often a fundamental barrier to participation in the formal economy, whether as an employee or as an entrepreneur. Without a legally-recognised identity, people are commonly unable to access bank credit (except on usurious terms), get a bank account or insurance or pensions coverage. They are also often unable to access government services. This in turn severely hampers economic productivity, not to mention life opportunities (World Bank 2018a, 2018b, 2019; Elgin et al. 2021; Addo and Senyo 2021). For the public sector, the informal sector is often hard to tax. Formalisation thus raises the tax take both directly (identified individuals and businesses can now be taxed) and through second-order effects (greater economic activity results in more taxes).

By some estimates, worldwide more than 1,5 billion people do not have a legally-recognised identity (Wang and Filippi 2020). Rolling out digital identity programs and technologies is seen as a means to provide people without a legal identity with one, and thus bring them into the formal sector (World Bank Group 2018a, White et al. 2019, Wang and Filippi 2020, López 2020, World Economic Forum 2018).

However, these people are largely concentrated in developing countries. In developed countries, most citizens and residents already have a legal identity. In the European Union (EU) and European Economic Area (EEA) states, between 95 and 99 percent of the population already has a legal identity (World Bank 2019). Moreover, access to identity in these states is usually straightforward and inexpensive.[7] This suggests that the reason why a small share of the population remains without a legal identity are complex and unlikely to be resolved by simply introducing a new piece of technology. The IMPULSE solution, in any case, requires the user to *already* possess a valid state identity card or passport. It is not intended as a tool to help people without identity obtain a legal identity for the first time, and cannot be used for this.

In developed countries, the informal sector is also significantly smaller than in developing countries. Estimates by Elgin et al. (2021) suggest that the informal sector in the EEA countries plus the United Kingdom is ~20 percent of GDP, compared to ~34 percent in Africa and South America.[8] More importantly, informality in developed economies may often be a choice rather than a necessity driven by a lack of legal identity (e.g. self-employed who take on additional work "on the side", in parallel to their regular formal-sector work). This suggests that neither the greater provision of digital identities in general, nor use of the IMPULSE solution in particular, will in themselves do much to drive further formalisation of economic activity in developed countries. This conclusion is supported by the McKinsey (2019) study, which finds that in developed countries, providing "basic" digital identities (such as would suffice to formalise *involuntarily* informal economic activity

[7] According to data presented on Wikipedia, in Europe the fee for a working age resident or resident for a new state identity card ranges from ~€1.8 (9 lei) in Romania to €61.5 in Austria, with most states charging between ~€10 and ~€30. See https://en.wikipedia.org/wiki/National_identity_cards_in_the_European_Economic_Area

[8] Own calculations based on the country data for 2017 and 2018 presented in Elgin et al. (2021).

and involuntarily "unidentified" individuals) would do little to drive additional growth and tax take. According to McKinsey, in developed countries only "advanced" digital identity solutions can do so. It should be noted that the present instantiation of the IMPULSE system (authentication services only) corresponds to what McKinsey labels a "basic" digital identity, while possible future instantiations involving wallets and QES functionalities would constitute an "advanced" digital identity.

3.2.1.2 Reducing fraud, corruption, and errors

A major source of savings to the public sector from the provision of digital identities has been the reduction in instances of fraud, corruption and errors thus effected. Where state registries and databases are incomplete, poorly cross-checked and/or still paper-based, or where public benefits are distributed to the population via poorly-controlled and audited intermediaries (e.g. local businesses, religious organisations or local notables), it has often proved possible to add non-existent ("ghost") workers or non-entitled claimants to payroll or benefits and pensions registers, or keep deceased claimants or departed workers on the rolls. As importantly, this also is liable to lead to errors and gaps illegitimately excluding legitimate beneficiaries from full benefits or pensions provision, or to unequal distribution of benefits. Providing all citizens (or at least all public sector workers and benefits/pensions claimants) with a unique digital identity helps eliminate such cases. Anecdotal evidence from Asia and Africa catalogued in World Bank (2018a) suggests that savings can be considerable.

However, the literature again suggests that these effects will likely be largest in developing countries, and have much more limited relevance for Europe. For one, the extent of benefits/pensions and public-sector payroll fraud in European countries seems mostly fairly low.[9] For another, European countries mostly already have sophisticated electronic registries and databases for their public sector workers, benefits and pensions systems in place. Low hanging fruit in terms of fraud prevention and error correction are thus likely to have already been picked. In other words, the introduction of IMPULSE is unlikely to have a significant impact in this regard. As none of the use cases relate to this issue, it is not further pursued.

3.2.1.3 Efficiency savings: public sector

Efficiency savings are the economic effect most frequently identified in the literature, both for the public and the private sector (e.g. World Bank 2018a, 2018b, 2019, White et al. 2019, Wang and Filippi 2020, Vassil 2016, Pignatelli et al. 2019, Nortal 2020, Echikson 2020, Wolfond 2017, Mahula et al. 2021, World Economic Forum 2018, Doerk et al. 2020). Transitioning to digital government (which relies on eID) enables two main forms of savings in the public sector. One is *material savings*, from paper, pens, postage, printing and phone calls, to office buildings and associated utilities costs, as processes are moved online and the need for paper-based and face-to-face processes is reduced. The second, and arguably easier to realise, are *time and labour savings*, for both public servants and citizens, when formerly analog, paper-based and in-person processes are digitised, as these are often more efficient.[10] While this *may* produce *monetary* savings for the public authority if staff numbers can be reduced, it should at least free up labour. The public administration may thus be able to redeploy its civil servants to focus on other, more valuable activities, and thereby raise the quality of public services and administration.[11] For citizens, time savings may be even greater, as in addition to more efficient processes, eID-enabled digital government should greatly reduce the need for them to appear in person at government offices, removing travel (and queuing!) time and expenses. It also removes the need to potentially take time off work to accommodate public offices' normal business hours. Besides added convenience, this also helps make public services more accessible, e.g. to people who live further away from government offices, have little time (e.g. parents with young families) or inflexible working conditions.

[9] For example, official estimates for the UK (which has some of the most systematic data on the topic) indicate that incidents of benefits fraud ranged from 0.3 to 3.9 percent of spending, depending on the benefit in question (Geiger 2018; see also Rand 2014). Investigations into fraud and error in cross-country social security coordination in the EU paint a similar picture (Jorens et al. 2015).

[10] Note that digitisation also facilitates automation, further saving time and labour.

[11] Indeed, given the growing difficulty of recruiting new staff in aging societies, reducing the amount of labour needed to perform public services may be crucial even to maintain them at their current level, never mind increase their quality.

At the same time, the overall economic savings thus achievable should also not be overstated. For example, Vassil (2016) estimates that in 2014, the Estonian "X-Road" digital government system saved Estonian citizens a total of 2.8 million hours of time – or 2.13 hours per person.[12] More optimistically, McKinsey (2019) estimates that the comprehensive implementation of digital identities and digital government could save Americans about 4.4 billion hours a year in 2030, or 12.5 hours per person[13] and Brits 450 million hours, or 6.5 hours per person. Very convenient, no doubt, but not an economic revolution. Similarly, a UK Cabinet Office estimate in 2012 suggested that annual savings of between GBP 1.7 and 2.4 billion could be possible, if most state-citizen transactions were moved online (cited in World Bank 2018a). It should be noted that this would represent ~0,25 to ~0,35 percent of 2012 UK government spending,[14] and most savings (78%) were to come from reducing the number of civil servants, which may not necessarily be feasible in the short term (see below).

Indeed, *monetary* savings (as opposed to time/labour savings) from digital government and digital identity may be harder and slower to realise than expected. For one, it is very likely that governments will have to retain the analog (face-to-face) option for accessing public services for equity reasons. Not all citizens have smartphones (which are generally necessary for digital identities), or feel comfortable with or even *want* to use digital government processes (fortiss and Initiative D21 2018; TUM and Initiative D21 2020). This restricts the degree to which civil servant numbers can be cut, or buildings and other assets liquidated. Even when nominal savings *are* realised, these may not be easily converted into cash. For instance, selling off or renting out a fraction of a building may not always be feasible. Third, both theoretical estimates and empirical experience in e.g. Estonia tend to suggest that large savings only materialise once (i) a wide range of public services and public systems are digitised and connected (thus permitting rapid data exchange between different parts of the public administration), and (ii) digital government is widely adopted by the population, with a number of estimates suggesting adoption rates upwards of 80% may be necessary (World Bank Group 2018a, 2018b, citing an Asian Development Bank study, the 2012 UK Cabinet Office estimate and further "anecdotal research"; Vassil 2016; White et al. 2019). While the Estonian experience suggests that achieving high adoption rates is feasible over time even if the population is initially sceptical or disinterested, this is also likely to take several years, during which the upfront investment costs for the system must be borne but savings are not yet being realised (see data on adoption presented in Vassil 2016). Finally, to the extent that digital government makes public services more accessible, this may lead to *increased* services consumption, which militates against achieving savings. (Of course, increasing services consumption may be a policy objective in itself, e.g. to improve equity.)

3.2.1.4 Public sector economic impact: initial conclusion from the literature

In summary, the following conclusions on the public-sector economic impact can be derived from the literature:

- Impacts are likely to be largest in developing countries and smaller in developed economies.
- Formalisation of hitherto involuntarily-informal sectors and reducing fraud and corruption are important drivers of the positive economic benefits in developing countries, but much less relevant in developed countries.
- Conversely the main positive economic effect for the public sector to be expected in developed economies are efficiency gains. Aside from enabling monetary savings, labour-saving efficiency gains through should also help secure current levels of service provision in the face of demographic change and labour/skills shortages
- Realising significant efficiency gains, however, likely depends on digital identities and digital government being widely adopted by the population, and on the comprehensive digitisation of

[12] Own calculation based on data presented in Vassil (2016) and Eurostat.
[13] Own calculations on the basis of UN Population Prospects data, which estimates the 2030 US population at 352.16 million, and the UK population at 69.18 million
[14] Own calculation from data presented in The Guardian (2012).

government services: digitising individual systems and processes alone is unlikely to pay large benefits.

- Even if direct economic benefits to the public sector are limited, it is still highly advisable to provide the public with digital identities and move to digital government: aside from the private-sector economic benefits this may realise (see below), digital identities and digital government can help drive inclusion and can significantly improve citizen convenience.

3.2.2 Economic impacts of digital identity in the private sector

As the World Bank (2018b) notes, identity "touches nearly every transaction" and thus it is to be expected that building a functioning, widely adopted digital identity system should deliver substantial economic benefits to the private sector. Nevertheless, quantifying these effects is challenging, for they are mostly "diffuse and second-order effects". "Rigorous research and reliable data" on the economic impact of identity systems on the private (as on the public) sector are "scarce" (World Bank 2018b). Broad measures like GDP growth or Ease of Doing Business scales are very noisy, while generalising from specific use cases – which can be found across many sectors – is difficult (ibid.).

Broadly speaking, four sets of effects can be derived from the literature, which partly parallel the effects on the public sector identified above.

3.2.2.1 Formalisation: private sector effects

While the public sector benefits economically from formalisation mainly through increased tax take, the private sector benefits directly: Bringing more people into the formal economy drives growth and thus private-sector profits by enabling companies to transact more easily with more people and businesses. In particular, it increases the available pool of potential employees, and makes it easier to issue financial and insurance products to people (World Bank Group 2018b, 2019, White et al. 2019, World Economic Forum 2018).

3.2.2.2 Efficiency savings and increased transactions in the private sector

Many contexts exist where businesses need to verify the identity of a potential customer, employee or business partner, and/or register their details to their systems (onboarding), both for compliance reasons and to reduce their own risk of falling victim to fraud. When identity systems are fragmented, paper-based and/or riven with errors and duplications, this requires substantial amounts of work and time for both the business and the customer, employee or business partner (Doerk et al. 2020, Dunphy et al. 2018, Wolfond 2017, White et al. 2019, World Bank 2018b). The longer and more complex the onboarding/identity verification process, the greater also the risk that the customer, etc., will break off (abandon) the process, or not initiate it in the first place (Richter and Anke 2021, von Schorlemer 2022).[15] Authoritative, general purpose digital identity systems that businesses can directly query, can reduce these costs substantially. In one example, the (very widely used, cf. Eaton et al. (2018) Norwegian BankID system, cut time associated with applying for university housing from 10-14 days to 1-3 days. Small savings too can add up: identity technology introduced in Dubai Airport cut time required for identity checks by 9-12 seconds per passenger, which at ~84 million passengers in 2016 would save up to 105-140 person *years* in administrative work (both examples taken from World Bank 2018b; own calculations). By making transactions easier and faster, digital identity systems should also be able to stimulate increased economic activity.

It should be noted that especially in advanced economies, reaping the full benefits of digital identity systems likely requires these to be *advanced* identity systems, that is equipped with QES functionality (so that legally-binding digital signatures can be given and the entire process take place solely online) and with digital wallets. This is discussed further in the section on economic effects of SSI.

[15] Experian claims that almost 50% of initiated online transactions are ultimately abandoned by customers before completion, often due to the friction in the onboarding and verification process. (Cited in World Bank 2018b). Survey evidence from German, Austria and Switzerland finds that ~47 percent of respondents have failed to initiate transactions (access services) because they did not want to have to create another digital identity (fortiss und Initiative D21 2019)

3.2.2.3 Improved security

Despite the substantial costs invested in verification processes, companies and individuals nevertheless still frequently fall victim to fraud. Reliable numbers are hard to come by, but one estimate reported in Dunphy et al. 2018 is that identity fraud affected some 15 million Americans in 2016, creating ~$16 billion in damages.[16] Robust digital identities can substantially reduce the incidence of identity fraud and associated costs.

3.2.2.4 Sale of identity-related services

Companies can sell digital identity system-related products and services to governments, businesses and end consumers. Indeed, in Europe this is an increasingly crowded market with both strong incumbents (e.g. in Scandinavia and the Baltics) and numerous start-up activities. Services include, inter alia, identity verification (fee per query), issuance of certificates, QES, and underlying digital components (e.g. wallets, blockchains) (World Bank 2018b, European Commission 2020).

3.2.3 Economic impacts of different authentication technologies

Three broad types of authentication technology are in widespread use today; smartcards, passwords (including PIN/TAN systems) and, increasingly, biometrics (for a detailed overview of identity technologies see (World Bank 2018c). The comparative economic implications of these technologies seem to have been little-examined to date. Generally speaking, *username/password systems* are likely the cheapest, at least up front. They are also very flexible and easy to use on both mobile and desktop applications. However, they have at least two disadvantages that are liable also to impose economic costs. Firstly, users are prone to choosing simple passwords, with low security guarantees. If this leads to hacks or identity theft, potentially substantial additional costs on the user and/or related businesses and public administrations are imposed. Secondly, users often forget their passwords or usernames (Wolfond 2017). This is liable to directly reduce the volume of service consumption, if users abandon an initiated transaction or refrain from even accessing a service, rather than go through the process of requesting a new password. Representative surveys of users in Germany, Austria and Switzerland found that ~47 percent had forgotten passwords, and between 41 and 47 percent had not accessed services due to the hassle involved in creating a new digital identity (which is comparable to – and in the users' minds may also cover – creating a new password) (fortiss und Initiative D21 2019). Lost passwords and usernames also create direct costs for businesses in the form of additional helpdesk requests. Data on this phenomenon, too, is scarce, but one often cited figure from Accenture (2013) found that ~30 percent of calls to UK banks' customer service centres concern lost passwords, with each call costing banks about US$25 (cited in World Bank 2018b).

Several types of *card systems* for digital identity are in use today (World Bank 2018c). The most common in the context of digital government are *contact smart cards*, which have an embedded microchip that is read with a card reader (ibid.). They have been used for digital government applications in Germany, Estonia, and Belgium, among other countries (Felden et al. 2020, Vassil 2016, Mahula et al. 2021, World Bank 2019). While they are generally more secure than password-based systems, they are less flexible. Since a reader is required, it is difficult to use them outside of a desktop context, which may reduce the frequency of transactions. Furthermore, the hardware is relatively expensive, with card readers costing between €20 and €90, depending on the security of the model. Reliance on smart cards and card readers has thus reduced uptake of digital identities and digital government among populations in Europe (Felden et al. 2020, fortiss and Initiative D21 2018), and these systems seem to be generally on the way out today. It is worth noting that, unless they are heavily subsidised, smart card and reader systems are likely to enjoy particularly *low* uptake among poorer sections of the population, due to their cost.

Biometrics include fingerprint, iris, facial and voice recognition. Fingerprint and facial recognition, in particular, are used increasingly widely for mobile phones (World Bank 2018c). Economically, they have the

[16] It should be noted that identity fraud may be more prevalent in the United States than in Europe, because unlike most European countries, the U.S. does not issue its citizens with a universal, state identity document (passports are voluntary, and many Americans do not have one).

advantage over password systems that they dispense with the problem of forgotten or insecure passwords, and over smart cards, that they dispense with the need for costly and inflexible hardware.

3.2.4 Self-sovereign Identity, Digital Wallets, and Electronic Signatures

Self-sovereign identity (SSI) is a relatively new approach to identity. The term seems to have been first coined by Christopher Allen (2016). The core idea of SSI is to give users more direct control over their identity and associated data, by disintermediating central or federated identity providers, like state agencies or private companies (e.g. "Log in with Gmail").[17] Architecturally, this is accomplished by storing the relevant identity data with the user, and *only* with the user (usually on their smartphone), at least until they decide to share it with a service provider in the context of accessing or registering for a service (e.g. providing a bank with their identity information in order to open a bank account).

In practical terms, the identity data is stored as so-called Verifiable Credentials (VCs) in the "digital wallet", a secure compartment in the SSI application on the user's smartphone or other device. VCs are essentially cryptographically secured digital credentials that are issued and signed by an issuing authority (e.g. a state agency, a university, a service provider). All manner of credentials can be issued as digital VCs and stored in a digital wallet; state identity cards, driving licenses, university certificates, registration/subscription (user account) information for some online service, etc. The user can then digitally present his VCs to counterparties, who can automatically verify these credential's authenticity by reading the credential content and signature of the issuing authority. The process is somewhat analogous to, for example, taking one's physical driving license out of one's physical wallet and presenting it to a car rental agency when hiring a car, to prove one's right to drive, and then returning the credential to one's wallet. The point is that the user retains control over the credential (VC). It does not pass into the possession of the rental agency or digital service provider (though both the rental agency, in the physical-world example, and the digital service provider in the digital case, may insist on noting down some of the information about the user thus presented to them in their own systems.) If SSI is combined with Zero Knowledge Proofs (ZKPs), the data shared with service providers can be further minimised.[18]

The contrast here is with both centralised identity systems, where all the identity data is stored in a central repository controlled by the identity provider (e.g. a state agency that issues passports), and with federated identity providers like Google (Gmail), where the provider retains at least the core attributes associated with an identity (e.g. name) and can track which online services the user accesses with the identity, to profile the user (Strüker et al. 2021). Because they can be cryptographically secured, VCs are also highly tamper- and fraud-proof – *far* more so than the pdf scans and photographs of physical documents, through which credentials are often still shared today.

While SSI has garnered considerable interest in the tech scene and, to some extent, among business circles (e.g. von Schorlemer 2022, Doerk et al. 2020, Deutscher Sparkassen- und Giroverband et al. 2021), research into the possible economic effects specifically of *SSI* has remained very limited so far (Kubach and Sellung 2021). Several papers have begun to examine possible business models in SSI ecosystems (Richter and Anke 2021, Stockburger et al. 2021), European Commission 2020, Kubach and Sellung 2021, Wang and Filippi 2020, Echikson 2020), though they too note that, to date, SSI-related business models "remain underspecified" (European Commission 2020). Rather than strictly economic benefits, the advantages most often ascribed to

[17] The degree to which SSI approaches could truly disintermediate *state* identity providers is questionable. Generally speaking, identities are valuable to the extent to which third parties (public agencies, private companies) recognise them as legitimate. To date, the most powerful legitimation of an identity remains its recognition by the state, and states generally recognise only the identities that were issued by themselves or by other states. Businesses too tend to require a state-validated identity for most sensitive or high-value transactions. Most SSI schemes seems to acknowledge that, in as far as the identities they themselves intend to issue, are usually based on a state identity document. This is the case in IMPULSE, for instance.

[18] ZKPs make it possible to demonstrate the veracity of a given statement (e.g., "the user is over 18 years old", "the user is entitled to drive a car") without sharing the underlying information ordinarily needed to prove the statement (e.g. date of birth, driving license).

SSI are enhanced privacy and security. In part, this likely reflects the more technologically-oriented motivating concerns of many of the developers behind the technical development of SSI. Nevertheless, certain potential economic impacts that SSI could have can be identified. Primarily, these revolve around the possibilities opened up by digital wallets.

The key advantage of digital wallets are the technical characteristics described above: that they allow individuals to collect comparatively fraud-proof digital certificates about all manner of aspects of their lives, store them on a personal device (e.g. a smartphone) where they are instantly available, and seamlessly present them to counterparties online, who in turn can verify them automatically. Moreover, with SSI systems users generally need to master only a single identity/authentication system and process across all the services they use.[19] By contrast, today users often need to manage dozens of separate digital identities and authentication processes, which leads to the problems of abandonment and non-initiation of transactions discussed above. These characteristics give SSI the following anticipated economic impacts:

- ***Increased consumption of online services*** as digital transactions become easier and faster for users, thus likely lowering rates of abandonment and non-initiation of transactions;
- ***Administrative, compliance and computing costs are reduced*** for companies and public institutions (the counterparties in online transactions), as verification of credentials can be done automatically and digitally rather than manually and paper-based, and as the counterparty need no longer store so much data about the users (as users store and manage their credentials themselves) (Pignatelli et al. 2019);
- ***Reduced fraud and identity theft*** due to the greater security VCs offer compared to the manner in which credentials are often presented today (e.g. PDFs of scanned paper documents) (Strüker et al. 2021)
- ***Greater interoperability*** of identity solutions across ecosystems (Richter and Anke 2021, Stockburger et al. 2021)

It should be stressed that at present, these anticipated impacts are largely hypothetical. SSI schemes remain limited to small-scale or specialised pilots to date, and business models are still at the exploratory stage (European Commission 2020). Building out SSI systems and in particular integrating them into existing IT systems and business ecosystems is likely to often be costly (Doerk et al. 2020). Moreover, while the fact that SSI moves the locus, where user data (certificates) are stored from the service provider to the user's device, promises to increase users' control over their data and reduce the computing, storage and compliance costs of service providers, it also makes the user responsible for the security of their data. However, private users are often relatively poor at managing their own IT security. Moreover, while high quality smartphones are very secure, SSI does introduce a single point of failure – at the limit potentially across *all* of a user's identity-related transaction. Loss or hack of a wallet can thus become a personally devastating and quite costly experience (Doerk 2020).

While one important promise of SSI (or perhaps rather, digital wallets) is that it can increase the volume and variety of digital transactions, sensitive or high-value transactions often require a legally-binding signature. This is true both of private-sector transactions (e.g. a mortgage application) and of public-sector ones (e.g. applying for a permit of some kind). SSI and wallets alone cannot supply these. In other words, realising the full promises of wallets/SSI requires users to have access to an easy-to-use, low-cost or free electronic signature function. Ideally, this should be directly integrated into the identity solution. It is worth noting that in several countries where digital government and the digitisation of the economy were most successful, like Estonia, the government directly subsidised the provision of e-signature solutions to the public (Vassil 2016).

[19] This is the case also for a system like IMPULSE, where users technically create a separate identity (certificate) for each service they register for with IMPULSE. However, from the user's perspective, each identity is simply differently-labelled icon in the wallet, that they then select to authenticate themselves to the service with. Indeed, in future iterations of IMPULSE, they may not even have to manually select the service-specific certificate (identity) when authenticating – the system may do it automatically. Thus, from the user's perspective, the authentication process is identical for each service.

Conversely, the fact that in Germany the government did not take comparable measures and acquiring electronic signature functionality thus remained relatively costly for end-users, is seen as one factor behind the country's slow digitisation ((Felden, et al. 2020).

3.3 Implications of the literature for the research questions

The following implications may be derived from the literature for our research questions.

What are the specific economic effects of using IMPULSE in the pilot cases and the private sector?

In summary, the literature suggests that the main effects to be expected from "basic" digital identity systems like the current instantiation of IMPULSE (authentication/log-in only), are limited efficiency gains in the public and/or private sector. In the case of most of the IMPULSE pilot cases, these are likely to be limited to the public sector, as the pilot use cases are in the public sector. Were IMPULSE come to be used more widely (i.e. beyond the current use cases) including in the private sector, there may be an increase in the consumption of public and private digital services, as the substitution of biometrics for traditional authentication technologies like passwords or smartcards removes friction from the transactions. Specifically in the private sector, IMPULSE might also lower costs resetting passwords, confirming people's identity, and losses to fraud and identity theft.

How large are the economic effects in the pilot cases likely to be?

It is helpful to distinguish two impact levels: impact "within" the use case (e.g. "10 percent savings to processing permit X") and economy-wide effects ("1 percent increase to GDP"). The size of "within"-use case effects depend on the specifics of the individual cases, and few ex-ante hypotheses can be derived from the literature. Regarding the size of economy-wide effects however will almost certainly be limited, simply because the use cases are limited. Indeed, the literature suggests that in developed countries, substantial effects are likely only once large numbers of use cases become accessible, and the digital identity solutions include wallet and QES functionalities (which are necessary to enable many of the higher-value use cases).

Does the use of biometrics for authentication give IMPULSE distinct economic effects, compared to other authentication technologies?

As noted, it can be surmised that use of biometrics should give IMPULSE distinct economic effects. Biometrics can reduce friction in digital transactions, non-completed transactions, and costs related to lost passwords and similar.

What economic effects could adding a Digital Wallet and QES functionality to IMPULSE have? What are the economic effects of their current lack in the IMPULSE solution?

The literature is clear that digital wallets and QES functionality are key to enabling manifold higher-value use cases. As they are missing from the current instantiation, effects observed in the use cases should likely be largely limited to efficiency effects.

Does being an SSI solution give IMPULSE particular economic effects, that other eID architectures will necessarily lack?

SSI solutions may increase consumption of digital services by removing friction (e.g. multiple passwords), reduce compliance and admin costs, and improve security and interoperability. However it is unclear whether these effects will show up in the use cases explored here. In particular, since each pilot involves only a single use case, it is unlikely that the particular friction- and interoperability-related effects will be observed, since by definition these can arise only once the same user consumes multiple use cases (services).

4 Study of Economic Effects in the different Pilot Cases

The IMPULSE project is trialling the IMPULSE eID solution in six pilots across Europe. They are located in Peshtera in Bulgaria, Aarhus in Denmark, Ertzaintza and Gijon in Spain, Reykjavik in Iceland and in northern

Italy (InfoCamere). This section analyses the economic impact of the IMPULSE solution in each pilot. Because the pilot use cases and their larger contexts are quite diverse, the analysis proceeds pilot by pilot.

4.1 Method

To understand the possible economic impacts of IMPULSE in the pilots, we proceeded as follows. We first studied various documentary materials about the pilots supplied by the consortium partners running the pilots (the "case owners"), and then conducted a semi-structured interview with each case owner in Spring-Summer 2022. A list of interviewees is included in Annex A. Each interview partner was asked a common set of questions (with some case-specific adjustments), with non-scripted follow-up questions as new themes emerged in the conversation. Questions focused on how the service, in which IMPULSE was to be deployed, was currently provided and identity authenticated; how using IMPULSE would change the process of service delivery and authentication for users (citizens) and public authorities, and what benefits but also drawbacks the interviewees expected from using IMPULSE, for both the citizens and the public administrations. As much as possible, we sought to quantify the benefits/costs of IMPULSE already during the interview. Possible obstacles to using IMPULSE were also covered. A questionnaire is included in Annex B. The interviews were recorded and analysed, with further follow-up questions by email or telephone, where needed. On the basis of the information thus collected, an initial set of quantitative models were built to estimate impacts. The results of these were reported in Deliverable 4.3. For this Deliverable, the analysis was expanded by collecting further data from the pilot case owners via questionnaires and email, from national statistics authorities, and by using the data collected in a large-N, cross-country survey (N = 740) of potential users in all the pilot countries as well as Germany, Finland, France and Austria, that was conducted as part of Task 4.1. This additional data was used to expand the estimates, in particular to consider scale-up effects to the national level, and generally make the estimates more reliable.

4.2 Results

4.2.1 Municipality of Peshtera, Bulgarian

4.2.1.1 Description of the Pilot Use Case[20]

The Bulgarian IMPULSE Use Case involves using IMPULSE for authentication when residents of Peshtera apply for a Certificate of Permanent Address ("certificate"). Residents[21] must obtain this certificate in various circumstances; e.g. when renewing their state identity card, when buying or selling real estate, and if they move (change address).

Since January 2021, when the Municipality of Peshtera (MOP) launched a digital services platform, residents have been able to obtain the certificate digitally. This platform is an initiative of the national government, and is used also in other municipalities of Bulgaria. However, in Peshtera this digital path is hardly used. Instead, most residents still go to the municipal offices to get the document in person. This face-to-face (F2F) path creates additional work for civil servants. Were residents to use the digital path, civil servant workloads could be reduced, and residents also save time. The F2F path also tends to lead to larger queues in the municipal offices, which was seen as a health risk during the pandemic.

The staff from MOP believe that a key reason for why residents have not used the digital path more to date, is that it requires them to first obtain a digital identity with QES functionality from one of the recognised Bulgarian digital identity providers. According to MOP staff, this is time-intensive (travel to another city, queue at the offices of the ID provider etc.) and costly (fees for the ID and QES service). Moreover existing eID solutions are not always well-adapted for mobile and/or require the use of additional hardware and passwords. The advantage of IMPULSE, in their view, is that the registration process is significantly faster and easier for residents, since they can sign up for IMPULSE at home without needing to visit a dedicated

[20] The following description is based on our interview and follow-up discussions with MOP staff.
[21] In the discussion of the case studies, we use the term "resident" to refer to both citizens (i.e., those with state citizenship) and non-citizens who live in the community and thus are part of the (potential) IMPULSE user base.

office. It may also be cheaper (but see discussion below), and does not require the use of a desktop computer. In summary, the main economic effect expected from IMPULSE for civil servants and residents are time/labour savings, as well as potentially lower expenses for other items (e.g. postage, hardware).

Version 1 of this Deliverable (D4.3) provided estimates for the economic savings to be achieved through use of IMPULSE for the Certificates of Permanent Address, Marital Status and Name Change. Unfortunately, it turned out that the savings would be quite limited. Even with 90 percent adoption of IMPULSE, the Peshtera civil service would only save around 107 working hours annually, approximately two and a half working weeks. It could be hard to justify adoption of IMPULSE in this scenario.

Nevertheless, this version of the Deliverable examines what the effects would be, if all 70 certificates, declarations and documents (henceforth, "certificates") that residents can obtain or submit for processing via Peshtera's digital services platform, were made available via IMPULSE. It also examines the national-level effects, if IMPULSE were scaled up to country-wide usage in local government contexts like Peshtera.

4.2.1.2 Processes and savings per certificate

The certificates and declarations ("certificates") that can be obtained or submitted via Peshtera's digital platform cover a wide range of circumstances relevant to residents and small businesses. They include the certificates of permanent address, marital and family statuses, tax declarations, property deeds, planning approvals, and more. The full list is contained in Annex C.

Table 1 lays out the steps and time required to obtain or submit the certificates via the F2F path, and via the digital path with existing eID solutions and with IMPULSE, for both residents and civil servants.[22] For all certificates, the process for obtaining or submitting them is the same, with one qualification: some (primarily tax declarations) only need to be *submitted* by the resident – they do not need to subsequently picked up again or otherwise returned to the resident. For these "submit only"-certificates, only the steps from Part 1 of the process described in Table 1 apply.

As Table 1 and 2 lay out, the amount of time required for residents and civil servants to issue or submit a certificate varies considerably by path. Using the F2F path, it takes the resident between ~82 and ~210 minutes, and the civil servant ~37 to ~40 minutes, for the resident to obtain a certificate (including time for the resident to return to the public administration building to receive the completed form back from the civil servants). If the resident only needs to submit the certificate, it takes the resident ~59 to ~174 Minutes and the civil servant about 34 minutes to complete the entire process.[23]

Using the digital path with either IMPULSE or the existing eID solutions, it costs the resident and the civil servant about ~24 and ~31 minutes, respectively, for the resident to submit/apply for and receive back certificates. Submission-only takes the resident ~23 minutes, and the civil servant ~30 minutes. Table 2 summarises these times requirements.

Compared to the F2F process, resident can thus save between ~52 and 183 minutes per certificate obtained (between ~36 and ~151 minutes per certificate submitted only) if they use either the existing eID solutions or IMPULSE. For the civil service, savings are between ~6 and ~9 minutes per certificate (~4 minutes for certificates submitted only) (Table 3).

Note that these time and savings estimates *exclude* the time it takes to on-board to either the existing digital solution (ca. 94 minutes) or to IMPULSE (about 3-5 minutes). Comparing IMPULE and the existing digital solutions, the main time saving IMPULSE offers the resident, is a much faster onboarding process. The time it takes to submit/obtain certificates *after* onboarding, is the same for both (Table 3).

Time savings have a monetary value. This is obvious in the case of working time (e.g. here of civil servants). But it applies also to the "free" time of residents. This follows the intuition that (i) people attach an at least

[22] The description of the steps and their sequence is based on our interview and follow-up discussions with MOP staff, as well as desktop research.
[23] These as well as all further estimates for the time required for the different steps are based on our interview and follow-up discussions with MOP staff, as well as desktop research.

implicit monetary value to their free time (they could work otherwise), and (ii) that in practice, time devoted to e.g. administrative errands like getting a state certificate, may come at the expense of working time.

To calculate the monetary value of the civil servant time savings, we use the average hourly labour cost for the public administration and defence sectors, as reported by the National Statistical Institute of Bulgaria (NSIB 2022a).[24] This reflects the cost to the state of an hour of civil servants' work. For the value of the residents' time, we calculate the average hourly wage (all sectors) based on annual wage data (NSIB 2022b).[25] This reflects the opportunity cost *to the resident* – the amount of money she or he could otherwise earn. However, for both groups the monetary value of the time saved is small: BGN ~11 to BGN ~34 for residents at 2022 wage levels certificates obtained, and BGN ~7 to BGN ~28 for certificates submitted only. This corresponds to €~5.5 – €~17 and €3.4 – € ~14 at average 2022 exchange rates. For the civil service, the monetary savings only amount to BGN ~2 – ~3 per certificate picked up, and BGN ~1.6 per certificate submitted only (€ ~0,8 – ~1.6) – the value of a few minutes working time.

There are also direct monetary savings. Excluding travel costs (counted here only in terms of time spent), the IMPULSE system offers residents at least two further sources of monetary savings. The first is costs for postage or curriers in the F2F path (BGN 1.8 and BGN 6 respectively, borne by residents), if residents do not pick up the issued certificate at the municipal offices in person. The second is cost for hardware. The existing Bulgarian eID schemes (e.g. that of BTrust) require the user to purchase a hardware reader system (currently priced at BGN 21). This cost falls away when using IMPULSE.[26] The annual value of these savings are presented in Table 3, assuming a 10-year lifespan of a reader device (i.e., BGN 2,1 = BGN 21 / 10).

4.2.1.3 Aggregate economic estimates: Peshtera

Table 3 presented the time and monetary savings from using IMPULSE for issuing a single certificate. How great could the *aggregate* savings for the municipality and residents of Peshtera be, if IMPULSE were widely used to obtain and submit certificates? To calculate this, we need to multiply the number of certificates issued or submitted annually with the savings described in Table 3, adjusted by the foreseeable adoption rate of IMPULSE.

Table 4 shows the number of certificates issued or submitted to MOP for each year since 2019. On average, about 3536 certificates were issued to residents each year, and residents submitted (without pickup) 4274 certificates. According to MOP, 97 percent of certificates are currently issued via the F2F path (with 94 percent being picked up in person by the residents); only 3 percent are currently issued digitally. Partly, this may reflect the digital path's novelty. It only became operational in January 2021; many residents may still not know about it, and/or lack an eID. Indeed, at 27 percent in 2021 (EuroStat 2023), the share of Bulgarians who have "used the internet" for some form of "interaction with public authorities" is considerably higher than the share who have used the digital path in Peshtera for certificates. Notably, the number of Bulgarians, who have used the internet to "interact with the authorities" in general, has been steadily rising (in 2015 it was 18 percent), suggesting that people are in general open to digital services provided by the government. Available data for smartphone ownership in Bulgaria, shows rapid increases.[27]

[24] Using the average public sector wage for the civil servant calculations is reasonable, as MOP staff told us that in practice, there can be considerable variation as to the staff (and pay grade) who provide F2F services to residents.
[25] We assume 160 hours of work per month.
[26] Existing Bulgarian eID systems also charge users an annual subscription fee. We do not count this as a saving, since IMPULSE may also charge users some form of fee. While IMPULSE is still too far from commercialisation for us to be able to say how it may be monetised and what fee/charging structures might be, it is reasonable to assume that IMPULSE could at least not charge *more* than competing systems.
[27] The only available empirical data is for 2014 – 2016. In this period, smartphone penetration (defined as ownership plus a minimum monthly usage) jumped from 30 percent to 48 percent (Statista 2017). It is reasonable to assume that penetration has escalated since.

Step	Face to Face Path			Digital Path – using existing eID solutions			Digital Path – using IMPULSE			Comments and Assumptions
	Description of Step	*Time Resident*	*Time Civil Servant*	*Description of Step*	*Time Resident*	*Time Civil Servant*	*Description of Step*	*Time Resident*	*Time Civil Servant*	
Obtaining a Digital Identity										
1 A	NA			Access Website, fill out forms	2 Min		Onboarding to IMPULSE	3-5 Min		
1 B				Travel to Office of Service Provider	30 Min					Nearest office is Pazardzhik; 24 Min. travel time by car (Google Maps); we add 6 Min. for parking etc.
1 C				Wait to be served	5 Min					
1 D				Present ID card, fill out further forms	7 Min					We measured the time required to fill out the forms
1 E				Return travel	30 Min					
1 F				Install reader hardware and software on home computer	20 Min					
Obtaining or Submitting Certificates: Part 1 – Submitting Certificates or Application Forms										
2 A	Travel to Municipal Office	10-15 Min		Access MOP website	1 Min		Access MOP website	1 Min		
2 B	Wait for turn	15-120 Min		Select & complete form	20 Min		Select & complete form	20 Min		
2 C	Speak to civil servant, state purpose, receive application form	2 Min	2 Min	Clarify open questions (FAQ page, etc.)	1-1.4 Min			1-1.4 Min		Every 5th resident using Digital Path needs extra 5-7 Min to look up information.
2 D	Complete form	20 Min		Upload completed form	1 Min			1 Min		
2 E	Ask Civil Servant clarifying questions	0.24-0,36 Min	0.24-0,36 Min							F2F: every 5th resident has questions taking 2-3 Min.
2 F	Return form, show ID card, pay fees	2 Min	2 Min							
2 G	Return travel (resident)	10-15 Min								
2 H	Civil servant processes forms, creates Certificate		30 Min			30 Min			30 Min	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004459

Step	Face to Face Path			Digital – existing eID solutions			Digital – IMPULSE			Comments and Assumptions
	Description of Step	*Time Resident*	*Time Civil Servant*	*Description of Step*	*Time Resident*	*Time Civil Servant*	*Description of Step*	*Time Resident*	*Time Civil Servant*	
Obtaining or Submitting Certificates: Part 2 – Receiving the completed Certificate										
	Option 1: Pick up by Resident at Municipal Offices			*Certificate sent to Resident by email, or uploaded to a secure electronic platform*			*Certificate sent to Resident by email, or uploaded to a secure electronic platform*			
3 A	Resident travels to Municipal Offices	10-15 Min		Certificate sent to resident by email or uploaded to electronic platform		1 Min	Certificate sent to resident by email or uploaded to electronic platform		1 Min	
3 B	Resident gets certificate from civil servant	3-5 Min	3-5 Min	Resident gets certificate from email or platform	1 Min		Resident gets certificate from email or platform	1 Min		
3 C	Return travel (resident)	10-15 Min								
	Option 2: Certificate of Address is sent by Post to Resident									
4 A	Civil servant prepares & sends resident letter with Certificate		2 Min							
	Option 3: Certificate of Address is sent by Currier to Resident									
5 A	Civil servant prepares & sends resident letter with Certificate		2 Min							
	Options 4: Certificate sent to Resident by email, or uploaded to a secure electronic platform									
6 A	Civil servant sends certificate to resident by email or uploads it to secure electronic platform		1 Min							
6 B	Resident gets certificate from email or platform	1 Min								

Table 1: Steps required to obtain and submit certificates in different paths

	Face to Face Path		Existing digital path		IMPULSE	
	Lower Bound	***Higher Bound***	***Lower Bound***	***Higher Bound***	***Lower Bound***	***Higher Bound***
Submission only – Time in Minutes						
Residents	59.24	174.36	23	23.4	23	23.4
Civil Servants	34.24	34.36	30	30	30	30
Certificate returned – Time in Minutes						
Residents	82.24	209.36	24	24.4	24	24.4
Civil Servants	37.24	39.36	31	31	31	31

Table 2: Time required to submit and obtain certificates in different paths

Item	Savings to Resident *per certificate obtained*		Savings to Residents *per certificate submitted only*		Savings to Civil Service *per certificate obtained*		Savings to Civil Service *per certificate submitted only*	
Savings from IMPULSE vs F2F	***Lower Bound***	***Higher Bound***	***Lower Bound***	***Higher Bound***	***Lower Bound***	***Higher Bound***	***Lower Bound***	***Higher Bound***
Time saved (Minutes)	52.24	183	36.24	150.96	6.24	8.4	4.24	4.36
Monetary value of time saved (BGN)	10.68	33.92	6.65	27.69	2.32	3.11	1.58	1.62
Postage savings (if post used) (BGN)	1.8	1.8	--	--	--	--	--	--
Currier savings (if currier used) (BGN)	6	6	--	--	--	--	--	--
Savings from IMPULSE vs. existing eID solutions								
Time saved incl. onboarding (Minutes)	88,6	91,4	--	--	--	--	--	--
Time saved excl. onboarding (Minutes)	--	--	--	--	--	--	--	--
Monetary value of time saved (incl. onboarding) (BGN)	16,25	16,76	--	--	--	--	--	--
Monetary value of time saved (excl. onboarding) (BGN)	0	0	--	--	--	--	--	--
Hardware savings (annual, over 10 years) (BGN)	2,1	2,1	--	--	--	--	--	--

Table 3: Time and monetary savings from using IMPULSE compared F2F and existing eID solutions (not applicable left blank)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004459

Certificate Type	2019	2020	2021	2022	*Average*
Certificates issued to residents ("apply for and pick up by residents")	3201	3527	3861	3554	3535,75
Certificates submitted by residents ("no pick up, submission only")	3600	3962	4683	4850	4273,75

Table 4: Number of Certificates issued annually by MOP

We next estimate the costs to residents and MOP over the past years, and the savings that could have been realised if IMPULSE had been used in the years 2019 – 2022. To calculate this, we first multiply the number of certificates issued for each year through the F2F and the existing digital path[28], with the time required of residents and civil servants per certificate issued or submitted. Then, we perform the same calculations for the assumption of 100 percent use of IMPULSE. Subtracting the latter from the former, we have the time savings IMPULSE would have enabled for the years 2019 to 2022. We express these in terms of working days (8 hours). For monetary savings, we multiply the hours saved/expended by residents and civil servants with the average hourly wage and the labour costs, respectively, for each of the years in question.

The time required of both civil servants and residents to issue a certificate can vary considerably within the same path, depending on vagaries like travel or queuing time. In Table 1, we therefore often gave time ranges. On this basis, in our estimates, we calculated high and low bounds for the annual time and monetary savings. However, for sake of ease of exposition, here we only show an average annual expenditures and savings (the average of the high and the low bound figure).

Figures 1 and 2 show the results for residents' time expenditure and its monetary value. From 2019 to 2022, residents are estimated to have spent between 1835 and 2301 working days annually on obtaining and submitting certificates in Peshtera. Had they used IMPULSE, conversely, this would have been reduced to just 335 to 421 working days. In monetary terms, this amounts to about BGN ~117,000 to ~198,000.[29]

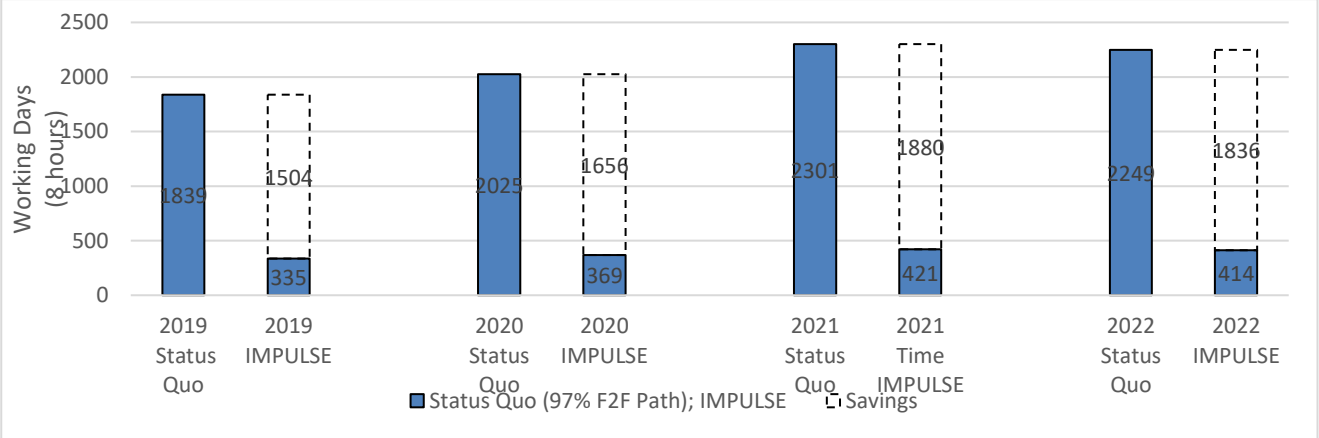

Figure 1 : Estimated time expenditure and (hypothetical) time savings for residents

[28] For the status quo, assume that 97% of certificates are issued or submitted through the F2F path. This number was arrived at from a sample of certificates

[29] For simplicity, it is assumed that all residents who used the F2F pathway to obtain certificates, picked these up themselves from the public administration building. In reality, a small number are returned by post or by curier. Based on a sample of certificates, MOP estimates that postage is used in 1 percent of the cases, and curier services in 3 percent. This would imply additional costs of between BGN 1.8 (post) and BGN 6 (curier) per certificate, counterbalanced by ~28 minutes time saving per certificate on average (corresponding to a time value of BGN ~3.7). In other words, the money value of time savings obtained by using post or curier and the additional expense these services impose, largely balance out, so that the overall results are barely affected by the simplifying assumption that all certificates obtained by F2F path are picked up in person.

For the civil service, the estimated costs and savings are as follows (Figures 3 and 4). From 2019 to 2022, the civil servants of Peshtera are estimated to have spent between 512 and 642 working days a year on receiving, processing and issuing certificates for residents. This corresponds to a monetary cost of between BGN ~55,500 and BGN ~112,400 a year. Had IMPULSE been used for all certificates, conversely, they would only have needed between 103 and 130 working days, saving between BGN ~44,300 and BGN ~89,500 annually.

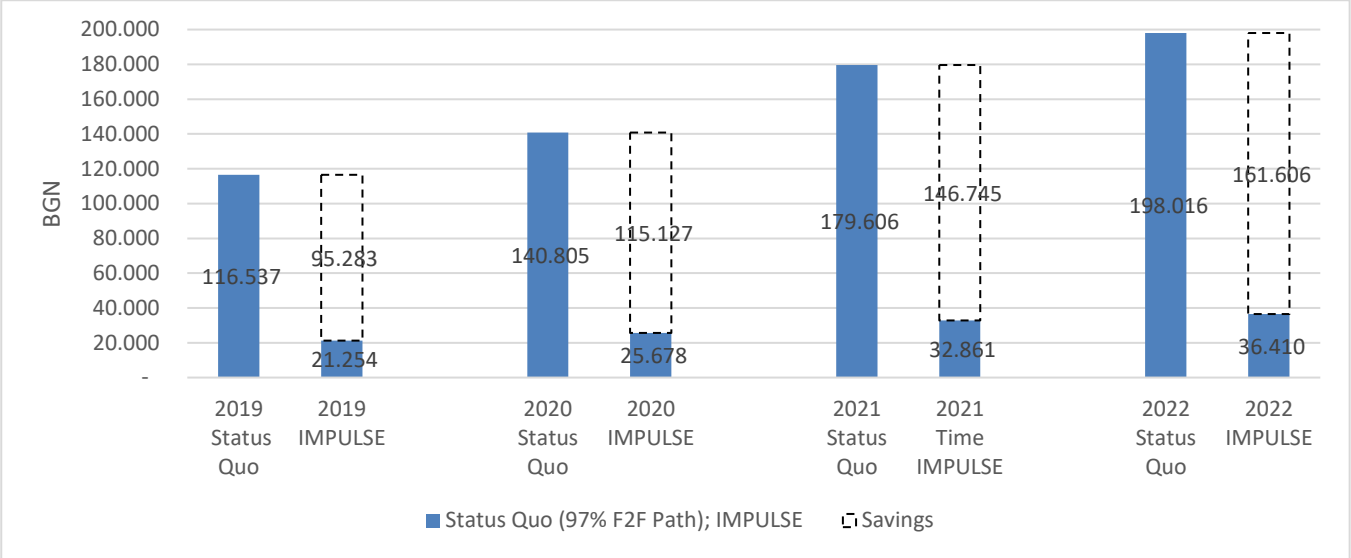

Figure 2: Estimated monetary value of time and (hypothetical) savings for residents

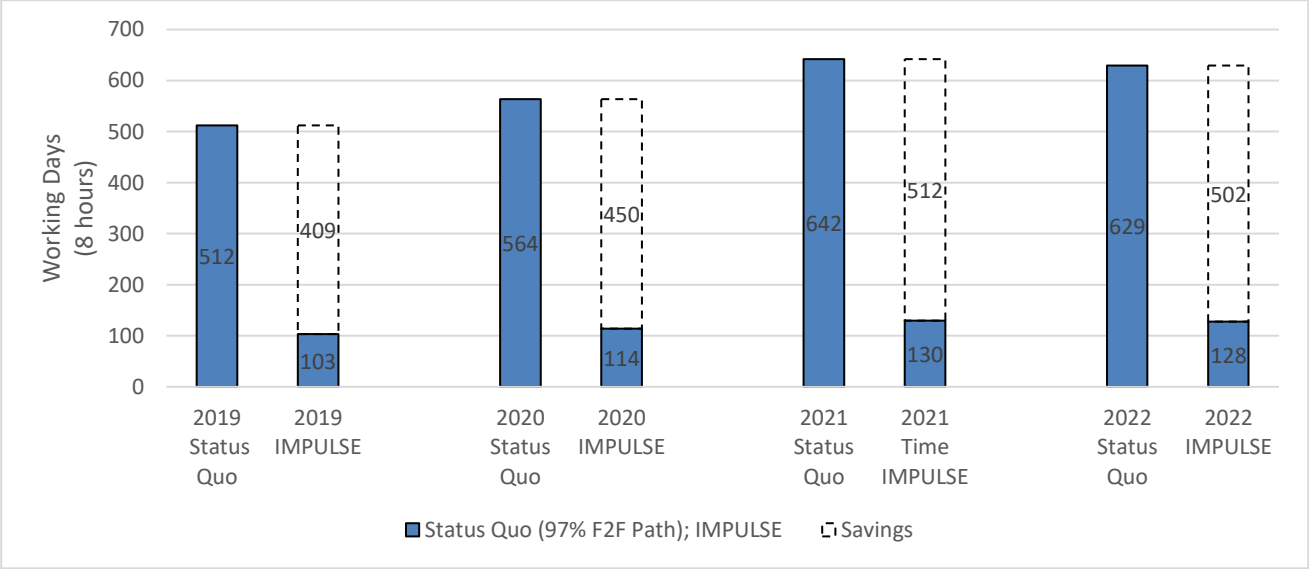

Figure 3: Estimated time expenditure and (hypothetical) time savings for the civil service of Peshtera

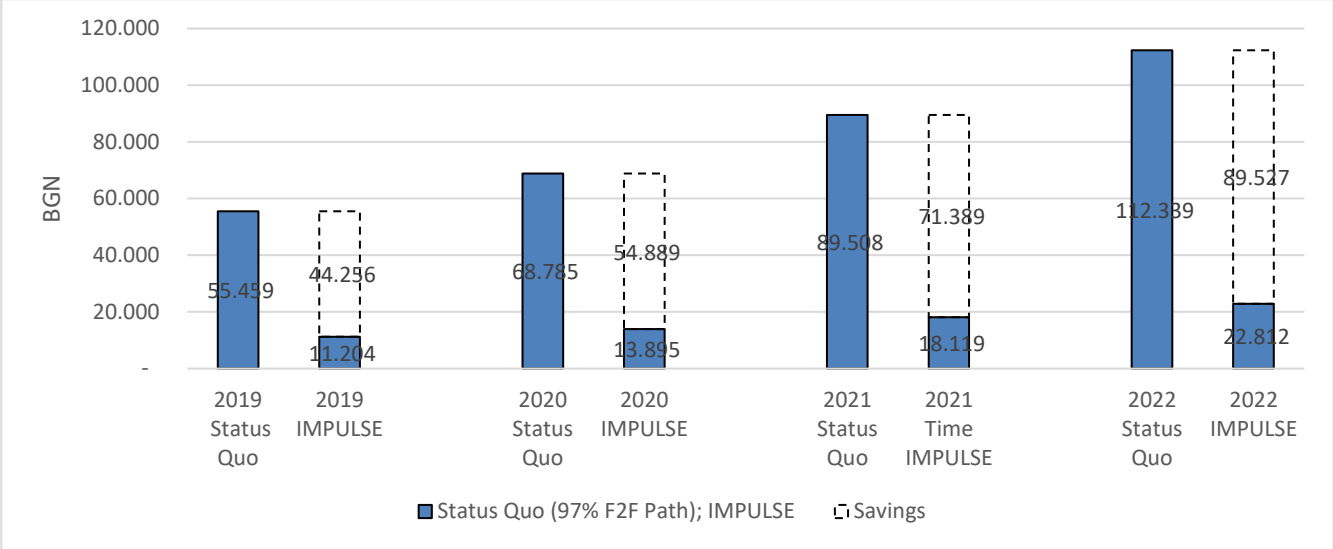

Figure 4: Estimated monetary costs and (hypothetical) savings for the civil service of Peshtera

4.2.1.4 Adoption scenarios and future savings in Peshtera

100 percent of IMPULSE, as assumed in the above calculations, is obviously unrealistic. But what levels of adoption are thinkable, and what economic effects would they have in Peshtera?

The experience of Estonia indicates that mass adoption of digital government services can follow an exponential curve, with a slow start followed by a rapid take-off after several years (Vassil 2016) – in other words, a typical S-curve known also from other technologies (Rogers 2003 [1962]). Nevertheless, comparative data suggests that even under best-case scenarios, adoption rates above 80–90 percent are unrealistic. These are the shares of the population that, as of 2021, had "used the internet for interaction with public authorities" in the highly digitalised countries Sweden (90 percent), Denmark (92 percent) and Estonia (82 percent) (EuroStat 2023).

Sweden and Denmark arguably provide limited guidance to possible adoption patterns in Bulgaria, given their much higher wealth levels. Estonia may be a better point of comparison, especially as the main adoption movement towards digital identities and electronic government took place in the 2000s, when the country was still much poorer. This suggests 80 percent, rather than Scandinavian 90 percent adoption levels, may be the upper limit of what could be possible. This number, it should be noted, would also be in line with the results of the survey conducted as part of the IMPULSE Workpackage 4.1.[30] Among the Bulgarian respondents, some 83 percent stated that they would or would "certainly" adopt IMPULSE, should it become available.

We therefore calculate two multi-year adoption scenarios: a baseline scenario and ambitious scenario (Figure 5). In the subsequent economic estimations, we compare these two scenarios to business as usual (BAU, i.e. continuation of the status with 97% of certificates issued or submitted F2F).

[30] Survey results are reported further in Deliverable 4.2

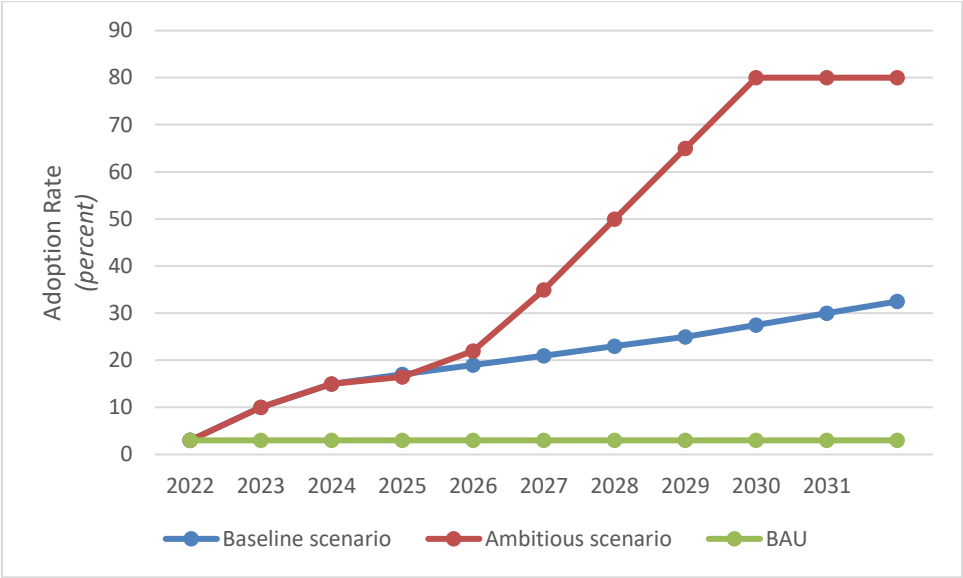

Figure 5: Adoption Scenarios for Peshtera

In the baseline scenario, usage of IMPULSE first grows rapidly, to 15 percent of people applying for certificates by 2024 using IMPULSE, as the most digitally-open section of the population – who may already use the internet for interactions with the public authorities, begin using IMPULSE. We assume growth to 15 percent rather than the 27 percent reported in the Eurostat data, to take account of the fact that Peshtera is a more rural area. Thereafter, though growth of the IMPULSE user base slows to 2-2,5 percent annually – a rate close to the average rate at which internet use for interactions with public authorities grew historically according to Eurostat – to finally reach 33 percent by 2033. In the ambitious scenario, growth does not level off, but accelerates to 35% in 2027 and 80% by 2030, at which point it levels off. These may seem like extreme figures, but if anything they are more conservative than the increases seen in Estonia once the "take-off" stage was reached (cf. Figure 3 in Vassil 2016).

Future costs are ultimately determined by how many certificates are issued and submitted by residents. In the long-term, this number should be a function of the population size: as the number of residents grows or shrinks, the number of certificates issued or submitted may be expected to grow or shrink. In the short-term though, the number certificates shows little relation to the number of people living in Peshtera, as Table 5 shows: Since 2016, Peshtera's population has steadily shrunk. Population decline averaged -1.3 percent between 2016 and 2021.[31] At the same time, at least from 2019 to 2022, the volume of certificates issued and submitted actually *increased*.

	2016	2017	2018	2019	2020	2021	2022
Population[32]	18136	17899	17716	17519	17329	16983	14459
Certificates				6801	7489	8544	8404
Ratio Certificates per Resident				0.39	0.43	0.5	0.58

Table 5: Population change and certificates in Peshtera

[31] It is worth noting that Peshtera's population suffered a particularly marked drop in 2022 (-14.9 percent [!]), pushing down the average annual population decline over the entire period 2016 to 2022 to -3.6 percent. It is not entirely clear what caused this abrupt drop.

[32] Data from National Statistical Institute of Bulgaria (2023a)

On the basis of these data, we project future population sizes and the volume of certificates issued/submitted each year out to 2032. We assumed an annual population decline of -1,3 percent,[33] and an annual volume of certificates of 0.48 per person (the average figure across 2019 to 2022). This is in line with both the observed data for Peshtera, and wider trends in Bulgaria (BNR 2023). Figure shows the results, with a gradual decline of both the population and number of certificates, to 12685 and 6089, respectively, in 2032.

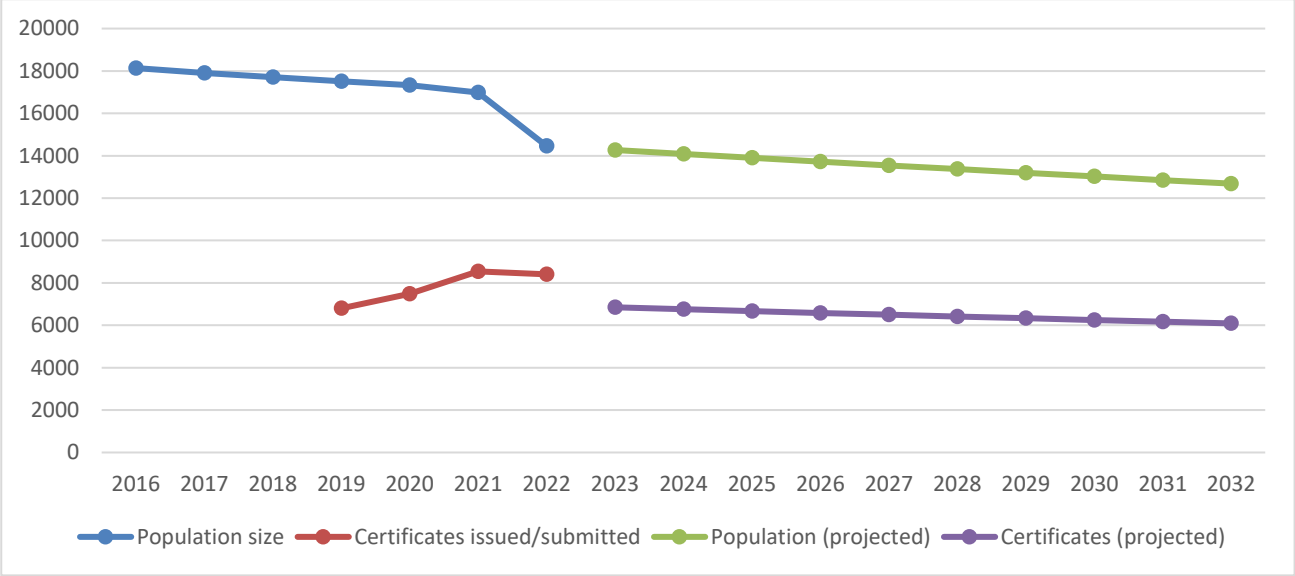

Figure 6: Projected population size and certificate volumes

We next model how many certificates are issued/submitted through the IMPULSE-mediated digital path and the F2F path under the different adoption scenarios given the projected future population size and certificate volumes. Figure 7 shows this for the business as usual (BAU) scenario; Figures 8 and 9 for the baseline and the ambitious adoption scenarios.

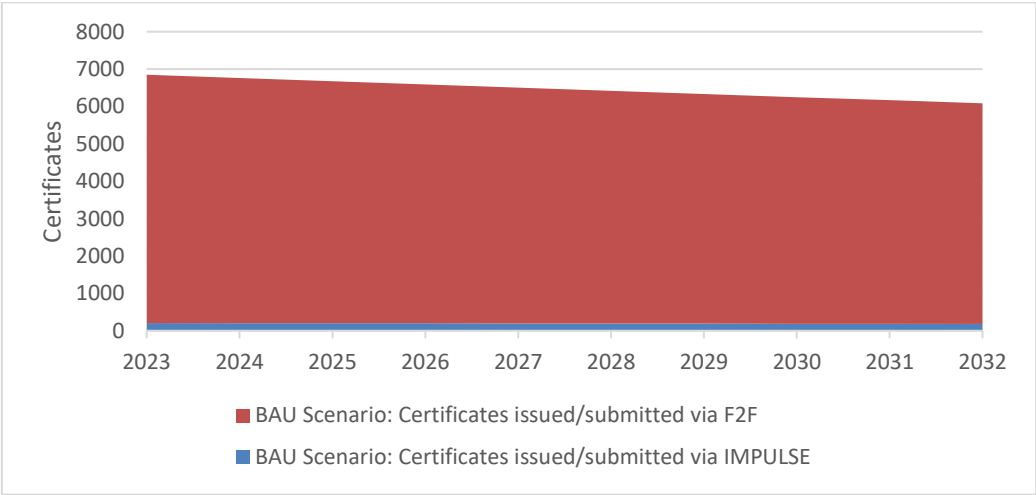

Figure 7: Certificates issued under the BAU scenario

[33] We assume -2 percent, rather than the average -3.6 percent observed for the entire period 2016 – 2022, because the sharp drop in 2022, which drives the higher number, is likely due to one-off factors. We take a greater number than the average decline observed for 2016 – 2021 (i.e. when the exceptional 2022 is excluded) because one-off factors can re-occur. Of course, one-off factors can also lead to population growth, and the entire trend of population decline could reverse in future.

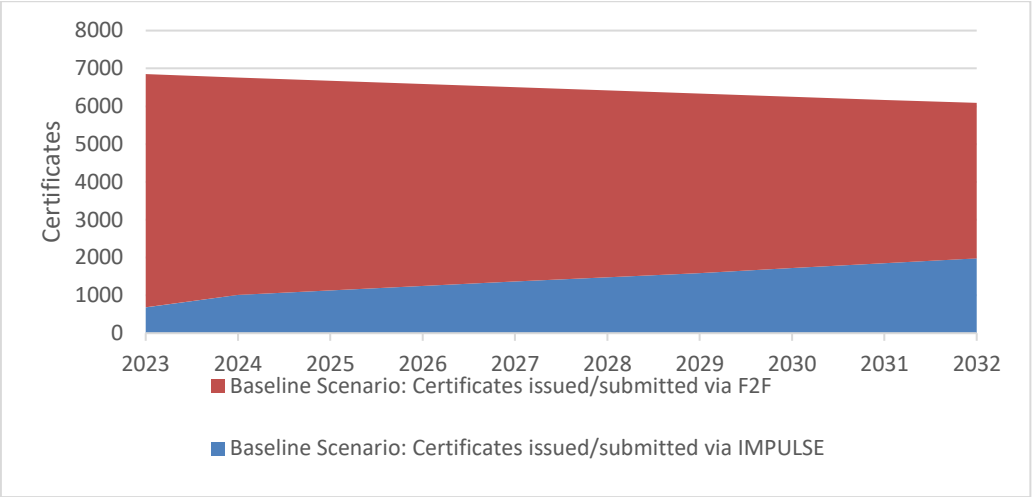

Figure 8: Certificates issued under the Baseline scenario

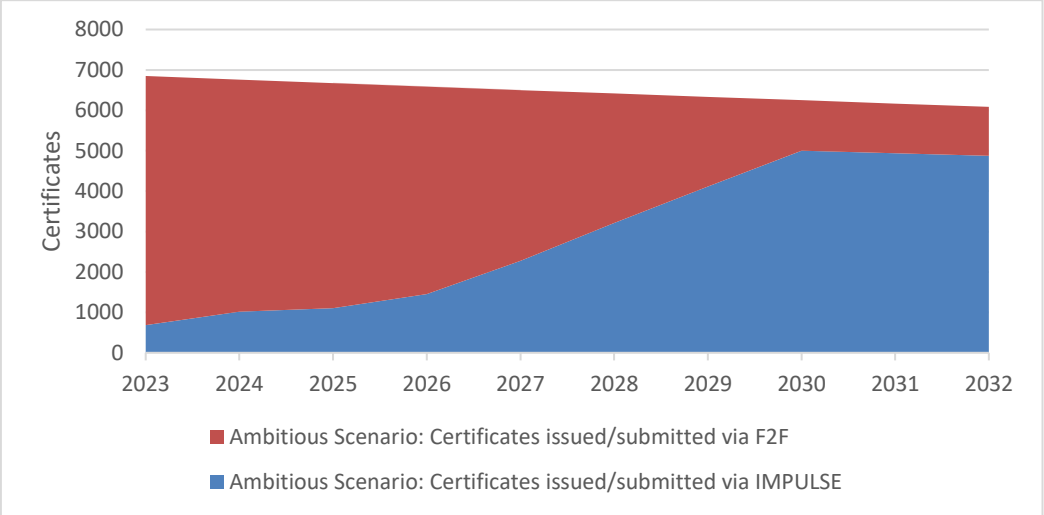

Figure 9: Certificates issued under the Ambitious scenario

Having calculated the projected annual volume of certificates, we can next model the expected time and monetary expenditures of residents and public administration in the different scenarios. Figure 10 shows the development of the residents' time expenditure savings over selected years for the different scenarios; Figure 11 shows the aggregate time expenditure and savings over the entire period 2023 to 2032. Savings accumulate gradually, as usage numbers slowly rise. While in 2026, the ambitious scenario foresees residents spending "only" 277 fewer working days than in BAU, by 2032 in the ambitious scenario the residents are saving more than half the days they would have to spend under BAU (Figure 10). In aggregate, over the ten years, the residents save 5917 working days in the ambitious scenario compared to BAU (Figure 11). In monetary terms,

over the ten years, these aggregate savings are worth BGN ~273,400 in the baseline and BGN ~602,700 in the ambitious scenario at estimated 2023 wage rates[34] (Figure 12).[35]

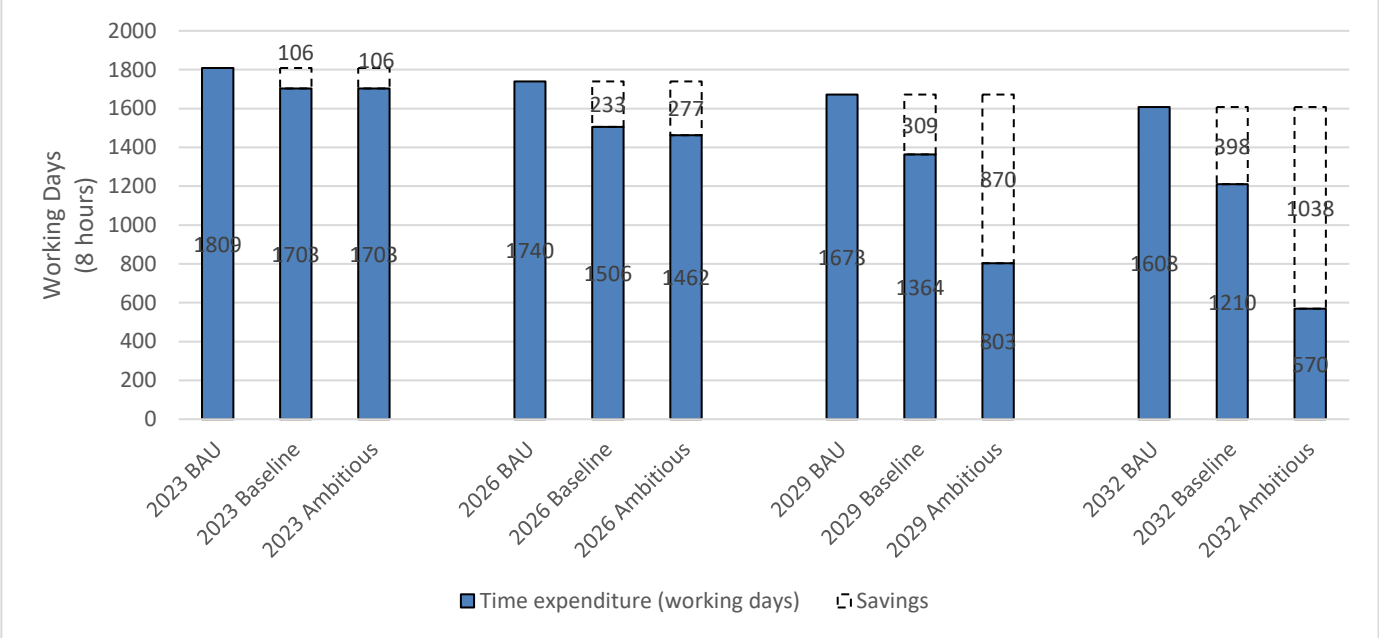

Figure 10: Residents' projected annual time expenditure and savings for selected years under different adoption scenarios (Peshtera)

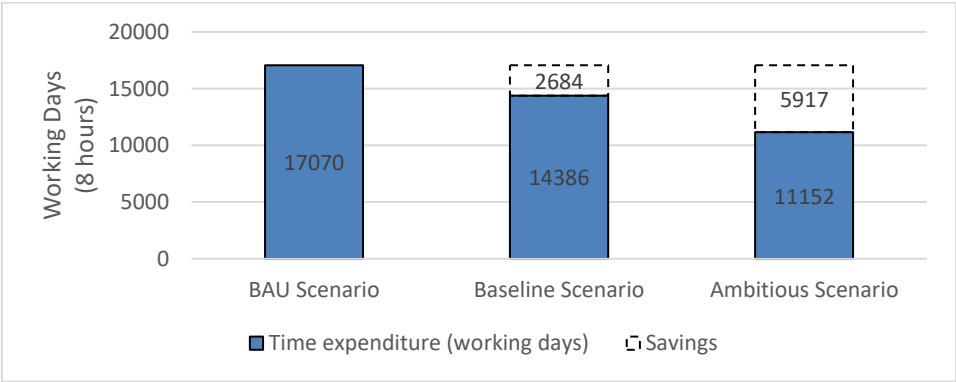

Figure 11: Residents' projected aggregate time expenditure and savings, under different adoption scenarios, 2023 – 2032 (Peshtera)

Turning to the possible savings for the civil service of Peshtera, we find the following results. Again, time and monetary expenditures fall gradually, with the biggest drops occurring only once high rates of adoption are achieved, i.e., relatively late in the time period examined here. Thus, in 2026, with an adoption rate of 19 percent in the baseline scenario and 22 percent in the ambitious scenario, Peshtera municipality saves only 12 working days a year in the baseline scenario and 15 in the ambitious. In 2029, with 25 and 65 percent adoption in the two scenarios, annual savings relative to BAU rise to 16 and 46 working days (Figure 13). In monetary terms, this amounts to annual savings of BGN ~1000 to BGN 3810 (baseline scenario) and BGN ~1000 to BGN ~10,000, estimated at 2023 civil service labour costs (Figure 14). Over the entire ten years, Peshtera municipality would save 143 working days in the baseline and 315 working days in the ambitious scenario;

[34] Average monthly salaries for 2023 were not yet available at the time of writing. To estimate average 2023 wages, we therefore adjusted the average 2022 salary with the data on wage growth in Q1 and Q2 2023 published by the National Statistical Institute of Bulgaria (2023b).

[35] It should be noted that calculating the implicit monetary value for residents of time savings over 10 years is a rather theoretical exercise. How meaningful, to a resident, is the information that over 10 years, she might save, say, 18 hours, with an implicit value of BGN ~200?

equivalent to BGN 25,704 and BGN 56,667 respectively (€13,142 and €28,974)[36] (Figures 15 and 16). It should be noted that these savings are quite modest. In percentage terms, they represent only ~6.5 percent of the entire time and monetary expenditure expected over this time period for processing certifications.

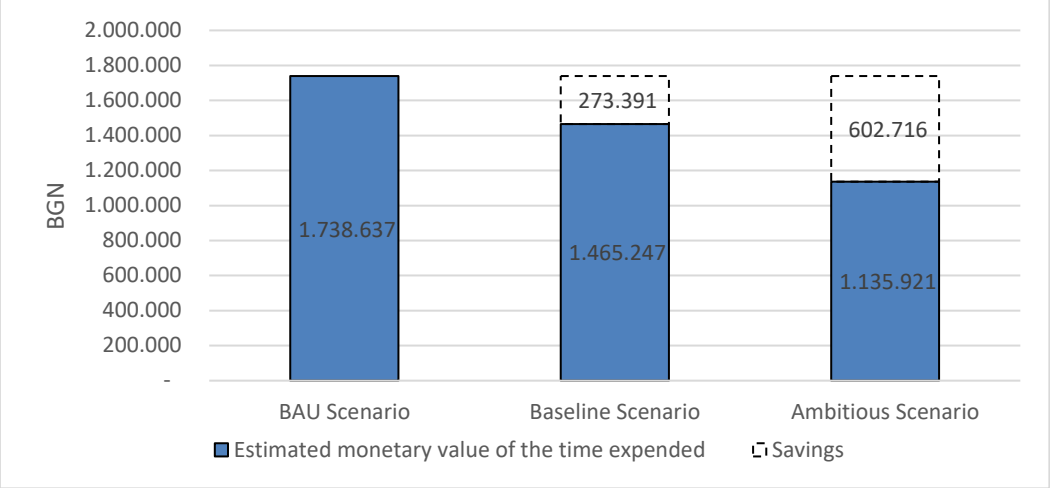

Figure 12: Projected aggregated monetary value and savings of residents' time expenditure under different adoption scenarios, 2023–2032 (Peshtera)

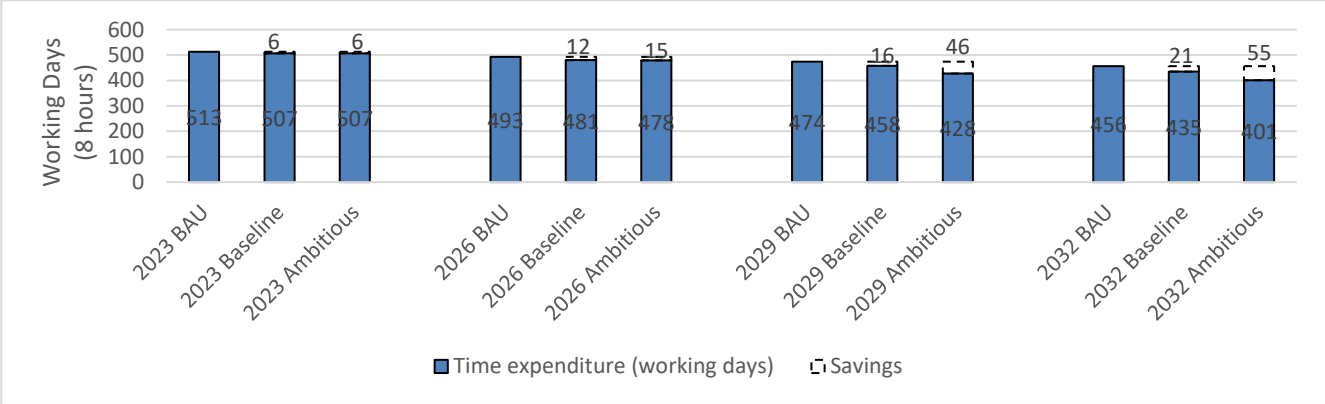

Figure 13: Projected annual time expenditure and savings of the Municipality of Peshtera for selected years under different adoption scenarios

[36] These figures are somewhat smaller than the hypothetical savings with IMPULSE in the years 2019–2022 that we calculated above. The reason for this is that (1) for heuristic purposes, the hypothetical savings 2019–2022 were calculated for 100 percent adoption of IMPULSE, (2) the population of Peshtera and thus the volume of certificates issued in the years 2019–2022 was somewhat greater than the population size and certificate volumes we projected for 2023–2032.

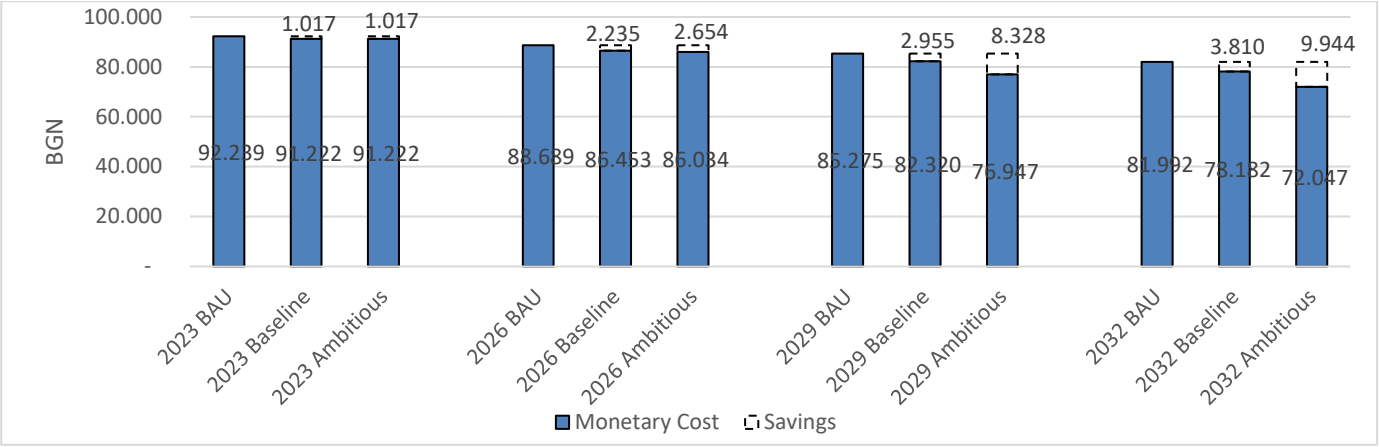

Figure 14: Projected annual monetary costs and savings of the Municipality of Peshtera for selected years under different adoption scenarios

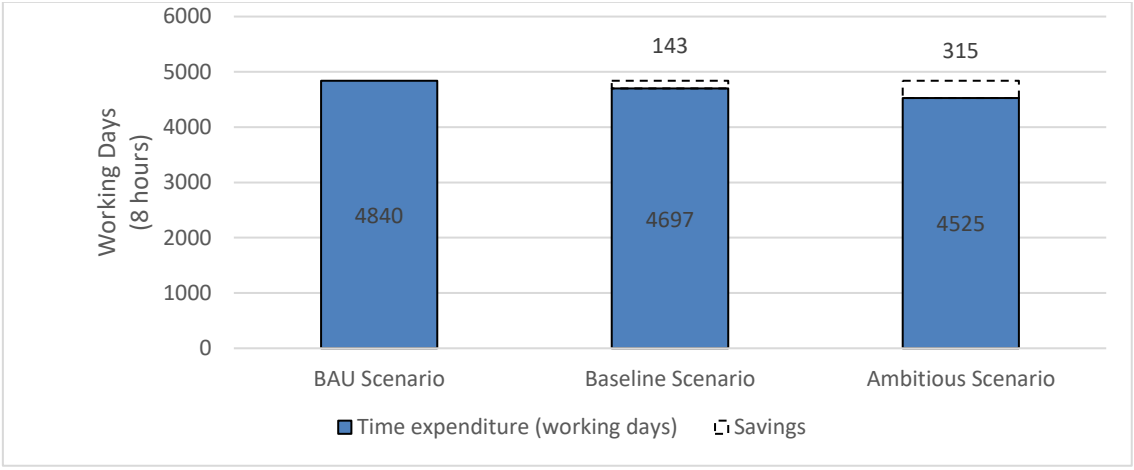

Figure 15: Projected aggregate time expenditure and savings of the Municipality of Peshtera under different adoption scenarios, 2023 – 2032

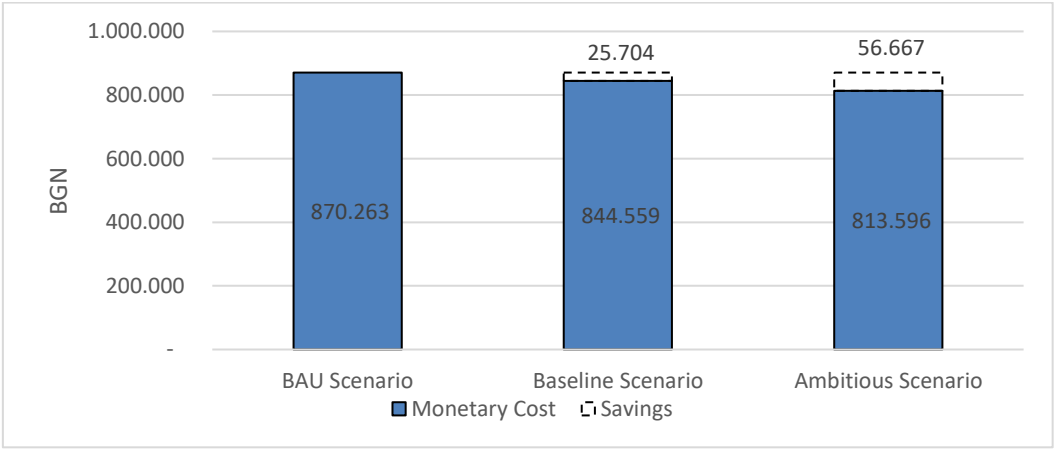

Figure 16: Projected aggregate monetary costs and savings of the Municipality of Peshtera under different adoption scenarios, 2023 – 2032

4.2.1.5 Possible national-level savings

The economic impacts estimated above for Peshtera are relatively small, in particular for the civil service. But what if IMPULSE was rolled out across all of Bulgaria? After all, the digital platform through which the certificates are submitted and provided, is available to all Bulgarian municipalities. To estimate possible savings, we apply the same calculations as above; viz. we estimate Bulgarian population development by

projecting forward to 2032 the linear trend in the population data from 2000 – 2022. To calculate the number of certificates issued or submitted, we use the annual certificates per person-factor we had calculated for Peshtera. We also assume that the amount of time it takes to obtain, submit and process certificates is *on average* the same countrywide as in Peshtera.[37] We use the same scenarios for adoption as described above, with one adjustment: we assume a steady state of 8 percent adoption in the business as usual (BAU) scenario, as opposed to the 3 percent adoption in BAU we had assumed for the Peshtera estimations. This upward revision of the estimate is made to account for the greater expected levels of adoption, even in BAU, in major urban centres like Sofia.

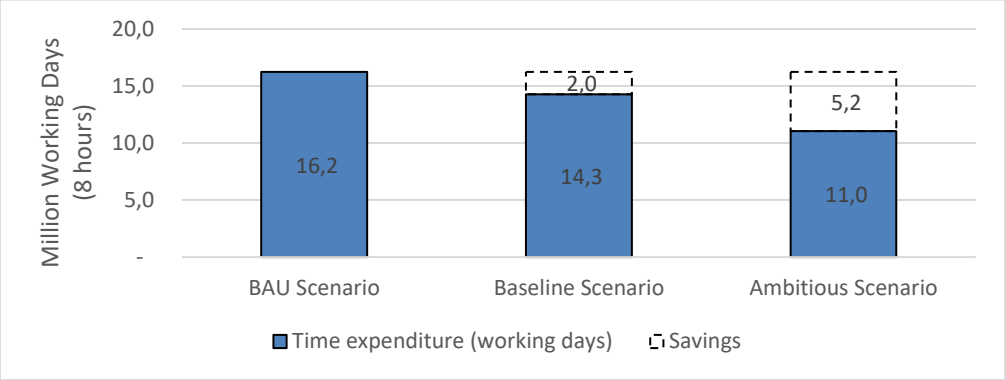

Figure 17: Projected aggregate time expenditures and savings of the Bulgarian population under different adoption scenarios, 2023–2032

Figure 17 shows the estimated aggregate national-level time savings to Bulgarian citizens and resident foreigners (Bulgarian population) over 10 years, given the projections and assumptions about time requirements and certificate volumes. These are fairly substantial in aggregate, amounting to 2 million working days in the baseline scenario and 5,2 million in the ambitious scenario.

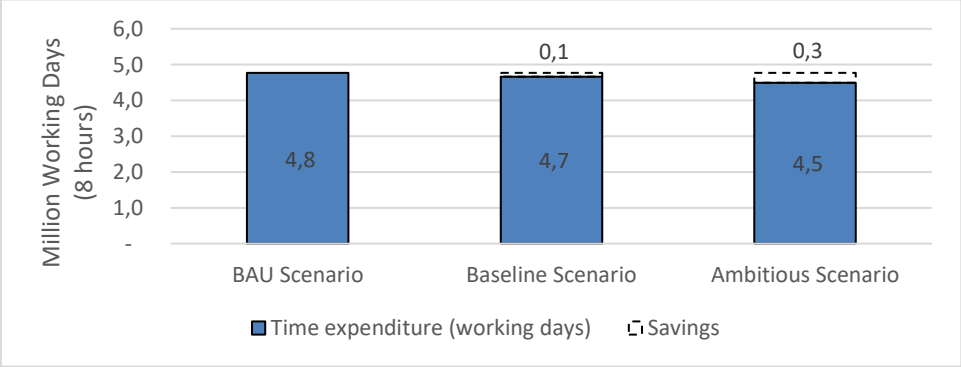

Figure 18: Projected aggregate time expenditures and savings for Bulgaria's local public administrations under different adoption scenarios, 2023–2032

Figures 18 and 19 show the projected savings for Bulgarian local government civil services over this same period. These are somewhat smaller. In the baseline scenario, the local public administrations would save about 100,000 working days over the ten year period; in the ambitious scenario, about 300,000. Arithmetically, this would correspond to 10,000 to 30,000 working days a year, but it is important to remember that most of these savings only begin to amount towards the *end* of the period. In monetary terms, these savings are worth about BGN 19 to BGN 50 million *over the entire period*, or BGN ~1,9 to BGN ~5 million *a year* (~€1 million to ~€2,6 million annually). It should be noted that these savings are equivalent to just ~1 percent of the total time and monetary cost for the civil service created from processing and issuing certificates in the baseline scenario,

[37] These arguably are somewhat strong assumptions. However, it is hard to know by what factor to adjust these numbers to obtain better estimates. Moreover, the objective of this exercise is to get rough order-of-magnitude estimates for possible savings. For this, these assumptoins should be acceptable.

and ~6 percent in the ambitious scenario. Nice to have for sure, but most likely not game-changing. Again, most of these savings would only manifest towards the end of the period.

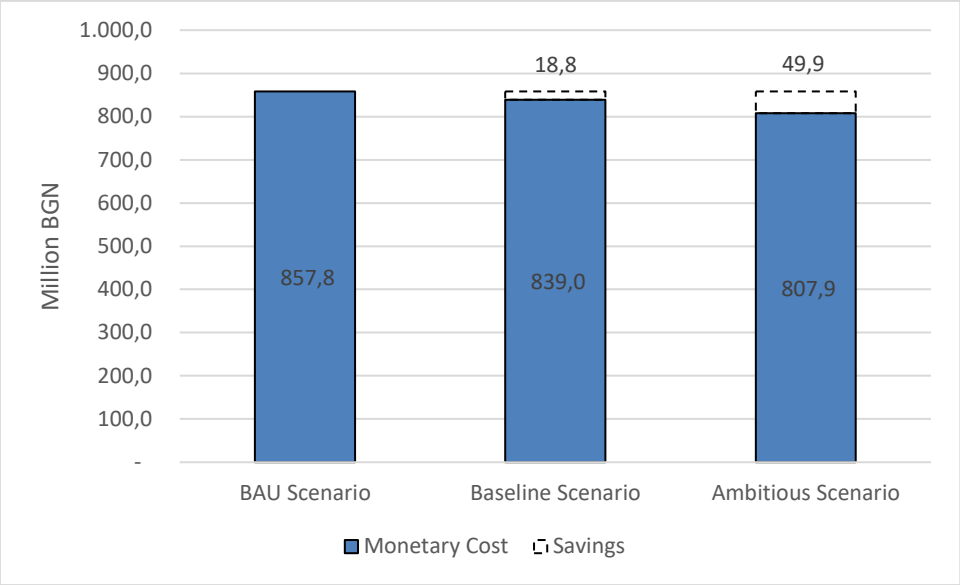

Figure 19: Projected aggregate monetary costs and savings for Bulgaria's local public administrations under different adoption scenarios, 2023–2032

4.2.2 Aarhus Case, Denmark

4.2.2.1 Description of the Pilot Use Case[38]

The Aarhus Pilot involves deploying the IMPULSE eID and facial recognition technology on lockers for the residents of homeless shelters in Aarhus. The lockers are to provide the shelter residents with a safe place to store small valuables and documents, in particular their NemID cards. NemID is the main identity scheme used in Denmark. Without it, it is difficult to apply for social services or take part in most fields of social, economic and political life. For homeless people, however, keeping their NemID safe can be challenging. According to the Aarhus municipal staff involved in the Pilot, the cards are frequently lost. This has two unfortunate consequences: shelter residents go without services they would otherwise be entitled to, and/or social services staff (as well as others, e.g. parish clerks, see below) become burdened with additional work, as the shelter residents often turn to them to help them apply for a new NemID card. This usually occurs at the monthly "social services clinic", which Aarhus social services staff run at the homeless shelters. It is hoped that by providing shelter residents with the lockers, the number of lost NemID cards can be significantly reduced. The lockers will also relieve shelter of the burden of being asked by shelter residents whether they could store their NemID cards on their behalf, something that may be a challenge for the staff to refuse, but is technically illegal.

4.2.2.2 Economic impact estimate

The main direct *economic* impact expected in the pilot is efficiency savings (labour time and cost) for the individuals involved in helping shelter residents to reapply for NemID cards. According to Aarhus staff, reapplying for a NemID card generally involves the following steps, described in Table 6. The labour and material costs are presented in Table 7.[39]

Step	Description of Step	Time required

[38] The following description is based on our interview and follow-up discussions with Aarhus municipal staff.

[39] Perhaps controversially, we do not estimate the monetary value of the shelter residents' time. Because the residents are generally unemployed and living on the margin of society, it is difficult to come up with a useful proxy. For example, since they are not participating in the labour force – and likely do not have the option of doing so, at least in the short term – hourly wages are not a meaningful proxy. At the same time, we do not wish to imply that these individuals' time is "worthless". Hence we also do *not* estimate its value as zero, but simply do not estimate it.

		Shelter Resident	*Parish Clerk*	*Social Service Staff*	*NETS Staff*	*Shelter Staff*
1	Shelter resident goes to parish church to obtain his/her birth certificate. Travel is by foot; travel time ~10 Min. each way.	60 Min.	40 Min.			
2	Attend one of the monthly social services clinics run by Aarhus municipality social service at the shelter, who help the resident reapply for a NemID card. ~30 Min. waiting time assumed	60 Min.		30 Min.		
3	Nets DanID Company issues new NemID card, which is posted to shelter				15 Min.[40]	
4	Resident receives post with new NemID card	1 Min.				2 Min.
Total time required		*121 Min.*	*40 Min.*	*30 Min.*	*15 Min.*	*2 Min.*

Table 6: Steps required to obtain a new NemID card for shelter residents

Item		Cost (DKK)
Shelter resident	*monetary value of time*	-- (see Fn. 39)
Parish clerk	*imputed hourly labour cost*[41]	248,67[42]
Social services staff	*imputed hourly labour cost*	228,97[43]
NETS DanID staff	*imputed hourly labour cost*	193,95[44]
Shelter staff	*imputed hourly labour cost*	230,40[45]
Material cost of card		4,1[46]
Postage (registered letter)		96[47]

Table 7: Labour, material and postage costs

The total cost of reissuing a NemID card to one of the shelter residents would thus equal to:

$$Cost_{Card} = W_{Clerk} * T_{Clerk} + W_{Service\_Staff} * T_{Service\_Staff} + W_{Nets\_Staff} * T_{Nets\_Staff} + W_{Shelter\_Staff} * T_{Shelter\_Staff} + M + P$$

[40] This number is our best guess, based on consultations of the literature and expert conversations. Efforts to contact Nets DanID A/S proved unfortunately unsuccessful.

[41] All hourly labor costs were calculated by multiplying the monthly wage data referenced in the following footnotes with a factor derived from wage and labour cost data of Statistics Denmark (Statbank Denmark), the Danish National Statistics Agency, and then working out the hourly cost on the assumption of 22 working days a month and a 7,4 hour day (37 hour week).
The labour cost factor was calculated as follows. Statistics Denmark reports total average hourly labour costs and earnings for 2021 for non-managerial employees in 6 sectors; viz. Information and Communication, Financial and Insurance, Real Estate, Other Business Services, Education and Health, and Arts, Entertainment and Other Services, but unfortunately not for public-sector employees. Moreover, it is not completely clear whether for instance the NETS DanID staff worker should be seen as falling into the Information and Communication sector (since NETS is an ICT company), or rather Other Business Services, since the job in question is primarily a clerical one without direct relations to IC technology. As labour costs as a percentage of earnings range between 103 and 117 percent, we used the average across the six sectors (108 percent) as adjustment factor. For the data, see Statistics Denmark (2021).

[42] For wage data, see https://www.ug.dk/job/job-fordelt-paa-erhvervsomraader/paedagogiskkirkeligtogsocialtarbejde/kirkearb/kordegn-job

[43] For wage data, see https://www.ug.dk/job/job-fordelt-paa-erhvervsomraader/kontorregnskabfinans/kontorsekretaerarb/assistent-i-det-offentlige

[44] For wage data, see https://www.ug.dk/job/job-fordelt-paa-erhvervsomraader/kontorregnskabfinans/kontorsekretaerarb/kontormedarbejder-job, “Office Clerk in private sector”. Note that the salary listed at ug.dk corresponded quite well to two salaries given for “customer representative” at Nets DanID on Glassdoor.com

[45] For wage data, see https://www.ug.dk/job/job-fordelt-paa-erhvervsomraader/paedagogiskkirkeligtogsocialtarbejde/socraadgivning/socialraadgiver-job

[46] Taken from OECD Cost of Doing Business data (https://archive.doingbusiness.org/en/data/exploreeconomies/denmark)

[47] https://www.postnord.dk/en/tools/postage-calculator

*w*here W is the hourly labour cost, T the time required per card reissuance and M and P the material and postage costs respectively. Adding in the numbers from Tables 6 and 7, the cost per card is thus 412.16 DKK.

The total homeless population in Aarhus numbered 507 individuals as of 2022.[48] The shelter staff estimate that about 30 to 50 percent of the shelter residents they come into contact with, no longer possess a NemID card. Thus, we may estimate that between ~151 and ~254 of the homeless in Aarhus have no NemID. Of course, not all these people are trying to get NemID cards reissued. On the contrary, the social services' staff who run the clinics estimate that each month, between 1 and 4 individuals come to them for help with card reissuance, so about ~12 to ~48 individuals a year. This would imply a total cost of between ~5238 DKK and ~20,954 DKK in 2022.[49] Of that, between ~2667 DKK and ~10,669 DKK are costs directly borne by the municipality[50] (cf. Table 8).

Homelessness in Aarhus has fallen considerably in recent years. In 2017, there were still 767 homeless in Aarhus; on average, between 2015 and 2022, there were about 673 homeless.[51] Applying the same ratios of cardless-to-homeless population and homeless-to-card reissuance as observed in 2022, that would translate to ~202 to ~337 homeless without NemID cards, and between ~16 and ~64 cards reissued to homeless people via the help of the social services staff in the monthly clinics every year.[52] This implies average total costs of between ~6954 DKK and ~27,814 DKK each year in 2015–2022, of which between ~3,540 and ~14,162 DDK would have been borne directly by the municipality (Table 8).

	2022 *lower bound*	**2022** *upper bound*	**2015–22 Average** *lower bound*	**2015–22 Average** *upper bound*
Cards reissued per year	12	48	16	64
Total cost of card reissuance	5238 DKK	20,954 DKK	6954 DKK	27,814 DKK
Direct cost to the municipality	2667 DKK	10,669 DKK	3540 DKK	14,162 DKK

Table 8: Annual number and costs of NemID card reissuance in Aarhus

How great might savings realistically be? It is hard to imagine that even with lockers, no NemID card would be lost anymore. We model three scenarios, with losses falling by 30, 50 and 80 percent, and compare these to the status quo (business as usual, BAU, scenario). Because the development of the homeless population is hard to foresee and liable to be driven in part by unpredictable external shocks, like refugee crises, we use the average annual number of homeless people in the period 2015 – 2022 (673 individuals), rather than either projecting the (lower) 2022 figure forward or calculating a linear trend and assuming this continues. To simplify the data presentation, instead of working with a ranged number of reissued card each year (e.g. 16 to 64), we assume that on average, 40 cards are reissued (status quo baseline).[53] Figures 20-22 present the results:

[48] https://www.aarhus.dk/nyt/sociale-forhold-og-beskaeftigelse/msb-2022/september-2022/investeringer-i-bolig-stoette-og-faellesskaber-hjaelper-unge-ud-af-hjemloeshed/

[49] The formula is $Cost_{Card}*12$ for the lower bound, and $Cost_{Card}*48$ for the higher bound.

[50] We assume that the salaries for social services' and shelter staff as well as postage and material costs are borne directly by the municipality.

[51] https://www.vive.dk/da/udgivelser/hjemloeshed-i-danmark-2022-18153/

[52] We arrive at these figures through the following calculations:
(1) we know that in 2022 Aarhus had 507 homeless, and between 1 and 4 cards were reissued each month (12-48 over the entire year).
(2) We calculate the ratios of annual card-reissuance-to-homeless for each of these two bounds; 12/507=0,024 (lower bound) and 48/507=0,095 (upper bound)
(3) We multiply these ratios with the average number of homeless in the years 2015-22 (673), to get the lower and the upper bounds of the number of cards reissued annually, on average (16 and 64)

[53] We arrive at this number as follows:
(1) We know that in 2022, between 1 and 4 cards were reissued each month
(2) We assumed an equal distribution of the four reissue values (1, 2, 3, 4) across the twelve months of the year. I.e., for three months, 1 card was reissued each months; for the next three months, 2 cards were reissued each month, etc.
(3) 3*1 + 3*2 + 3*3 + 3*4 = 30 cards reissued across all of 2022.
(4) Following the procedure described in Fn. 41, we now calculate the cards-reissued-to-homeless population

Compared to BAU, and depending on scenario, this produces total annual savings between 5238 DKK (30 percent reduction in card reissuance) and 13,969 DKK (80 percent reduction) would be saved. Direct municipal savings range from 2667 DKK to 7112 DKK.

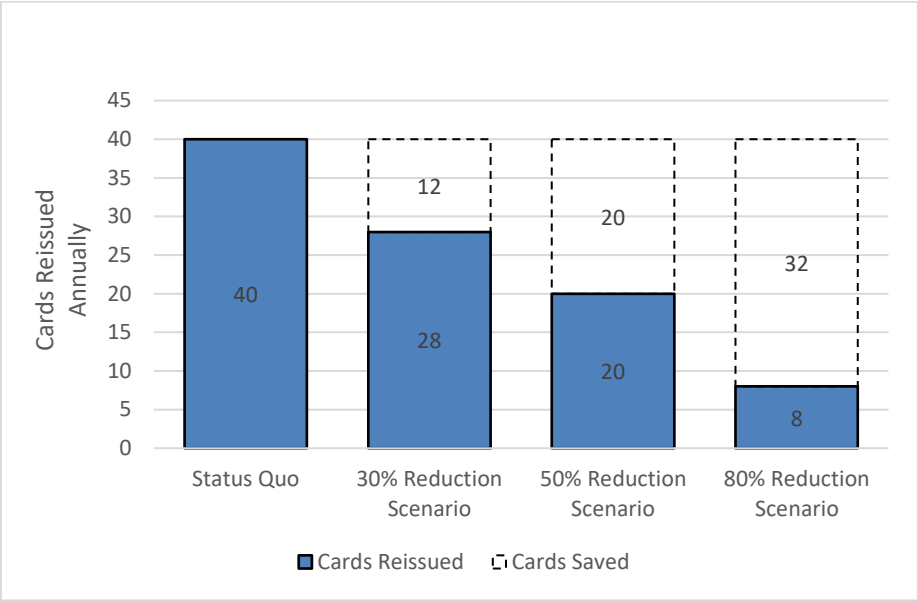

Figure 20: Number of cards reissued/saved each year under different scenarios (Aarhus)

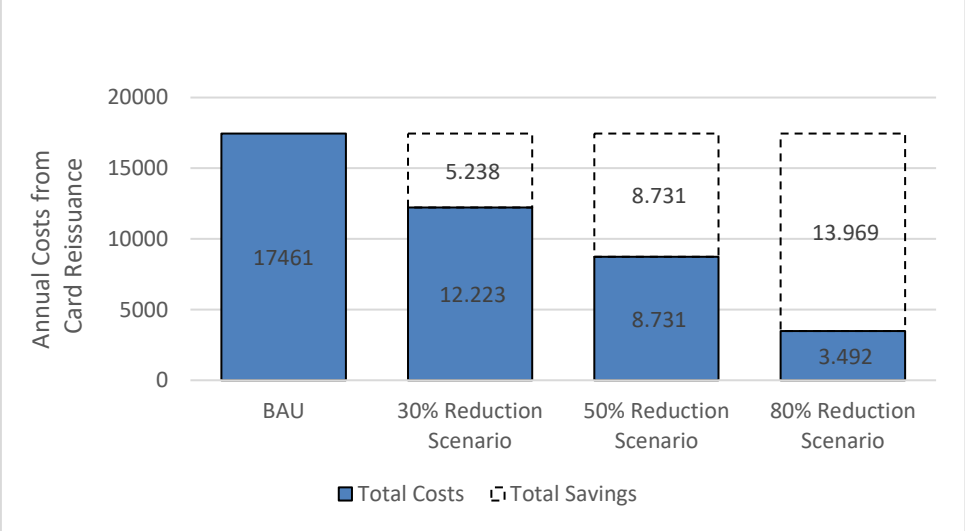

Figure 21: Annual total costs and savings under different scenarios (Aarhus)

(30/507=0,59) for 2022, and then multiply this ratio with the 2015-22 average homeless population (673), to arrive at 40 cards reissued on average each year in that period (673*0,59 = ~40).

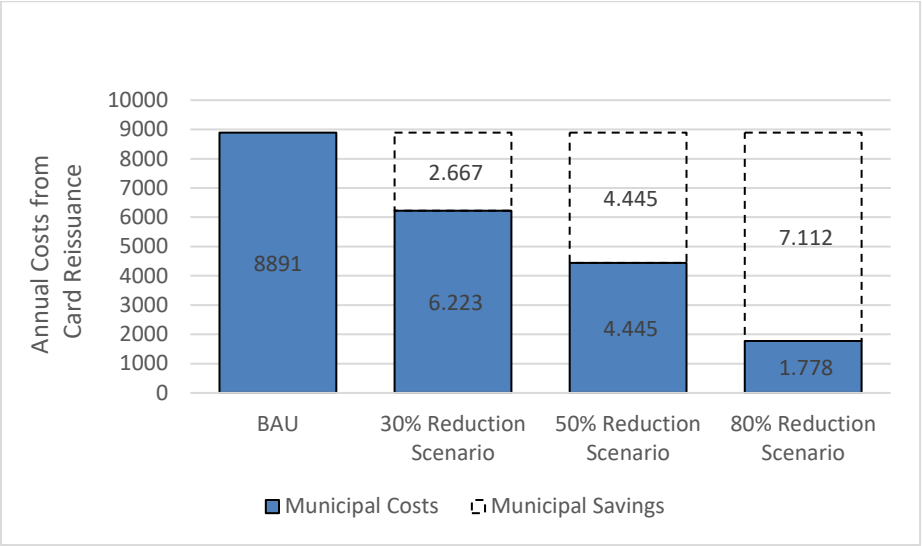

Figure 22: Annual municipal costs and savings under different scenarios (Aarhus)

The bottom line is that direct economic savings from the installation of the lockers are quite limited. Indeed, the (gross) savings calculated above also need to be put against the cost of the lockers. According to Aarhus social services staff, about 5 to 6 lockers would be needed to provide all Aarhus shelter residents with a personal locker drawer. Little data is available on the cost of purchasing, installing and maintaining the lockers, but from the above savings we can calculate what the maximum permissible locker cost would be, if the municipality is to at least break even. We assume a life span of 10 years for the locker. According to our scenarios, over ten years, direct municipal savings could range between 26,672 and 71,125 DKK (~3,581–9,548 EUR). An examination of lockers on offer at Amazon.com suggests that basic multi-drawer metal lockers are likely to cost at least ~200€ a piece (~1500 DKK). 6 Lockers would thus run to ~9000 DKK initial purchase cost. Assuming installation and maintenance are performed by a local-government janitor, that installation time per locker is one hour and it receives 1 hour of maintenance per year, maintenance and installation costs would equal to ~11,100 DKK over ten years.[54] Purchase, installation and maintenance costs would thus equal ~20,100 DKK over ten years, or between ~28 percent and ~75 percent of the total municipal savings expected over ten years, depending on scenario.

It should be stressed that this does *not* yet include the costs for software service and maintenance, which are likely to be non-trivial. In summary, net savings are likely to be small at best. It should be noted that the costs for initial software development and integration – which are substantial, at ~150,000 DKK according to Aarhus staff – are *not* included in these estimates, as they are largely financed through the IMPULSE project. Were they included, savings would almost certainly turn negative. As the cost/savings calculations made above largely focus on *variable* costs per locker, it is unlikely that the basic picture would change much, were the locker system for instance to be installed also in other Danish cities with substantial homeless populations (e.g. Copenhagen). While gross saving would of course rise, (variable) costs would too, thus leaving the net savings picture largely unchanged.

A further benefit expected from the introduction of IMPULSE-enabled lockers and the (hoped-for) reduction in lost NemID cards, are time savings for the social services staff (as well as parish clerks), who currently need to devote part of their working time to helping shelter residents reapply for new cards. Time savings for these workers might constitute a net benefit for the municipality, even without overall monetary savings. For

[54] We assume an average hourly labour cost of a janitor of DKK 181,12, in line with wage data reported at https://www.ug.dk/job/job-fordelt-paa-erhvervsomraader/rengoeringejdservicerenovation/ejdservicearb/ejendomsfunktionaer-job and the wage-to-labour cost adjustment calculation described in Footnote 41.

example, they might now be able to perform valuable work and thus raise the quality of social services overall. How large might these time savings be?

As noted above, social services staff spend about 30 minutes per lost and reissued NemID card, while parish clerks spend about 40 minutes. Our scenarios project that between 12 and 32 fewer cards would be lost and reissued annually if the IMPULSE lockers are introduced. Figure 23 shows the expected time savings for both. As can be seen, these two are fairly small. Social services' staff would save between 6 and 16 hours annually, while parish clerks would save around 8 to 21 hours – or roughly 1 to 3 working days a year.

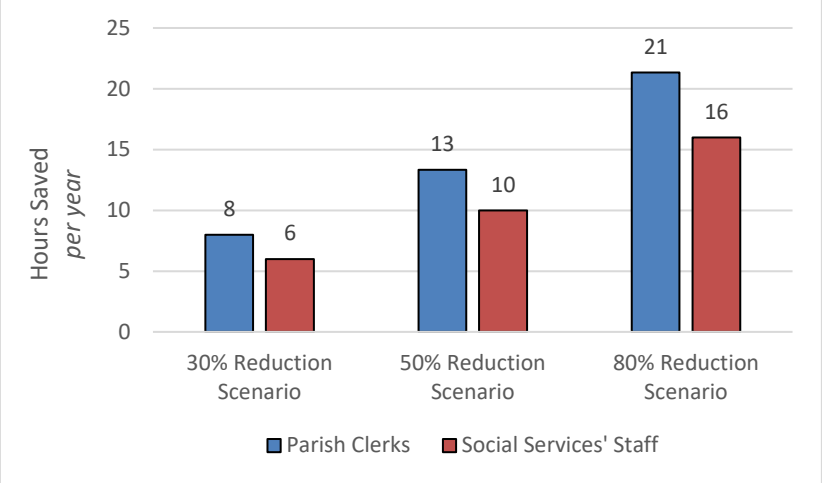

Figure 23: Time savings under different scenarios (Aarhus)

Not shown in Figure 23 are the time savings for the shelter residents. Getting a card reissued takes about 2 hours of a resident's time. The total time savings for the residents as a group would thus range between 24 and 64 hours a year.

While this analysis thus finds no strong *economic* case for installing the IMPULSE-enabled lockers in Aarhus, this does *not* mean that they should not be installed. On the contrary, provision of the lockers may have a number of important of social benefits. These include facilitating the re-integration of shelter residents into regular social and economic life by reducing the number of "cardless" individuals, and reducing moral pressure on shelter staff to engage in what is an illegal activity (storing NemID cards for residents). It would also offer social services' staff and parish clerks a modest time saving.

4.2.2.3 Possible National-Level Savings

Aarhus is, of course, not the only municipality in Denmark with homeless people who are housed in shelters. The Aarhus use case could thus in principle be extended across Denmark. But what would this imply for the economic estimates?

In the time period 2015 to 2022, there were on average 6248 people homeless in Denmark in any given year, of which about 60 percent resided in the four municipalities of Copenhagen, Aarhus, Odense and Aalborg (Benjaminsen 2022). On the basis of the Aarhus data, this would imply that about 370 NemID cards were reissued to the homeless people each year. Plugging this number into our cost model yields the following results. In total, between DKK 48,455 and DKK 129,213 could be saved per year, depending on scenario (€~65,000 to €~173,500) (Figure 24). For the municipalities, savings would be smaller, ranging between DKK 24,671 and DKK 65,790 (€~33,100 and €~88,300). Over ten years, this would add up to savings between DKK~246,000 and DKK~658,000, or €331,000 and €883,000, for the municipalities.

Of course, the cost structure discussed above would likely remain similar. More than half the costs are accounted for by on-site labour and services (installation, maintenance). These are unlikely to be subject to scale economies. What could be subject to scale economies is the cost of the lockers themselves. However, even we assume that scale purchases lead to a generous 33 percent price reduction, costs just for purchase,

installation and maintenance of the lockers would still come to between 24 percent and 64 percent of the anticipated municipal savings (depending on the extent to which the system really does lead to reduced volume of NemID card losses and reissuances). Costs for software service and maintenance would be on top, further eating into savings.

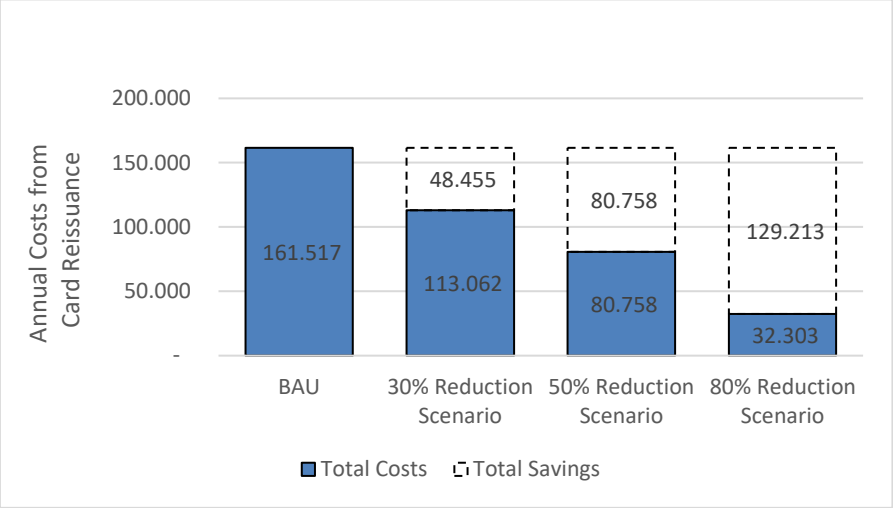

Figure 24: Annual total costs and savings under different scenarios (national)

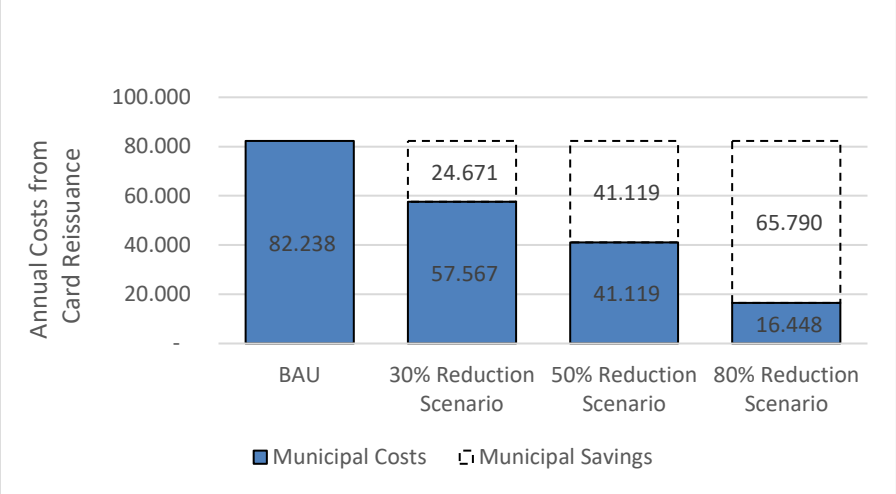

Figure 25: Annual municipal costs and savings under different scenarios (national)

4.2.3 Ertzaintza Case, Spain

4.2.3.1 Description of the Pilot Use Case[55]

The Ertzaintza pilot use case involves the further development of an existing system for the digital submission of criminal complaints in the Basque region. Traditionally, people who want to file a criminal complaint had to do so in person (F2F) at a police station. For some years now, Ertzaintza, the Basque law enforcement (police) agency, has allowed people to submit complaints about minor crimes[56] through an online form. However, they still need to go the police station afterwards, to sign the complaint in person, within 72 hour. Otherwise, the complaint is considered invalid and discarded.

[55] The following description is based on our interview and follow-up discussions with Ertzaintza staff.
[56] Such as petty thefts, vandalism and administrative infringements.

The intention in the IMPULSE Pilot is to enable people to lodge complaints entirely online (i.e., without having to appear at the police station to sign the complaint in person afterwards). Discussions with Ertzaintza staff revealed three main expected benefits from this:

- Time and cost savings for the Ertzaintza police officers
- Time and cost savings for the residents lodging complaints
- Making it easier for residents to file complaints, thus reducing the number of unreported crimes

In 2022 it became possible to submit complaints entirely online, using the regional state electronic identity system, BAK and BAKQ. The process for doing so is identical to IMPULSE, and IMPULSE and BAK/BAKQ offer identical savings. The difference between BAK/BAKQ and IMPULSE is that BAK/BAKQ is a username and password-based system, while IMPULSE works with facial recognition (see ch. 2.1 above).[57]

4.2.3.2 Economic Estimate

Table 9 lists the process and time required for filing a complaint via the F2F, existing digital and IMPULSE paths.[58] Based on our conversations with Ertzaintza, we assume that officers of different ranks are involved.

Step	Description of Step	Time Required – *F2F Path* –			Time Required – *Existing Digital Path* –			Time Required – *IMPULSE Path* –		
		Resident	*Junior Officer*	*Senior Officer*	*Resident*	*Junior Officer*	*Senior Officer*	*Resident*	*Junior Officer*	*Senior Officer*
		All times in Minutes								
1	Travel to police station	15 – 30			15 – 30					
2	Waiting time at police station	15 – 20			15 – 20					
3	Resident prepares statement / is interviewed by officer (F2F)	25 – 40	25 – 40		20 – 40	0 – 40		20 – 40		
4	Processing statement with residents (printing, identity verification, signature etc.)	10	10		10	10				
5	Return travel from police station	15 – 30			15 – 30					
6	Further processing of the complaint		15			15			15	
7	Consultation with senior officer		5	5			5		5	5
8	Follow-up and clarification of complaints submitted exclusively online							x	x	
Total Time Required (in Minutes)		*80–130*	*55–70*	*5*	*65–130*	*25–65*	*5*	*20 – 40*	*20*	*5*

Table 9: Estimate of time required for filing criminal complaints through different paths

Filing a complaint via the F2F path takes residents between 80 and 130 minutes, and involves about 55 to 70 minutes work for a junior police officer and 5 minutes for a senior officer. Filing via the existing digital path takes residents 65–130 minutes, and the officers 25–65 minutes (junior) and 5 minutes (senior). With IMPULSE, it takes residents only 20–40 minutes, and junior and senior officers 20 and 5 minutes, respectively.

As can be seen, IMPULSE could offer quite substantial time savings, especially for residents. They could possibly save between 60 and 90 minutes per complaint filed compared to the F2F process, while the Ertzaintza could save between 35 and 50 minutes of a junior officer's time. There are no savings for the senior officer. Possible savings compared to the existing digital path are substantial too, though not quite so great (Table 10).

Time Savings	Savings compared to the F2F path	Savings compared to the existing digital path
Residents	60 – 90 Minutes	25 – 90 Minutes
Junior Officers	35 – 50 Minutes	5 – 40 Minutes
Senior Officers	--	--

[57] BAKQ further includes two-factor authentication, as an added security feature.
[58] The path with BAKQ is identical

Table 10: Estimated time savings from IMPULSE

What are the monetary savings? These are composed of (1) the monetary value of the time spent by residents and Ertzaintza to file and process complaints, and (2) travel costs for residents to and from the police station. We set the travel costs to €3 (€1,5 each way). This is based on current public transport costs.[59]

According to data from the National Statistical Institute of Spain, the average annual salary in 2021 was €25,896.82. To approximate 2022 salary levels, we apply assume a salary increase of 8.32%, in line with inflation (Statista 2023). This implies an average annual salary of €28,051.44.[60] On average, Spanish workers work about 1686 hours per year (University of Groningen and University of California Davis 2021)[61], implying an average hourly salary of €16.64 in 2022 and in €15.36 in 2021. Hourly labour costs in the Ertzaintza are about €21.84 for a junior officer and €24.06 for a more senior officer, such as an Inspector.[62]

Putting these data together with data on the time it takes residents, junior and senior officers to file a complaint as well as the travel costs, yields the following monetary costs and savings (Table 11):[63] The monetary cost to a resident of filing a complaint via the F2F path is between €25.19 and €39.05, with the existing digital path it is €21.03 to €39.05. For the Ertzaintza, the monetary costs work out at €20.02 to €25.48 for the junior officer in the F2F path, and €9.10 – €23.66 in the existing digital path. The cost for the senior officer is €2 in both paths. IMPULSE conversely creates costs of only €5.55 to €11.09 for the resident, and to the Ertzaintza of €5.46 (junior officer) and €2 (senior).

Again this implies considerable savings: about €19.5 to €28 for the resident and €14.5 to €20 for the Ertzaintza compared to the F2F path, and €15.5 to €28 for the resident and €3.5 to €18 for the Ertzaintza compared to the existing digital path. (For exact values see Table 11).

Monetary Savings	Savings compared to the F2F path	Savings compared to the existing digital path
Residents	€19.64 – €27.96	€15.48 – €27.96
Ertzaintza (junior officer)	€14.56 – €20.02	€3.64 – €18.20
Ertzaintza (senior officer	--	--

Table 11: Estimated monetary savings

[59] Tickets for the public *Bizkaia bizkaibus* system, which covers all of the Basque region, currently run to €1.35 – €3.35 a trip, depending on the number of zones travelled (Bizkaia bizkaibus n.d). On the basis of our discussions with Ertzaintza, we assume that residents on average travel two zones. Of course, residents may also walk or cycle to the police station for free, or take a car or even taxi which would be more expensive. An average cost of €3 for the round trip thus seems a reasonable approximation.

[60] €28,051.44 = €25,896.82 * 1,0832

[61] Data taken from the Penn World Table v. 10.01 (Feenstra et al. 2015). The Penn World Table is one of the most established statistical sources for data on cross-country (real) GDP and productivity measures, including hours worked.

[62] These were calculated as follows: Junior officers in the Ertzaintza earn about €23.600 excluding bonuses; a more senior officer such as an Inspector about €26.000 (Euskal Opodis 2023). Assuming 1686 working hours per year as per the Penn World Table (University of Groningen and University of California Davis 2021), this translates to an hourly salary of about €14 for a junior officer, and €15.42 for an Inspector. To arrive at hourly labour costs, we multiply the hourly salary by 1.56. This factor was calculated using data from the Spanish National Institute of Statistics (INE n.d.). INE reports labor market data at the regional level (i.e., for the Basque region, where Ertzaintza is). But unfortunately, INE only reports unit labor costs at the sectoral level (industry, services etc.). To obtain the needed factor, we therefore used the reported total hourly labor cost and the hourly salary cost for 2021 – 2023 for the service in the Basque region, dividing the labor cost by the salary cost. This yielded an average factor of 1.56.

[63] The math is in all cases straightforward: $MC_{resident} = (HSAL/60) * TS_{min/max}$, where *MC* is the monetary cost, *HSAL* the hourly salary and $T_{min/max}$ the minimum and maximum time required for each path. The formula for the monetary costs to the Ertzaintza MC_{Ertz} is identical, except that *HSAL* is replaced by *HLC*, the hourly labour cost.

As discussed above, at the individual level these monetary savings are unlikely to be noticeable, though the time savings may be somewhat more so, especially for residents. Interesting from an economic perspective are rather the potential aggregate savings, especially to the Ertzaintza.

According to data provided by Ertzaintza, in the five years from 2018 to 2022, residents submitted an average of 31,230.6 complaints annually. Of these, over 99% were submitted via the F2F path. The existing digital path was almost not used at all. The new BAK/BAKQ path however showed somewhat stronger adoption. (Table 12).

	2018	2019	2020	2021	2022	*Average*
All complaints submitted	27,313	38,695	22,774	30,051	37,320	*31,230.6*
Submitted F2F	27,234	38,574	22,687	30,004	36,801	*31,060*
Submitted through existing digital channel	79	121	87	47	49	*76.6*
Submitted via BAK/BAKQ					470	*n.a*

Table 12: Number of complaints submitted annually through different paths

This implies that from 2018 to 2022, the existing systems created the following annual costs in time and money for residents and the Ertzaintza: Total time expenditure of residents for filing complaints was between ~3800 and ~10.500 working days a year, with a working day defined as 8 hours. Conversely, had residents filed all their complaints in these years using IMPULSE, they would only have needed approximately 950 to 3225 working days. On average, they would have saved from 3890 to 5840 working days a year. Figures 26 and 27 present the data. Figure 26 graphs the minimum and maximum amounts of time that filing the complaints submitted each year through the existing paths should have taken residents, as well as the time it would have taken with IMPULSE (minimum / maximum estimates). Figure 27 graphs the annual minimum and maximum savings that residents theoretically would have enjoyed, had they used IMPULSE for *all* filings.

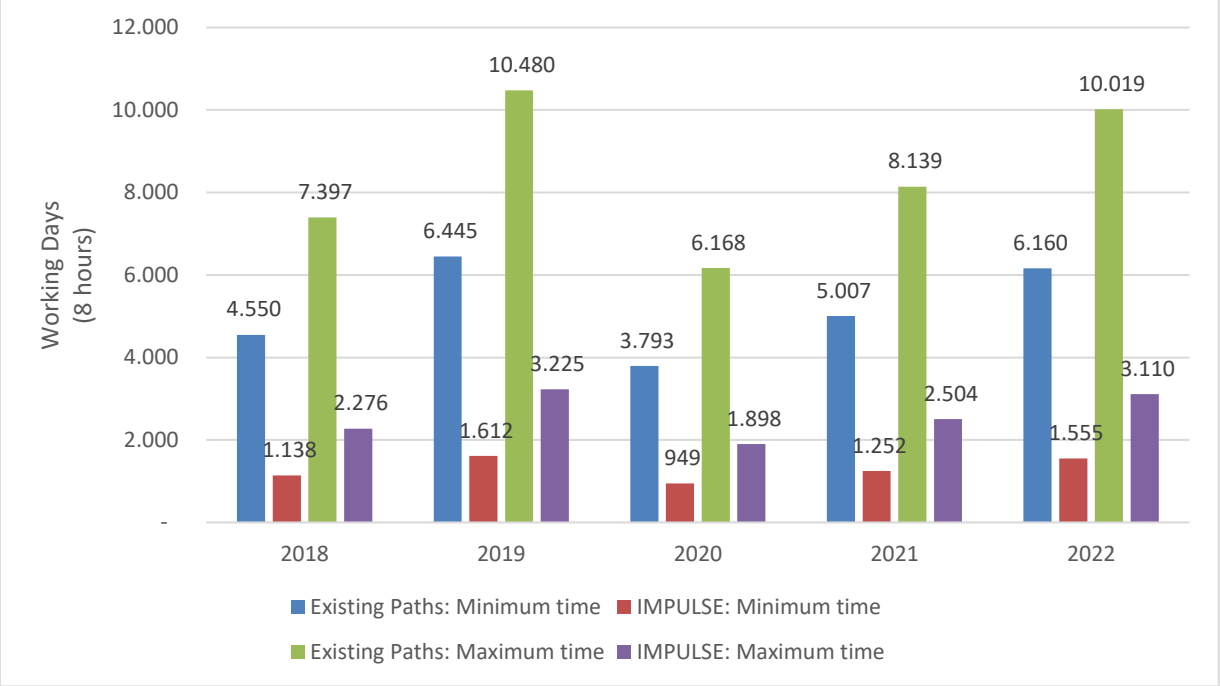

Figure 26: Time required of residents to file complaints under different paths, annually

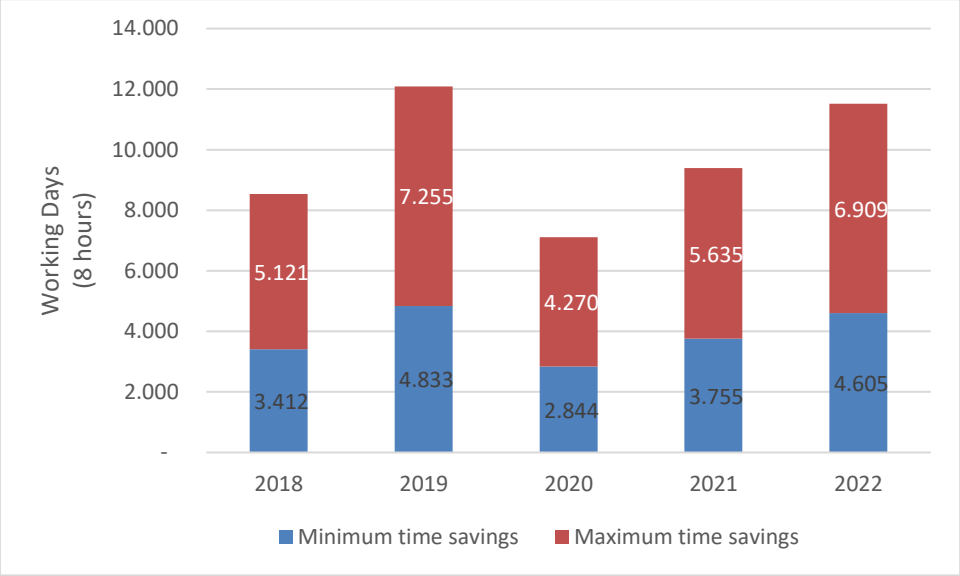

Figure 27: Residents' annual time savings with IMPULSE (theoretical)

For the Ertzaintza, the time savings would have been substantial too. With the existing paths, accepting and processing complaints filed by residents' cost the Ertzaintza approximately 2840 to 6045 working days a year, mostly of junior officers' time. If the residents had all used IMPULSE, this would have been reduced to between about 950 and 1612 working days (Figure 28). On average, the Ertzaintza would have saved between 2590 and 3567 working days a year (Figure 29)

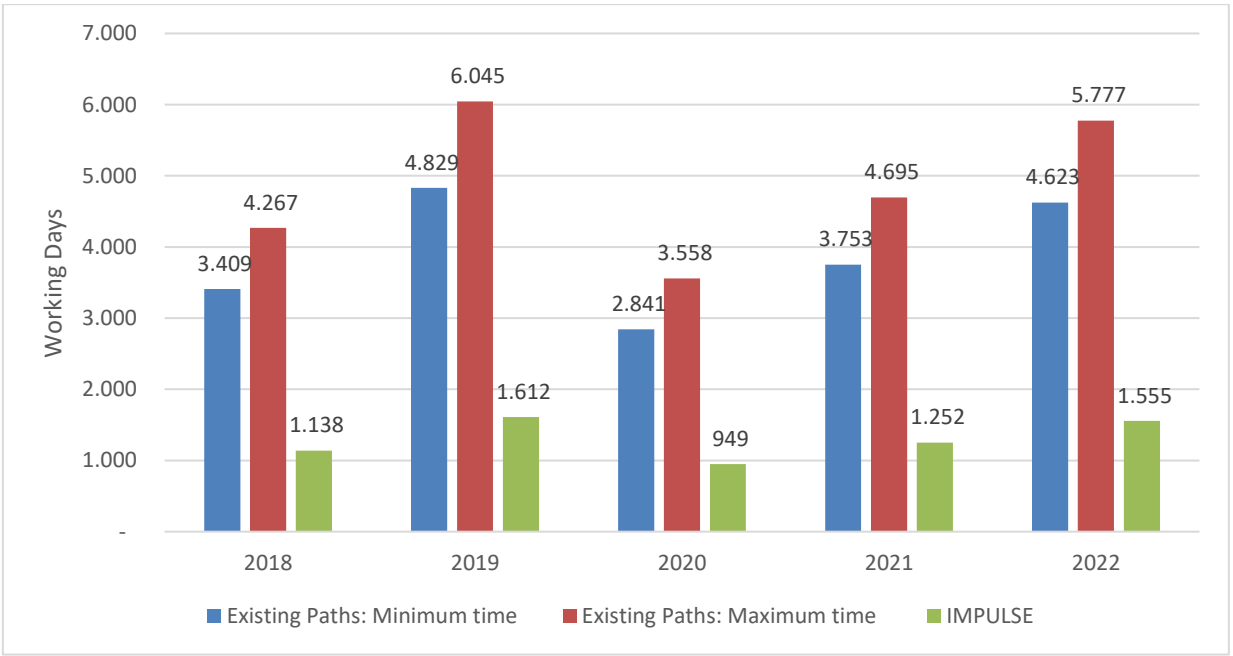

Figure 28: Time required of police officers with residents filing complaints under different paths, annually

What monetary expenditures and savings does this correspond to? Figures 30 to 34 provide answers. The monetary cost to the residents in time (implied monetary value) and travel costs for filing complaints between 2018 and 2022 under the existing pathways came to about €570,000 to €1.51 million annually. With IMPULSE, the implied monetary cost would only have been about €150,000 to €670,000, and travel costs of course zero (Figure 30). In other words, using IMPULSE would have afforded the residents (real and implied) savings of about €450,000 to €1.08 million (Figure 31).

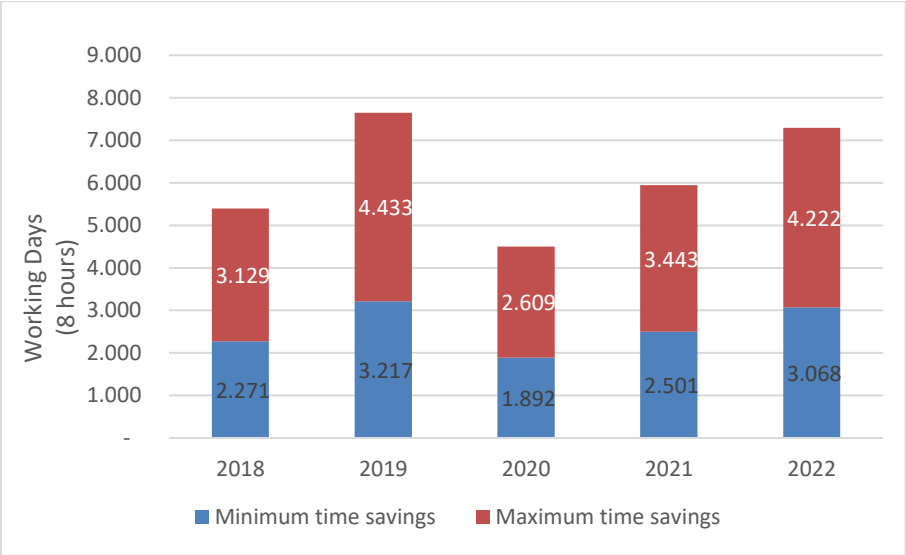

Figure 29: Annual time savings for the Ertzaintza with IMPULSE (theoretical)

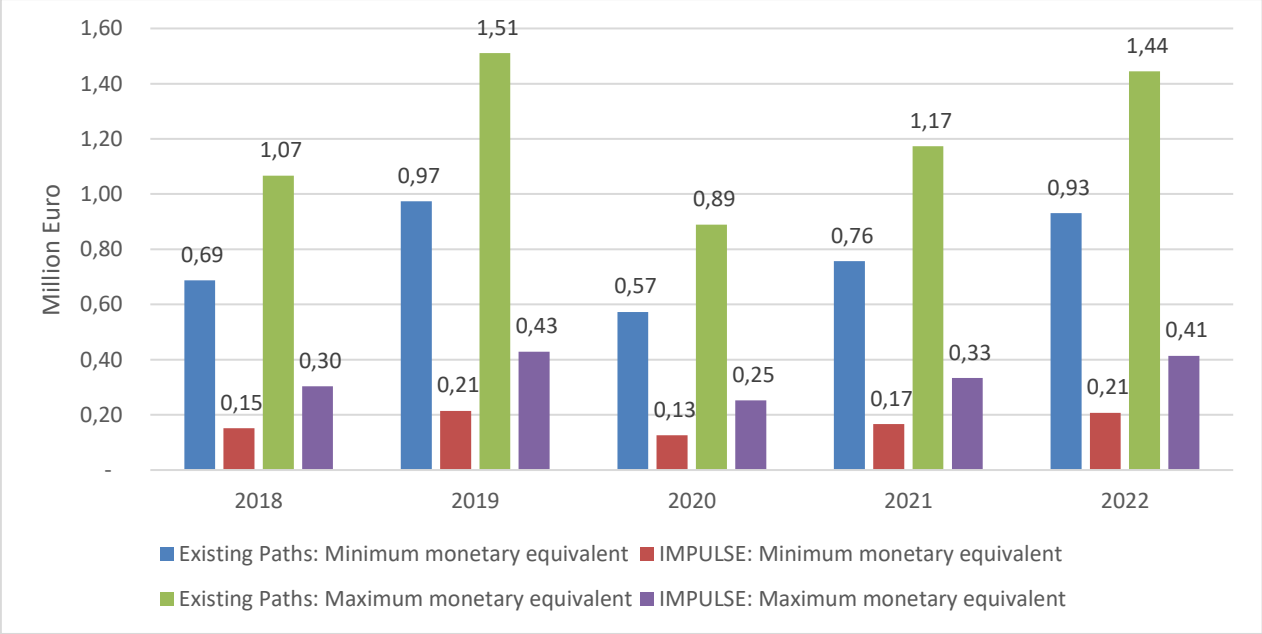

Figure 30: Annual implied monetary value of residents' time spent on filing complaints under different paths

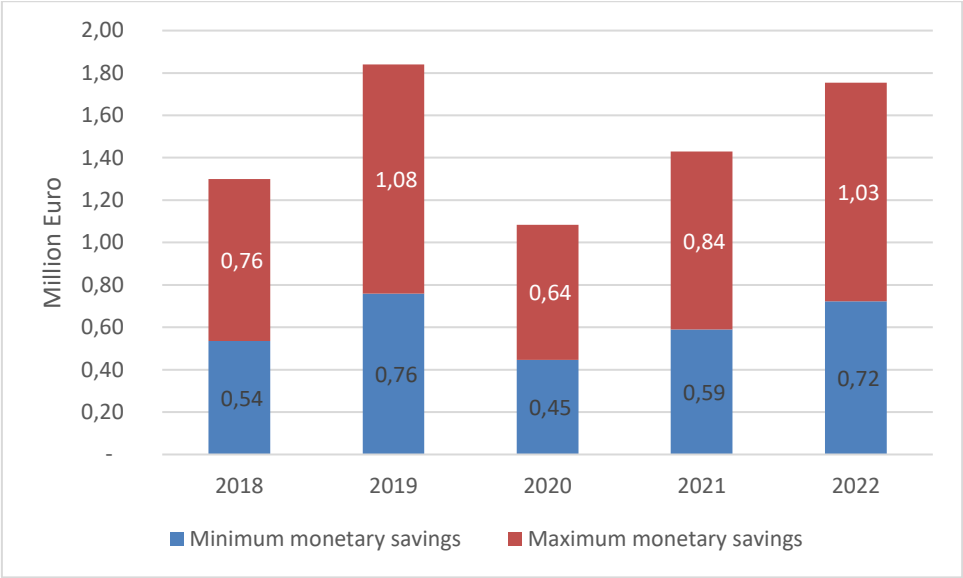

Figure 31: Annual implied monetary savings of residents with IMPULSE (theoretical)

For residents, the monetary value of time is likely to often be a somewhat theoretical quantity. But for the Ertzaintza, it is anything but, since working time translates directly into salary costs. Figures 32 and 33 show the estimated monetary cost to the Ertzaintza of residents using the current F2F and existing digital pathways to file complaints.

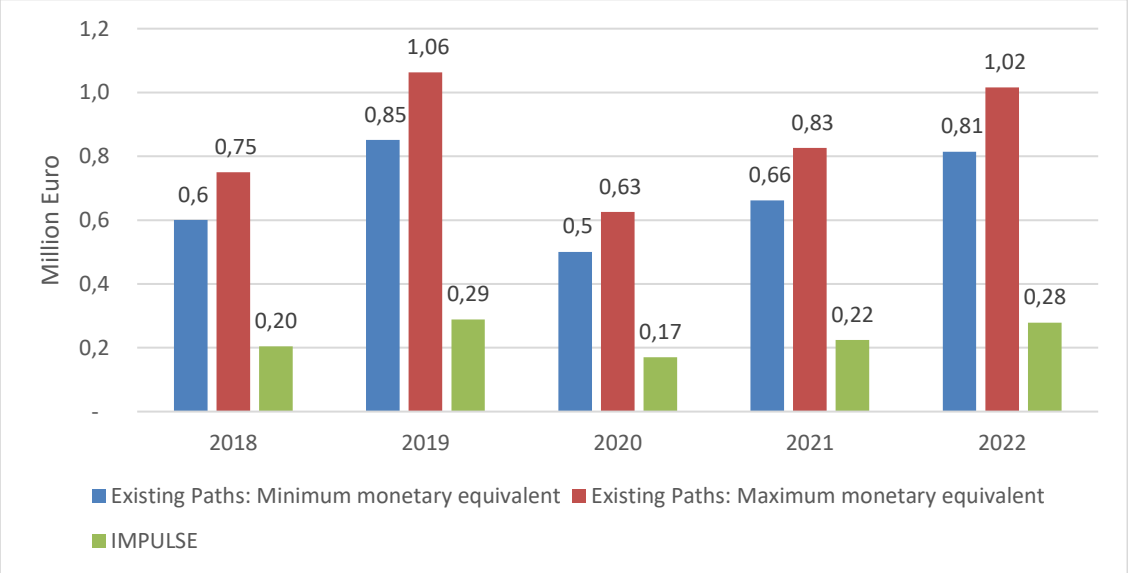

Figure 32: Annual cost to the Ertzaintza of complaints filed through different paths

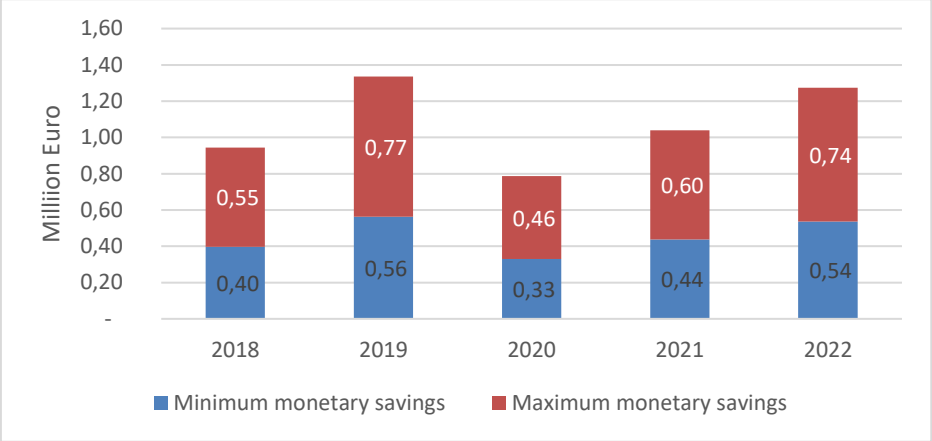

Figure 33: Annual cost savings to the Ertzaintza with IMPULSE (theoretical)

As can clearly be seen, the existing systems create an annual personnel cost to the Ertzaintza of between ~€500,000 and ~€1.06 million. If the residents instead used IMPULSE for all their filings, these costs would drop to around ~€170,000 to €290,000 (Figure 32) – in other words, annual savings of between €330,000 and €770,000 (Figure 33).

How realistic are these savings and what could be expected for the future? Clearly, a 100 percent adoption rate of IMPULSE, as assumed in the calculations above for purposes of illustration, is hardly realistic. But what levels of adoption might be realistic? As Table 12 above showed, the existing digital path has largely *not* been adopted by residents. The greatest usage that the existing digital path ever achieved, was 0.4 percent of all complaints submitted. This was in 2020, and use of this path declined thereafter (to just 0.1 percent in 2022). That the path was not widely adopted, is perhaps not surprising, since it offered residents limited benefits – they still had to physically travel to the police station to sign, after all.

More impressively, the BAK/BAKQ system, which was only made available for submitting complaints in 2022, immediately gained a usage share of 1.3 percent – a share more than four times greater than the existing digital path ever achieved. This suggests that usage of BAK/BAKQ may well grow further over the coming years.

However, BAK/BAKQ also has certain disadvantages compared to IMPULSE. In particular, it relies on a username/password combination for authentication technology. This is less user-friendly than IMPULSE's reliance on facial recognition. This suggest that in a "fair fight", IMPULSE might well win out over BAK/BAKQ and/or motivate even greater adoption than BAK/BAKQ can. Indeed, in the IMPULSE Task 4.1 survey referred to above[64], some 65 percent of Spanish respondents indicated that if IMPULSE were to become available, they "would" or "would certainly" switch to using IMPULSE instead of their current authentication system. A further 11 percent indicated that they might, but might also not, switch to IMPULSE, while only 24 percent stated that they would not or "certainly not" use IMPULSE. Of course, survey responses are an uncertain guide to people's actual choices, so these numbers must be interpreted with caution. But they do suggest that an ultimate adoption rate of 70–80 percent is by no means impossible, especially if network effects start to work in IMPULSE's favour. Of course, it is also possible that network effects do *not* take effect and usage of IMPULSE remains low. In particular, if BAK/BAKQ comes to be widely adopted, IMPULSE may struggle, as residents would quite likely be reluctant to switch to IMPULSE having only just adopted BAK/BAKQ.

We therefore model four scenarios: a baseline scenario, where IMPULSE adoption is low and only reaches 30% by 2032; a middle scenario, where adoption reaches 50%; and an ambitious scenario with adoption at 80% in 2032. These are compared to a business-as-usual scenario (BAU) that simply continues the situation of 2022, with 98.4 percent of complaints filed via the F2F path and the remainder via BAK/BAKQ and the

[64] Survey methodology and results are described further in Deliverable 4.2

existing digital path. For each scenario, we calculate the amount of time expended by residents and Ertzaintza officers, as well as the monetary value of this time. While we calculate both the minimum and maximum ranges for the time expenditure and monetary cost for each scenario and year. However, in the figures below only the averages are shown (i.e., the sum of the minimum and maximum value, divided by 2). This is to make the graphs easier to read. In the discussion, minimum and maximum ranges are referred to where relevant.

How much time and money the residents and the Ertzaintza spend on filing and processing complaints each year *in total*, is a function of the annual volume of complaints. But what is the future volume of complaints. This is obviously hard to know. The available data (Figure 34, blue line) shows that the number of complaints submitted each year bounced around quite a bit. A trend line (blue dotted line) though shows constant increase, albeit at a low rate. To obtain estimates for future complaint volumes, we project this trend line forward (red line). It is of course possible that we see will see a larger or smaller number of complaints, but no strong reason is known to us to expect this. Hence, we use the trend line projection, under which complaints grow gradually from approximately 37,000 in 2022 to about 44,000 in 2032.

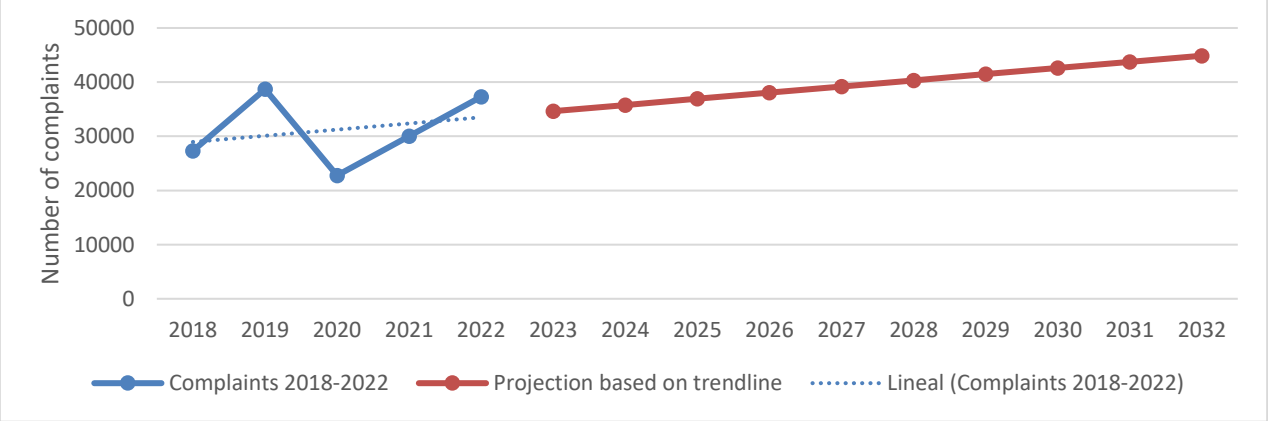

Figure 34 Number of complaints filed, 2018 – 2022, trend line and future projection

Figure 35 shows the average amount of time residents in the Basque region are expected to spend on filing complaints each year under the four scenarios. As can be seen, as the share of residents who have adopted IMPULSE grows larger towards the end of the period, the difference to the BAU scenario becomes big, especially in the high-adoption scenarios. While residents are projected to spend about 9700 working days on filing complaints by 2032 under BAU, a 50 percent adoption share of IMPULSE reduces this to 6310 working days. With an adoption rate of 80 percent, the time spent falls further, to just ~4200 working days.

Figures 36 and 37 show the average annual time savings to residents, and the cumulative savings over the 10 years to 2032. These are clearly substantial: If IMPULSE were widely adopted, residents would cumulatively save between about 9700 working days (30 percent adoption) and ~27,500 working days (80 percent adoption) through to 2032. On average, they would save between circa 970 working days (30 percent adoption) and 2750 working days (80 percent adoption).

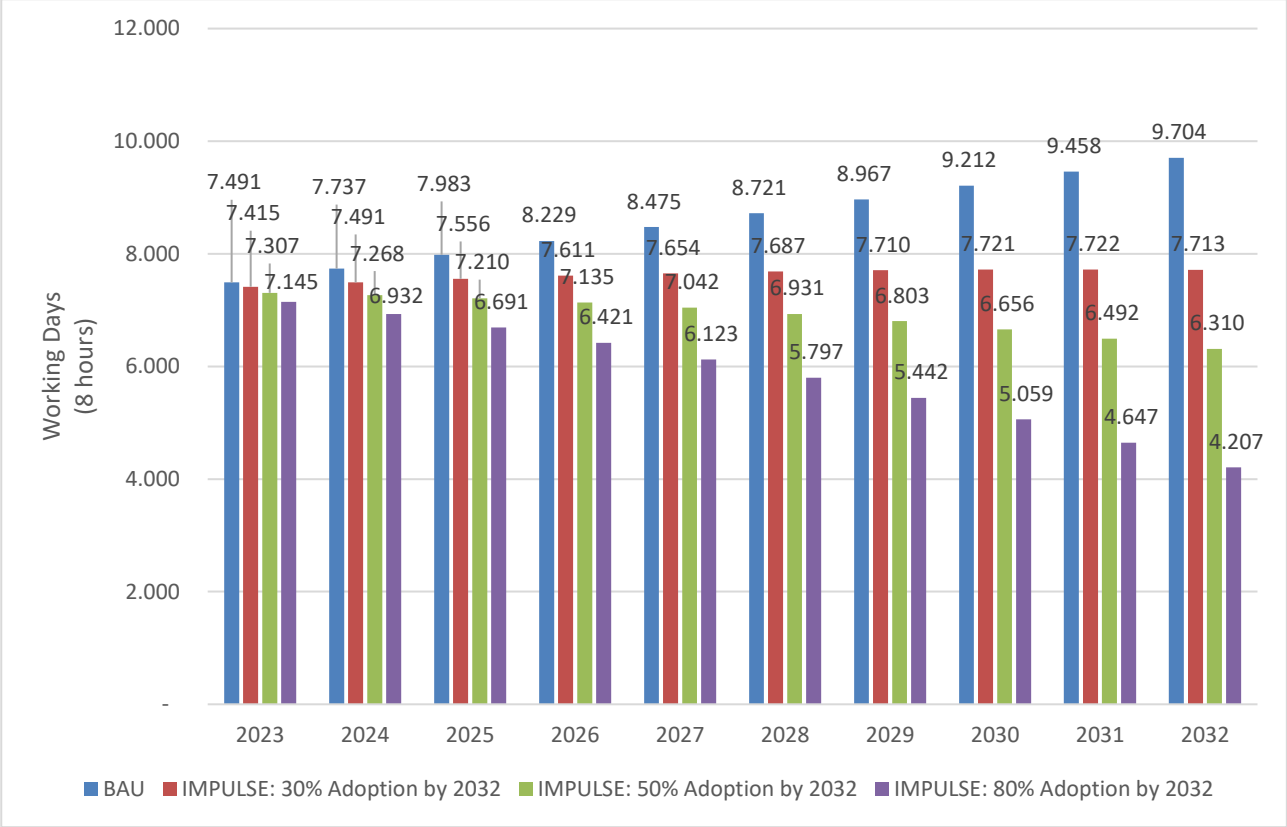

Figure 35: Time spent by residents filing complaints under different adoption scenarios, annual averages

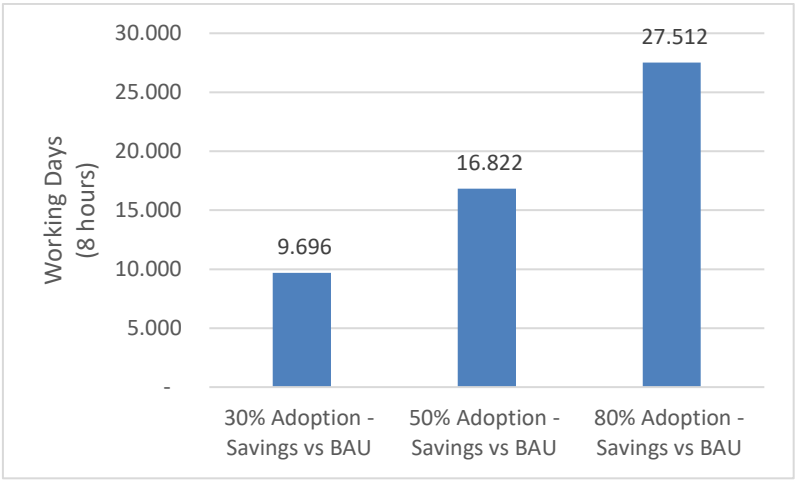

Figure 36: Residents' cumulative time savings over 10 years under different adoption scenarios (average)

The time savings for the Ertzaintza are substantial, too. Figure 38 shows the number of working days Ertzaintza are predicted to have to expend on receiving and processing complaints submitted by residents through to 2032, under the different adoption scenarios. Under the BAU scenario these grow to about 6240 working days in 2032, while with strong IMPULSE adoption, they *fall* substantially *below* the time required today (2023) under BAU, even though complaints rise by about 30% in all scenarios (cf. Figure 34): down to 4090 with 50 percent adoption of IMPULSE, and to ~2760 with 80 percent adoption. Predicted cumulative savings over 10 years under these scenarios range from ~6140 working days (30 percent adoption) to ~17,420 (80 percent adoption), while average annual savings come to 614 working days at the low end to 1742 at the high end (cf. Figures 39 and 40).

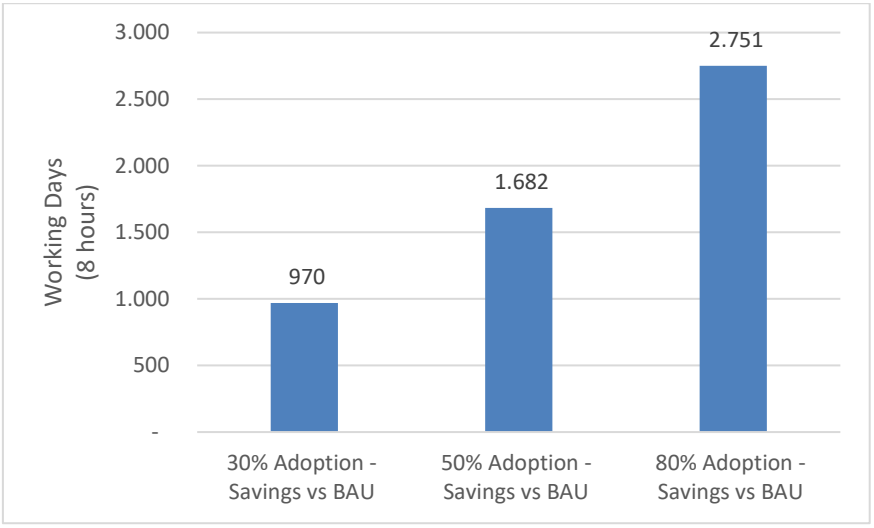

Figure 37: Aggregate annual time savings to the residents under different scenarios

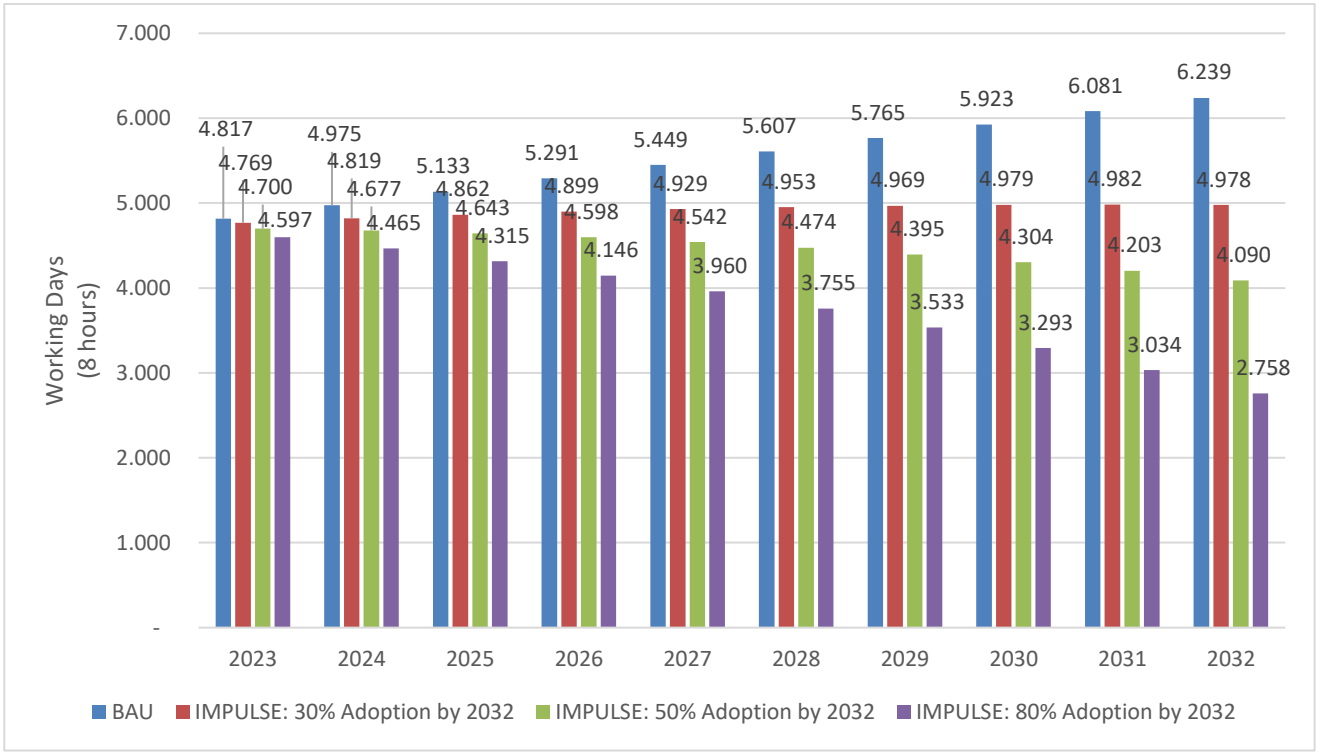

Figure 38: Time spent by Ertzaintza receiving and processing complaints under different adoption scenarios, annual averages

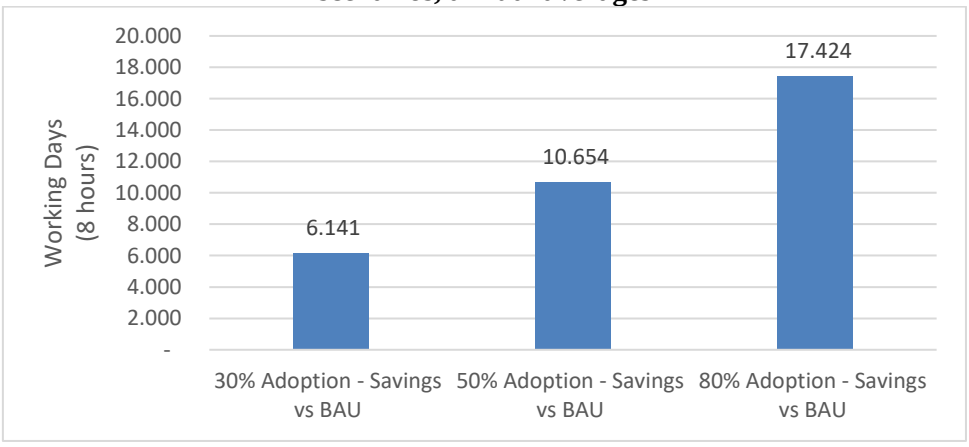

Figure 39: Cumulative time savings to the Ertzaintza over 10 years under different adoption scenarios

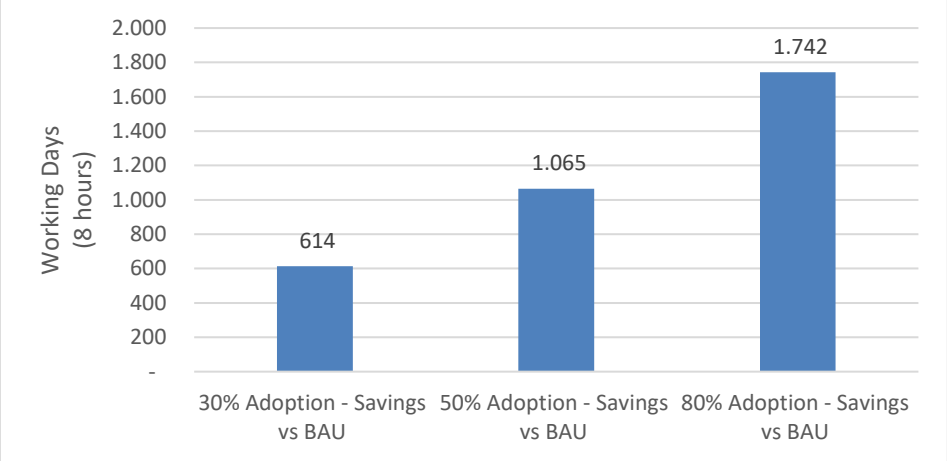

Figure 40: Average annual time savings to the Ertzaintza under different adoption scenarios

Turning to monetary savings, we see a similar picture. Under BAU, the average aggregate monetary cost (travel costs plus implied monetary cost of time) to the resident of filing complaints grows from ~€1.1million in 2023 to ~€1.42 million in 2032. With IMPULSE, costs in 2032 range from ~€1.12 million (30 percent adoption) to as low as ~€590,000 (80 percent adoption) (Figure 41). This implies aggregate savings over ten years of between ~€1.5 and~ €4.2 million, or ~€150,000 to ~€420,000 a year (Figures 42 and 43). (Note that for clarity of presentation, Figure 28 has been scaled to Million Euros, while the units in Figures 42 and 43 are just Euros.)

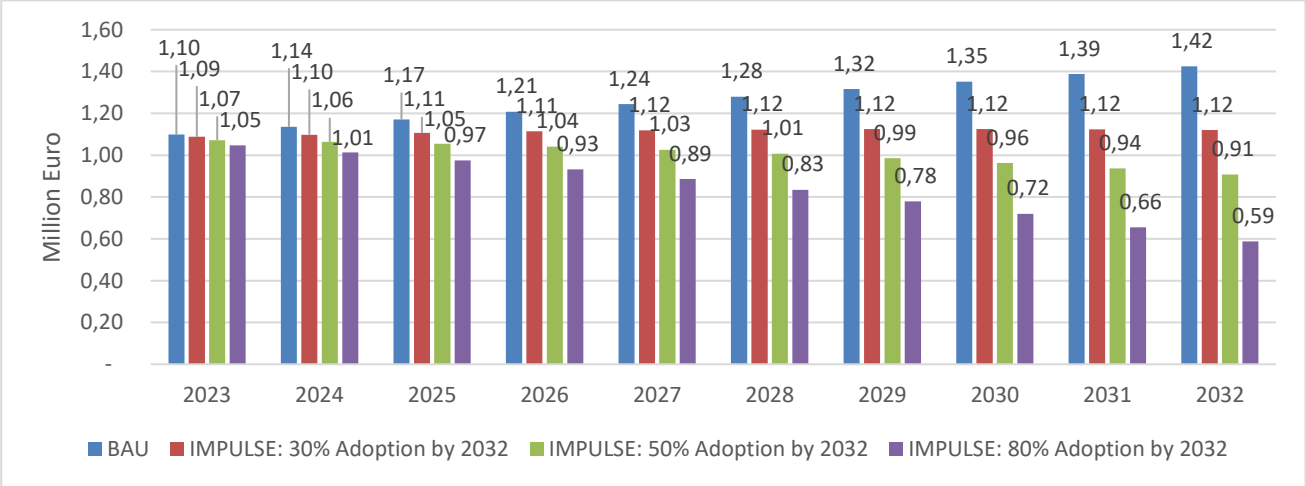

Figure 41: Monetary costs (travel and implied money value of time) to residents under different adoption scenarios

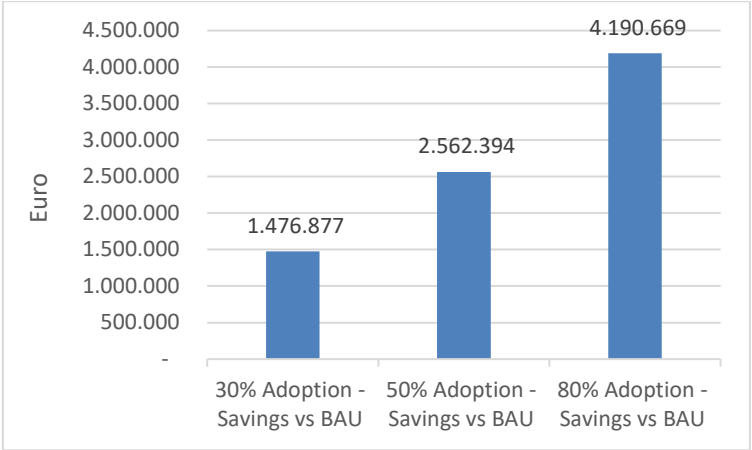

Figure 42: Cumulative monetary savings to the residents over 10 years (2023 – 2032) under different adoption scenarios

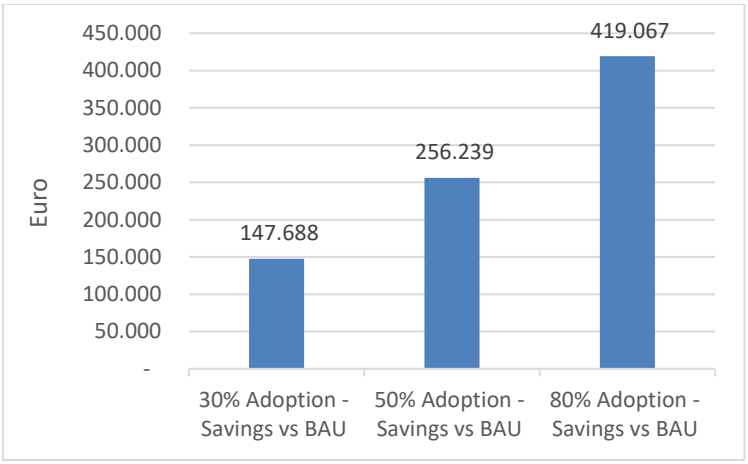

Figure 43: Average annual monetary savings to the residents under different adoption scenarios

For the Ertzaintza, the picture with regard to monetary costs and savings is as follows. As Figure 44 shows, annual costs under BAU rise from ~€850,000 in 2023 to ~€1.1 Million in 2032. But were IMPULSE to be widely adopted, costs in 2032 would only be ~€723,000 (50 percent adoption) or even as low as ~€490,000 (80 percent adoption). In other words, if an adoption rate of 80% could be achieved by 2032, expected costs in that year would be more than 40 percent below the costs predicted for 2023 – despite the projected 30 percent rise in complaints assumed in the model. (If complaints do not increase or increase less than 30 percent, saving would of course be larger.) Given the assumptions made in the models, for the Ertzaintza total savings compared to BAU over the 10 year period 2023 – 2032 range from ~€1.07 Million (30 percent adoption of IMPULSE) to ~€3.04 million (80 percent adoption) (Figure 45). Annual savings are between ~€107.000 and €304.000 (Figure 46).

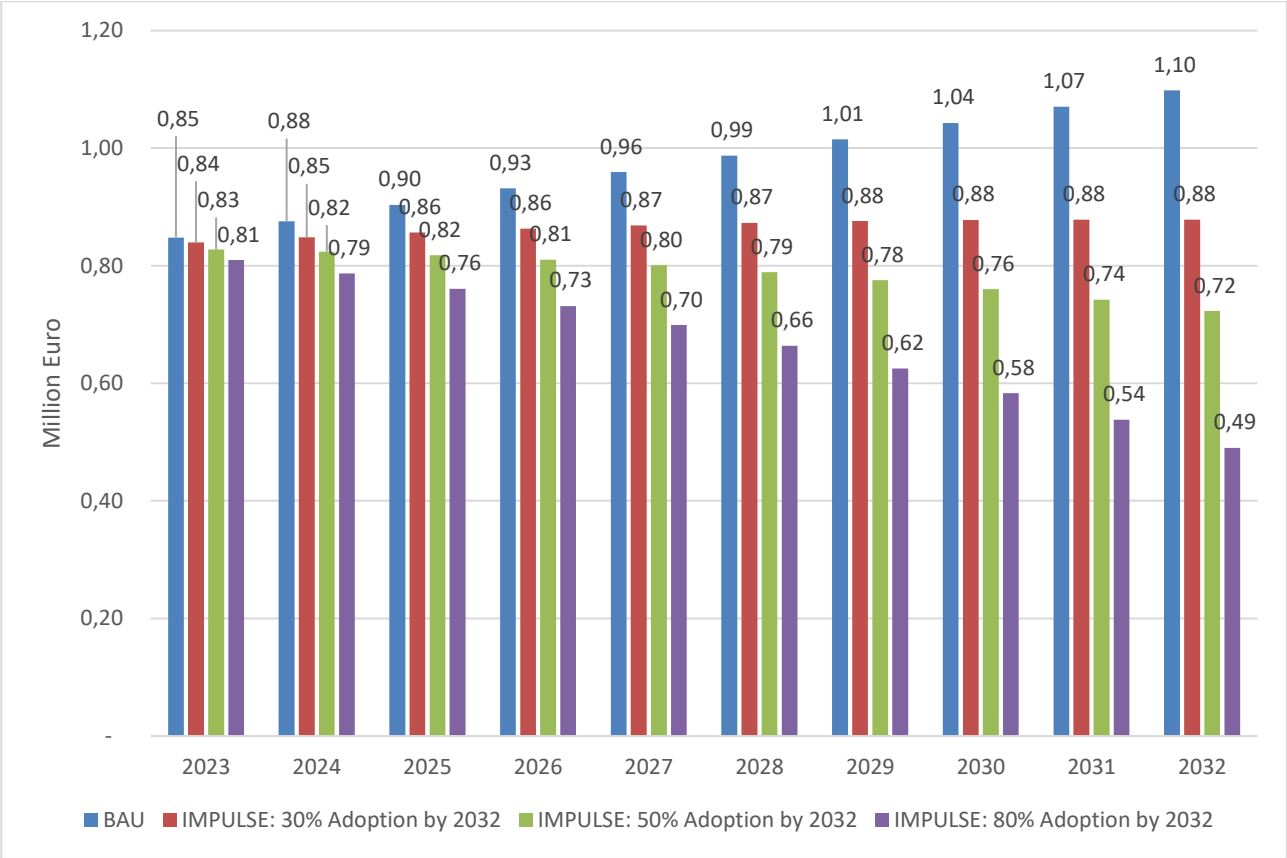

Figure 44: Monetary costs to Ertzaintza under different adoption scenarios

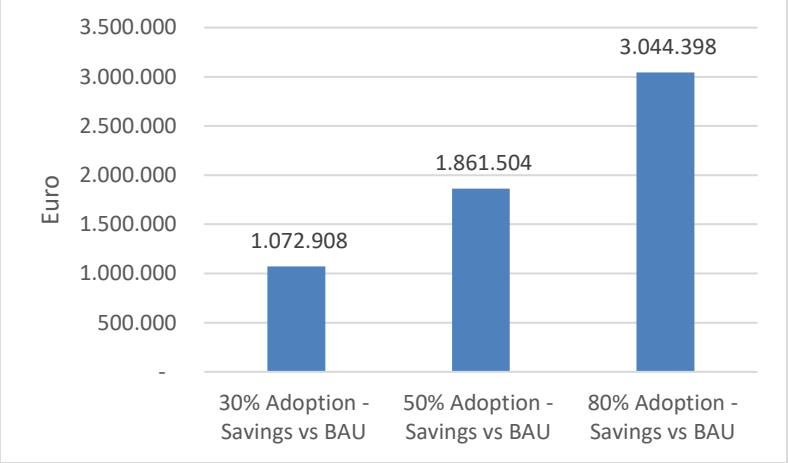

Figure 45: Cumulative monetary savings to the Ertzaintza over 10 years (2023 – 2032) under different adoption scenarios

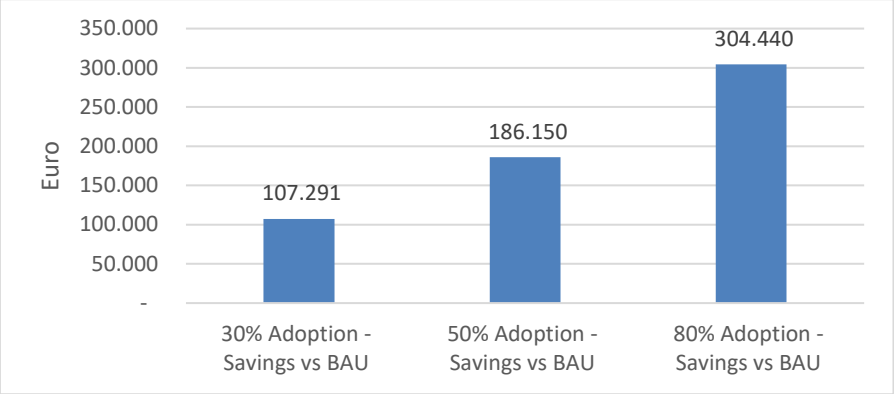

Figure 46: Annual monetary savings to the Ertzaintza under different adoption scenarios

4.2.3.3 Estimates for scaling the use case up to the national level

We next provide estimates for potential savings were the Ertzaintza use case to be scaled up to the national level. This must be understood as a more theoretical exercise, whose purpose is to provide *rough orders of magnitude* on the potential savings IMPULSE could unleash. It is not intended as an exact or definitive statement in this regard. Different regions in Spain may have different patterns of crime and complaint volumes than the Basque country (*Euskal Autonomia Erkidegoa*, *Comunidad Autónoma Vasca*). The institutional structures and internal processes for processing complaints may also vary somewhat between police forces in the different regions and *Comunidad* of Spain, though the basic steps can be expected to be the same, as is the legal code, which ultimately governs these matters.

As we could not obtain national-level data on complaint volumes, we used the 2018-2022 Basque data on complaint volumes to calculate the Complaints/Population ratio for the Basque country for each year (i.e., the number of complaints per person). We then multiplied this ratio with the Spanish population number, to obtain an estimate for the complaints submitted in all of Spain, for each year from 2018 to 2022. The formula is:

$$(Complaints_i / Population_{Basque}) * Population_{Spain} = Complaints_{Spain,\, i}\ i \in \{2018, 2019, 2020, 2021, 2022\}$$

As for the Basque country above, we then used these (synthetic) data on the annual volume of complaints in Spain in 2018 to 2022 to estimate future complaint volumes, by projecting forward the linear trend line, to 2032. We then used these data to calculate estimates for the amount of time Spanish residents and police officers were likely to spend filing and processing complaints for the years 2023 – 2032, under the different scenarios (BAU; 30, 50 and 80 percent adoption of IMPULSE), as well as the monetary cost (value of time and travel costs). From this we derived estimates for the savings IMPULSE could offer.

Figures 47 and 48 show the time and monetary expenditures and savings of Spanish residents for filing complaints under the different scenarios. Over the ten years to 2032, they are estimated to spend about 1.84 million working days on filing complaints under BAU, but with IMPULSE adoption that drops to between ~1.6 million and ~1.3 million working days – a savings of between ~208,000 and ~590,000 working days (Figure 47). In monetary terms, the projected costs (implied monetary value of time plus travel expenses) are €249 million under BAU, but only ~€218 million to ~€160 million with IMPULSE adoption, saving residents between €31.4 million and €88.8 million (Figure 48).

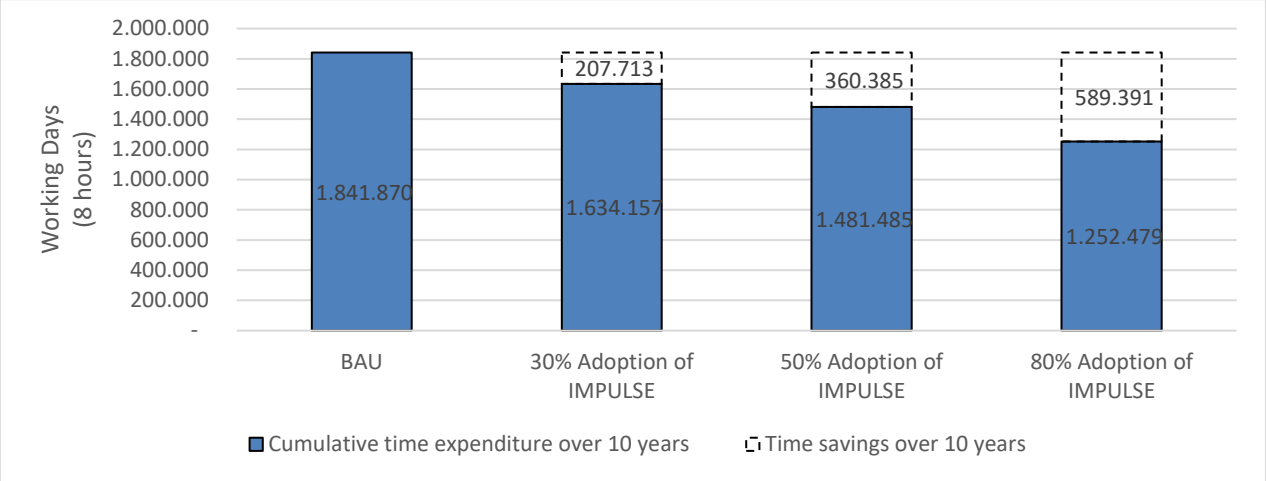

Figure 47: Estimates of Spanish residents' time expenditure and savings under different adoption scenarios

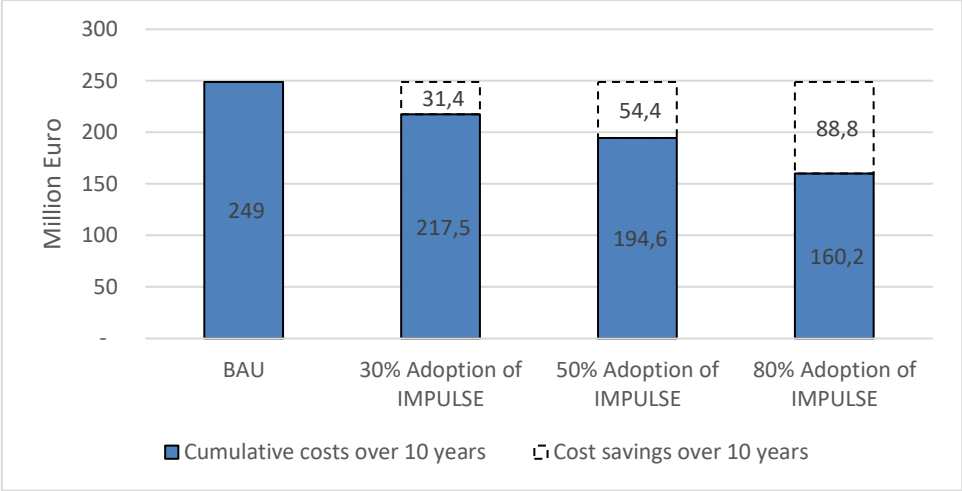

Figure 48: Estimates of the monetary cost and savings to Spanish residents under different adoption scenarios

For Spanish police forces, the costs and savings are as follows. Under BAU, Spanish police forces are projected to spend a cumulative ~1.2 million working days on receiving and processing complaints over the ten years to 2032. Widespread adoption of IMPULSE would allow them, so the projections, to save between ~132.000 and ~373.000 working days (Figure 49). In monetary terms, this would amount to a cumulative cost of ~€209 million under BAU, but only ~€186 – €143 million with IMPULSE adoption, i.e., savings of €23 – €65 million (Figure 50).

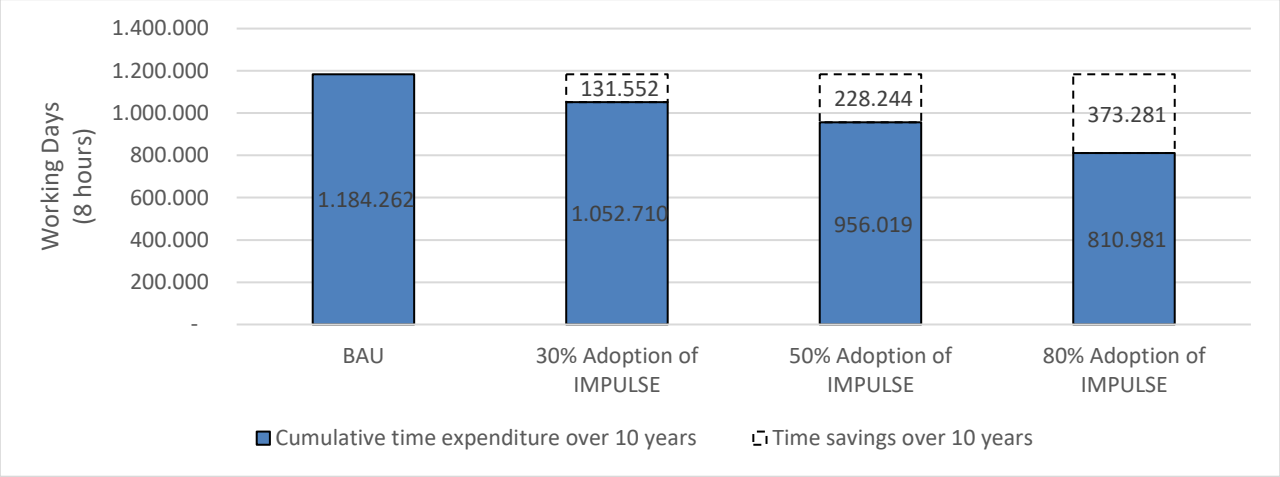

Figure 49: Cumulative time expenditure for Spanish police forces under different adoption scenarios

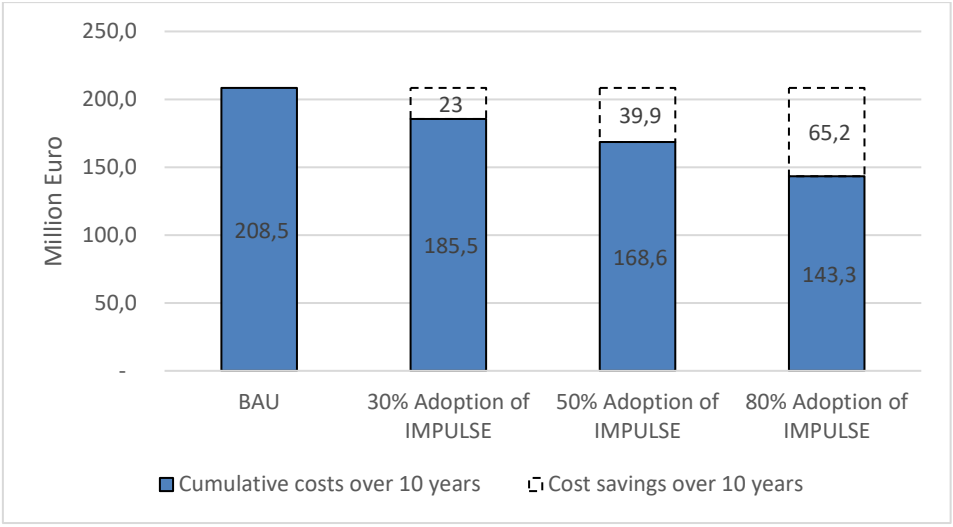

Figure 50: Cumulative monetary costs and savings for Spanish police forces under different adoption scenarios

4.2.4 Gijon Case, Spain

4.2.4.1 Description of the Pilot Use Case[65]

The Gijon Pilot use case is special because Gijon already has a well-established, widely-used digital identity and digital government system. This is the so-called "Gijon Citizens' Card"-system, which was begun in 2002. Corner stone of the system is a plastic smart card, which residents can use as a digital identity to access a wide range of municipal services. Services include paying for public transportation (buses, etc.), borrowing from libraries, scheduling appointments with city offices, reserving sports facilities, short-term rental of bikes and electric cars, paying for parking, and many more.

The card comes with a user account, over which residents can charge their card with money and monitor and manage their transactions. For the longest period, the residents had to go to one of the dedicated ATM terminals in Gijon to log into their account (using their card and a PIN, much like a bank card). Since 2019 the plastic citizens' *card* has been complemented by a mobile app (the "Gijon Citizens' App"), through which users can access their account (log-in using their card number and the PIN). The app can be used in much the same way as the smart card and the ATMs; viz. to access some (though not all) of the municipal services accessible through the plastic card, and charge their card/user account and manage transactions. The IMPULSE pilot

[65] The following description is based on our interview and follow-up discussions with Reykjavik Pilot staff.

involves substituting the IMPULSE identity verification system for the app's currently-used system (card number and PIN).

Use of the app has grown relatively slowly. While there are ~340,000 cards in circulation, only ~53,000 unique users have installed the app since 2019. There are at least two likely reasons for this. For one, many services are only accessible through the card, but all services that can be accessed through the app are also accessible through the card. For another, it appears that several of the most intensively-used services can either *only* be accessed through the card, or – if they are also accessible through the app – are likely *easier* to access through the card compared to the app.

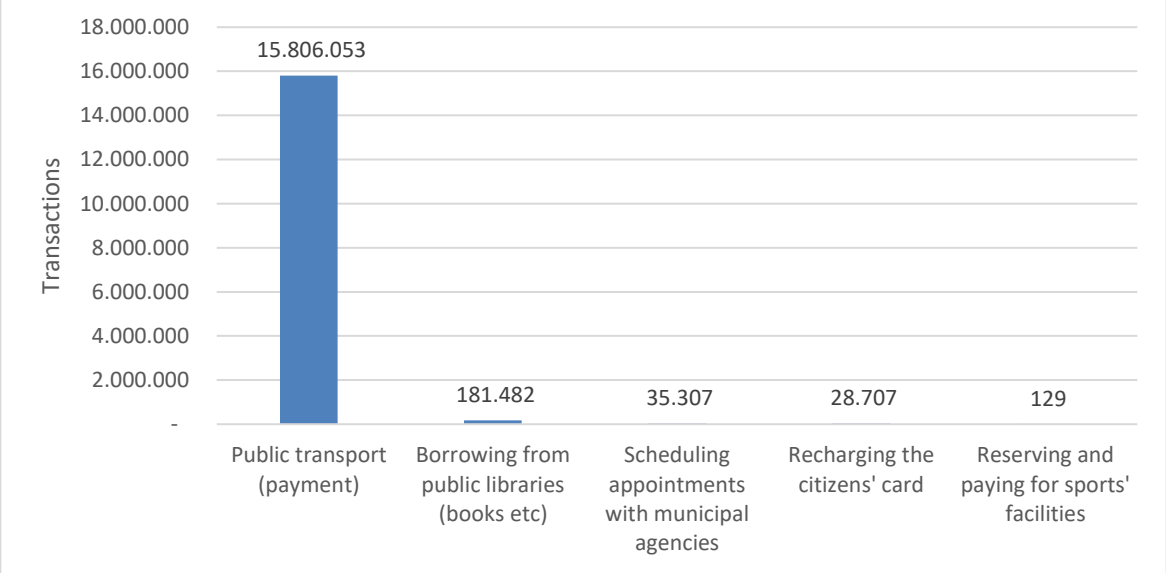

Figure 51: Most-used Citizen Card and App services: average annual transactions (2019-22)

Figure 51 shows the five most intensively used citizen card/citizen app services. As can be seen, by far the most intensively-used services are paying for public transport, and library borrowing. Accessing either of these services involves interacting with external physical systems and devices, not just web interfaces – e.g. swiping the card through reader devices to pay or book a loan.

Indeed, public transport payment currently can *only* be done with the card. Enabling payment by app would require installing new and different billing systems in the public buses. It should be noted that there is no obvious benefit from doing so. Indeed, residents may well find swiping their card to pay much easier than using an app that they would first have to log in to. This is true of many of the other public services offered in Gijon via the citizens' card (e.g. bike and car rental, parking and traffic guidance systems, museum entry, …). Library borrowing can be done both via the app and the card. Again though, it is likely that many residents find using the card, which be quickly swiped, at least as convenient as the app.

Conversely, numerous other services are likely more easily performed via the app, because they are most conveniently completed through a web interface (mobile or desktop); e.g. scheduling appointments or reserving facilities. Given the usage patterns implied by Figure 51, as well as user inertia, however, it must be assumed that the Gijon digital public services system will for the foreseeable future remain primarily card- and not app-based. This in turn implies strict limits on the potential economic impact of IMPULSE in Gijon.

The main benefits Gijon expects from using the IMPULSE solution for the app are:

- Reduced instances of lost PINs
- Greater security compared to the four-digit PIN
- In the longer term, therefore, potentially the option of offering increasingly sensitive public services via the citizen card/app system

- In the longer term, potentially better interoperability with other municipalities' digital public service provision systems

What economic impacts might this have?

4.2.4.2 Economic impact estimation

The main immediate impact that IMPULSE could have, would be reducing residents' time lost to resetting lost PINs. On average, in the last two years, there were 2614 PIN reset requests a month, or 31,368 a year. A PIN reset can be requested online, and completed by email or SMS. We assume that the entire process of losing and resetting one's PIN (from mis-entering it three times to accessing the Citizen Card Website, entering one's email or mobile phone number, and receiving the new PIN) takes about 3 minutes. This would imply a total of 31,368 * 3 = 94,104 minutes (1568,4 hours, 196,05 working days [8 hours]) of resident time lost. Applying the average Spanish hourly wage of 17 EUR[66], this would carry a monetary value of EUR ~26.663 a year – though for the residents, the reduced hassle would likely be more immediately valuable than the (theoretical) monetary saving. Assuming a 90 percent adoption rate for IMPULSE was ultimately reached, this would imply aggregate savings of ~176,4 working days annually for the residents (~1411 hours, implicitly priced at ~24,000 EUR).

Of course, it is unrealistic to expect residents to immediately switch to IMPULSE, were this to become available. Adoption would most likely be gradual, with a full conversion to IMPULSE of all residents likely decades out (unless policy forces residents to switch faster, e.g. by ending support for PINs.). This in turn means that a reduction in PIN resets is unlikely to produce many direct savings for the municipality. The main direct cost for the municipality of PIN resets is maintaining the necessary IT infrastructure. Since for a long period of time, both IMPULSE and the existing PIN system would likely be used by residents, this infrastructure would have to be maintained (as well as the new IMPULSE system). In short, this would more likely generate additional net costs, rather than net savings.

It is harder to give an economic value to the other benefits Gijon foresees from moving the App log-in system to IMPULSE. Security breaches can be costly, but it is difficult to make a meaningful quantitative estimate of the gains from moving to a different system (IMPULSE) and thereby avoiding possible future breaches. Likewise, while the idea of offering more sensitive public services through the Card/App system in future is intriguing, at present it is still not clear what services precisely might be offered in this fashion. A benefits assessment is thus not possible. The same goes for greater interoperability with other municipal systems: it is unclear with which services and municipalities interoperability might be sought, making further analysis difficult.

4.2.5 Reykjavik Case, Iceland

4.2.5.1 Description of the Pilot Use Case[67]

The Reykjavik Pilot use case involves using the IMPULSE solution as an alternative log-in solution for resident messaging boards and chat fora. The expectation is that IMPULSE may be useful in particular for handicapped residents, who struggle with conventional authentication technologies.

We consider this a very worthwhile application of IMPULSE. However, we are not able to identify clear direct or indirect economic effects from it. Therefore, it is not further analysed.

4.2.6 InfoCamere Case, Italy

4.2.6.1 Description of the Pilot Use Case[68]

The current iteration of the InfoCamere Pilot use case involves developing IMPULSE as an alternative path for companies to access the so-called "digital drawer" (*cassetto digitale*) with company information. The

[66] Eurostat data. The number is from 2021.
https://ec.europa.eu/eurostat/databrowser/view/LC_LCI_LEV/default/table?lang=en&category=labour.lc.lcan
[67] The following description is based on our interview and follow-up discussions with Reykjavik Pilot staff.
[68] The following description is based on our interview and follow-up discussions with InfoCamere Pilot staff.

cassetto is a digital version of the national business register, containing the key data about each company operating in Italy. Company representatives access the digital drawer of their company in order to retrieve electronic versions of key documents and data, to identify and authenticate themselves to other companies (business partners, banks etc.).

A widely used digital identity system to authenticate to the *cassetto* already exists. This is the "SPID" system, which uses the user's tax number as identifier, and can be used to authenticate to many other public and private services in Italy. IMPULSE would constitute a further, alternative authentication technology.

While it is always sensible to have multiple distinct technologies for a given task, to add resilience, we have so far not been able to identify a specific advantage of IMPULSE over the SPID system, given that it is already widely used. One potential, albeit longer-term benefit that was highlighted by the InfoCamere staff, was its potential interoperability with other systems in Europe. Were IMPULSE to be truly widely adopted in Europe, this would potentially allow Italian entrepreneurs to reduce the number of digital they use, since they would no longer have to use one identity and system (e.g. SPID) for their domestic activities, and further ones for their business activities elsewhere in Europe. This would certainly be valuable, however, the case is at this point still rather underspecified, so we have refrained from attempting a quantitative evaluation of it.

5 Private sector impacts of IMPULSE

The IMPULSE project does not include private-sector use cases, which makes it harder to analyse possible impacts of IMPULSE on the private economy. As discussed in section 3.2.2 above, there are four general mechanisms through which digital identities positively impact the private sector; viz. formalisation, efficiency savings and increased transactions, security, and the provision of identity services themselves. As discussed, of these the first (formalisation) has limited relevance for Europe and thus for IMPULSE, as well over 90 percent of the European populations already possess officially-recognised identities and any transactions that occur in the informal sector generally do so for reasons unconnected to any lack of official identities. In as far as the market for digital identity solutions is increasingly crowded and competitive, with numerous solutions in production or under development (World Bank 2018b, European Commission 2020), it is also unlikely that IMPULSE could have *economy-wide* effects through the fourth mechanism, viz. the sale of identity-related services. This is because this sector *already exists* (or at least is rapidly coming into being): if IMPULSE became established as an important new player in this sector, it would be more likely to *redistribute* business *within* the sector (with IMPULSE taking business from other players) than *add additional business* to the sector. This leaves the two other mechanisms – efficiency savings and increased transactions, and security – as the main pathways through which IMPULSE might produce wider economic impacts in the private sector.

5.1 Economic impacts in light of the survey results

To explore these further, we asked respondents to the survey conducted in IMPULSE T 4.1 nine questions:[69]

1. Whether they would switch from their current digital ID system to IMPULSE, were IMPULSE to become available?
2. What kind of services/use cases they believe IMPULSE would be appropriate for (with various options given, e.g. banking, health care, e-commerce, filing taxes, social media, and others)?
3. Whether they would prefer to have a single digital ID for all online services, as opposed to the status quo where most people have multiple digital IDs?
4. Whether they sometimes forget their username/password, or forget which identity is for which service or account?

[69] The exact wording of the questions is given in Annex D. Note that the order the questions were asked in in the actual survey does not correspond exactly to the order they are listed in above. In particular, a number of other questions were asked before what is question 1 in the list above, and further questions were asked between most of the questions listed above.

5. Whether managing multiple digital identities is experienced as taxing?
6. Whether they sometimes don't use an online service because the registration process is too much hassle
7. Whether they would use more online services if registration were easier and faster
8. Whether they would use more services if they had only one single, secure digital ID that they could use for all online services?
9. To roughly estimate how many online services they regularly used that required a digital ID.

All of the questions listed above except questions 2 and 9 were implemented as Likert Scale (1 – 5) questions, with 1 representing a certain negative ("certainly not", "strongly disagree" etc.) and 5 the corresponding certain positive. Question 2 asked respondents to choose between 6 different services, plus the option of writing in a further service, or "none".[70] Question 9 asked respondents to specify a number in a free text box. At the beginning of the survey, respondents were shown a short film that described how IMPULSE works.[71]

The survey was conducted online and disseminated through snowballing, using the private and professional networks of the consortium members. In total, 740 people answered the survey.[72] The responses were somewhat biased towards people in their twenties to forties (Figure 52) and strongly biased towards people with higher education and more affluent households (Figures 53 and 54). These factors have to be borne in mind when analysing the survey results and their implications. While there was mild variation in these regards across countries, the general trend was remarkably consistent, and in statistical analysis (not shown here), country dummies generally did *not* emerge as significant.

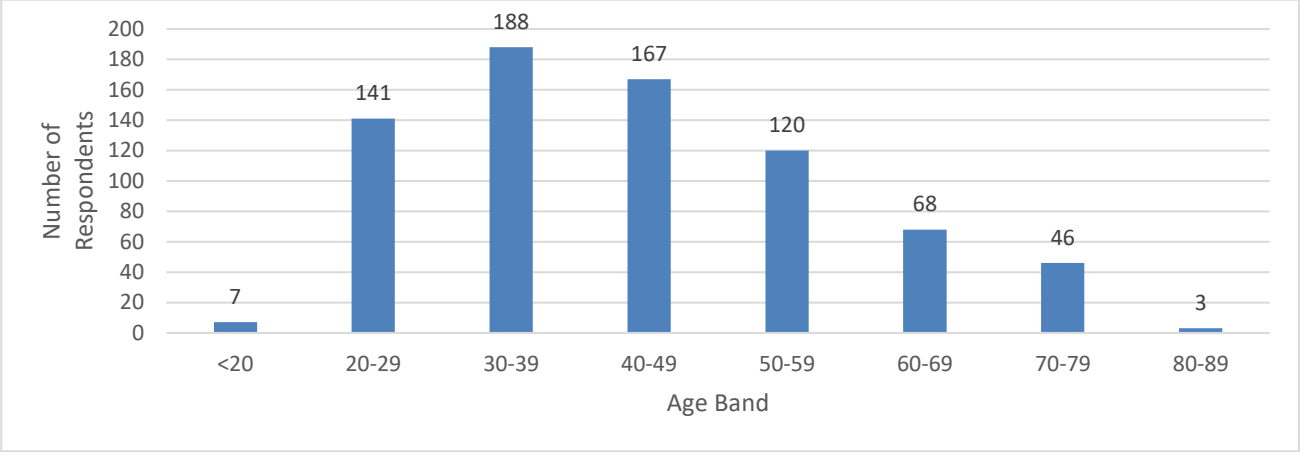

Figure 52: Age structure of the respondents to the Task 4.1 survey

[70] The services listed to choose from were online banking, eHealth, digital vaccination certificate for Covid or other diseases, social media, e-commerce, completing tax returns online, registering for social services online, email (plus Other and None)

[71] The film can be watched at https://www.youtube.com/watch?v=P3j-xJK5fXA

[72] Of these, about two-thirds came from Germany (192 responses), Spain (203) and Italy (116). The remainder were distributed as follows: Denmark: 62, Iceland: 60, Bulgaria: 42, Finland: 39, France: 24, and Austria: 2.

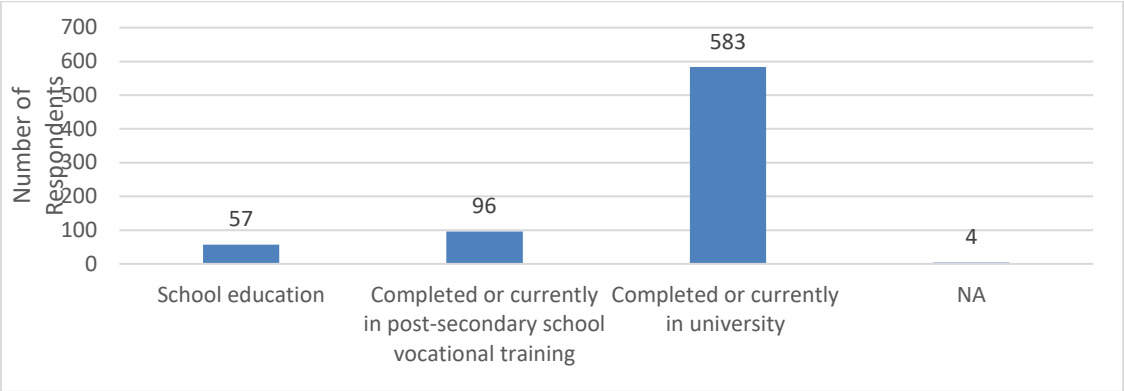

Figure 53: Educational attainments of the survey respondents

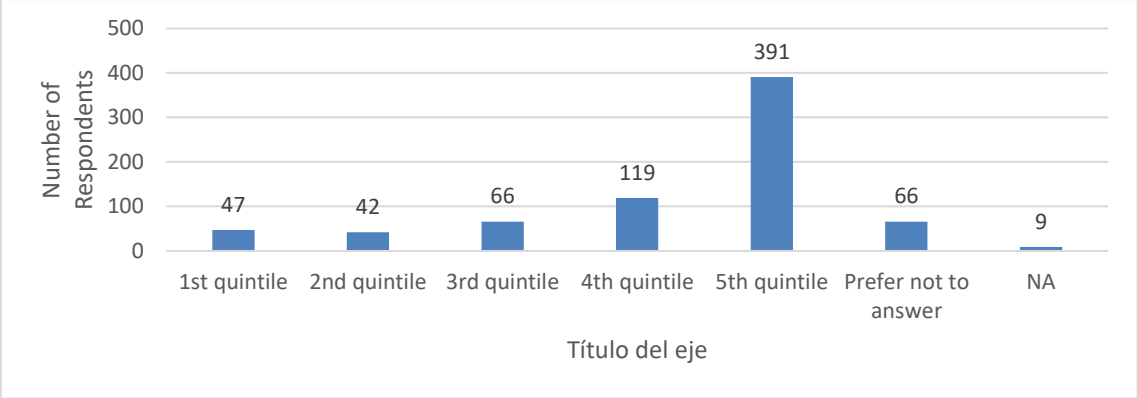

Figure 54: Respondents by household income quintile

Regarding the first question, we find that across all countries IMPULSE is fairly popular. About 52% of respondents would "certainly" or would probably (Likert values 4 and 5) switch to IMPULSE in place of their existing digital identity solutions, should IMPULSE become available, and another ~25 percent of respondents are neutral (Likert value 3). Only 23 percent would "certainly" or would probably *not* use IMPULSE (Likert values 1 and 2) (Figure 55). These patterns are broadly similar across countries.[73]

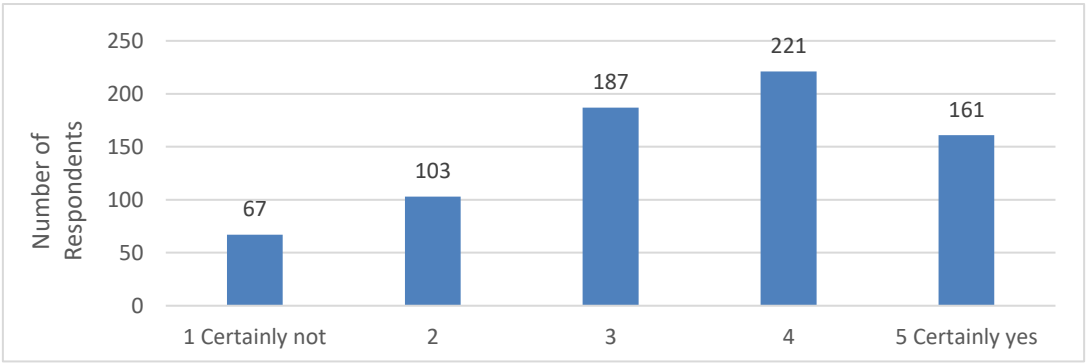

Figure 55: "Would you use IMPULSE instead of the digital identity systems you currently use?"

[73] Acceptance / adoption is discussed in more detail in Deliverable 4.2. IMPULSE is *least popular* in Iceland and Denmark – something likely accounted for by the fact that both countries have well-established digital identity system, wherefore respondents seem to find limited added value in IMPULSE – and in Germany, which seems related to data protection concerns driven by disquiet about facial recognition. In general, acceptance seems to be mainly driven by (i) data protection concerns, (ii) whether people feel that their existing digital identity solutions suffice for their needs, and (iii) technology openness/pleasure derived from trying out new technology (a sort of attitudinal counterpart to data protection concerns.

These numbers must obviously be treated with caution. It is easy to say one would adopt IMPULSE, harder and more costly to actually "pay" the switching costs of moving to a new system (hassle, time consumption etc.). But they do suggest that – at least in the younger, better educated and more affluent segments of the population – there is a significant volume of people across Europe who would be very open to using IMPULSE. Given that these population segments, in particular, tend to be disproportionately heavy spenders and consumers of (online) goods and services, this suggests that IMPULSE could potentially have larger impacts in the private sector.

Indeed, the answers to our further questions revealed considerable dissatisfaction with existing digital identity solutions, and that their shortcomings have a negative effect on service consumption. Clear majorities to struggle with remembering their passwords, usernames and accounts, and would prefer to have one single digital identity for all services. A large minority even feels that managing multiple digital identities "overtaxes" them (Figures 56, 57 and 58). It is worth underscoring, in this context, that the survey respondents are disproportionately younger and better educated – precisely the population segments we should expect to have *least* problems with managing and remembering their passwords and accounts. If even these people struggle with this, it is to be expected that the problems will be even greater among older and/or less educated voters.

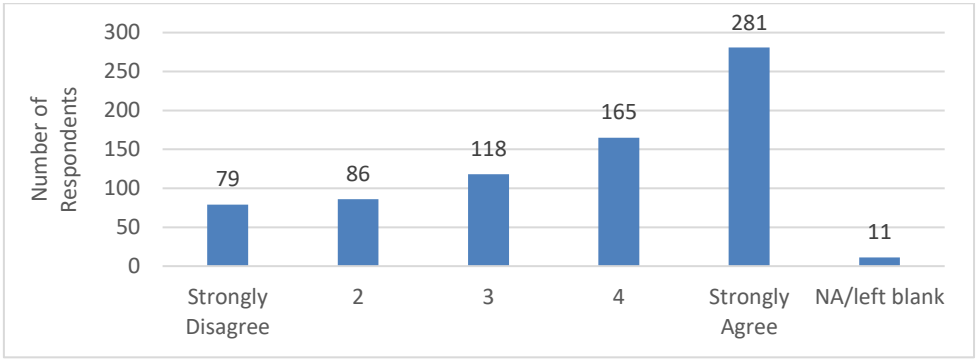

Figure 56: "I would prefer to have a single digital ID for all online services and accounts"

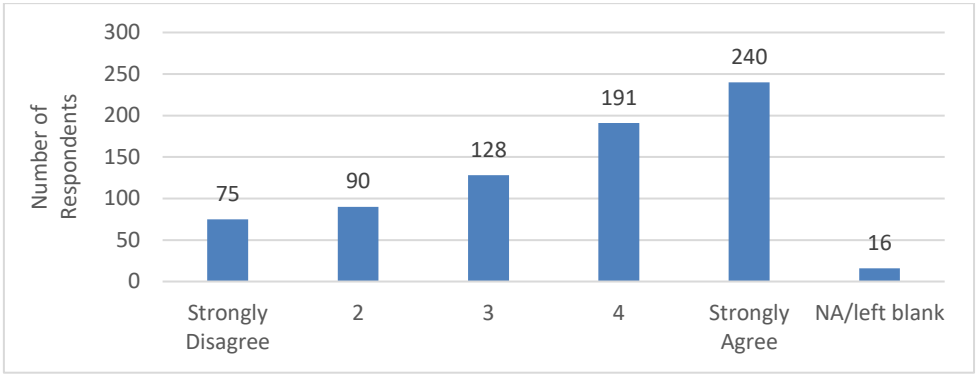

Figure 57: "I sometimes forget my username/password, or forget which identity to use for a service or account"

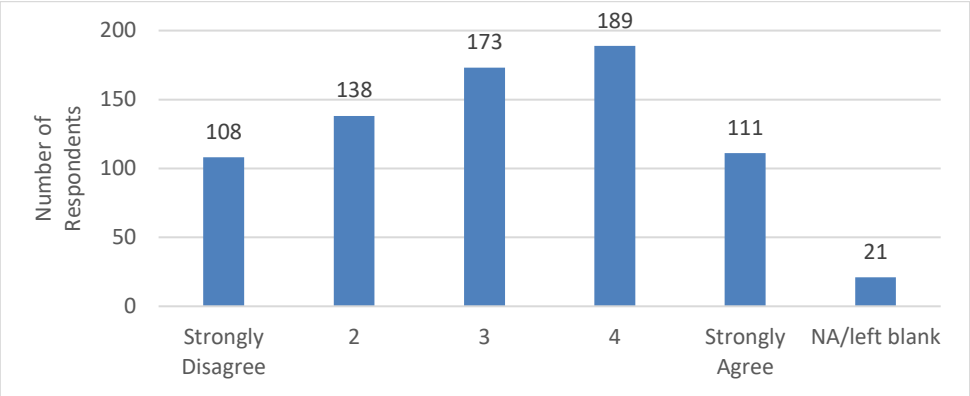

Figure 58: "Managing multiple digital identities and ways of identifying myself overtaxes me"

The shortcomings of many existing identity systems – multiple identities for different services, reliance on hard-to-remember usernames and passwords, which then get forgotten – that these survey results underscore can have economic consequences for the private sector through at least three pathways: administrative and compliance costs, reduced security, and reduced transactions. We explore these next. We address the question of reduced transactions (and whether IMPULSE may increase them) in some detail, as the survey enables this. The former two pathways are harder to explore, absent a quantifiable private-sector use case (which was not included in the IMPULSE project). Therefore, they are dealt with more briefly.

5.1.1 Administrative and compliance costs

Forgotten usernames and passwords are liable to result in increased administrative costs for companies when users have to contact help desks to have passwords reset and identities checked for this purpose. By doing away with passwords, IMPULSE removes this problem. As noted above in the literature review, there is very little data on how substantial these costs are. One often cited figure from Accenture (2013) found that ~30 percent of calls to UK banks' customer service centres concern lost passwords, with each call costing banks about US$25 (cited in World Bank 2018b). More recently, the consulting companies Forrester Research and Gartner have claimed that password reset calls to helpdesks cost about US70 a call, and that about ~40 percent of help desk calls are related to passwords and resets (HYPR 2022). At the same time, many forgotten passwords do *not* lead to costly calls to help desks: users go through an automated password reset process, or just create a new account. This is the norm for much of the digital economy (e.g. e-commerce, social media, …). *Costly* password resets – where users call up help desks – by contrast are concentrated in particularly sensitive services like banking, healthcare or telecommunications, where manual checks of a user's identity are necessary. Whether IMPULSE can reduce burdens here depends on whether users would consider these services appropriate use cases for IMPULSE. As discussed further below, in fact they seem to do so (cf. Figure 62). This suggests that IMPULSE could indeed lower costs to corporations from users' forgotten passwords and similar. For the users themselves, IMPULSE would of course save the time hitherto wasted on password resets and similar.

Sensitive services like banking also often have to perform detailed – time-consuming and costly – identity checks on customers as part of their compliance duties, independent of any password reset (e.g. Know Your Customer Regulation). To what extent IMPULSE might simplify or even substitute for these processes is ultimately a decision for the regulator. In purely technical terms, though, it would likely hold some potential. This could offer substantial economy-wide cost savings.

5.1.2 Security

As discussed in the literature review, various forms of security breach and identity fraud remain common in the digital economy, creating substantial damages, though these are hard to quantify precisely. IMPULSE might help to reduce at least some forms of identity fraud and security breach, such as those deriving from insecure passwords. Quantifying such hypothetical effects is however entirely beyond this study. Whether this would translate into a *lasting*, *absolute* reduction in security breaches and/or identity fraud and not merely

prompt their displacement into other areas of the digital economy is a further open and at this point unanswerable question.

5.1.3 Transactions

A majority (51 percent) of survey respondents indicates that they have sometimes not used services because the registration process – which IMPULSE would simplify and speed up – was "too much hassle", and substantial minorities of respondents believe they would consume more services if signing up for services were easier or they had a single digital identity that could be used for all services (Figures 59 – 61). It is worth noting that these figures are very similar to the results of a very high-quality, representative survey of Germany, Austria and Switzerland, which found that ~47 percent of respondents have failed to initiate transactions (access services) because they did not want to have to create another digital identity (fortiss und Initiative D21 2019).

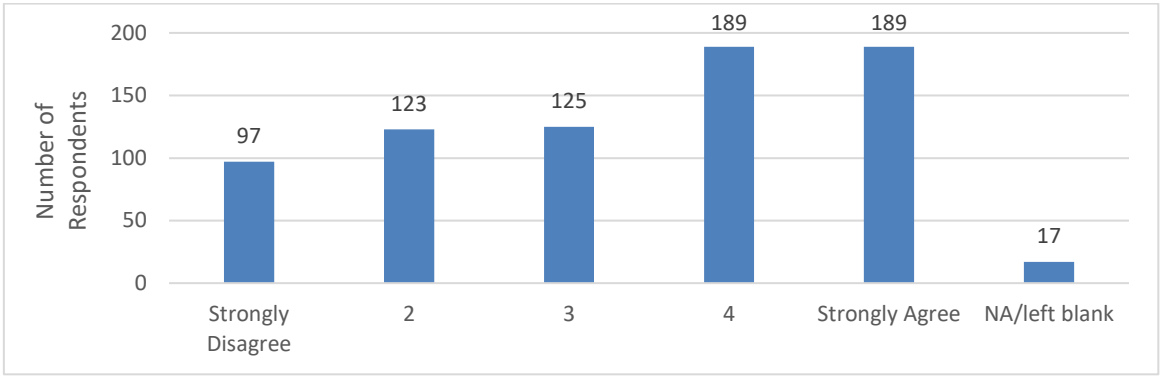

Figure 59: "I sometimes don't use a service because the sign-up process is too much hassle"

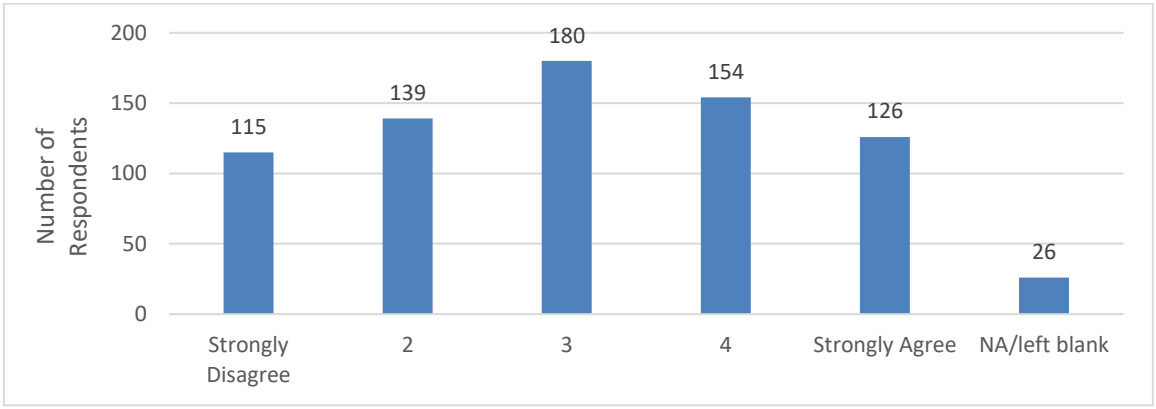

Figure 60: "If signing up for services were easier and faster, I would use more services"

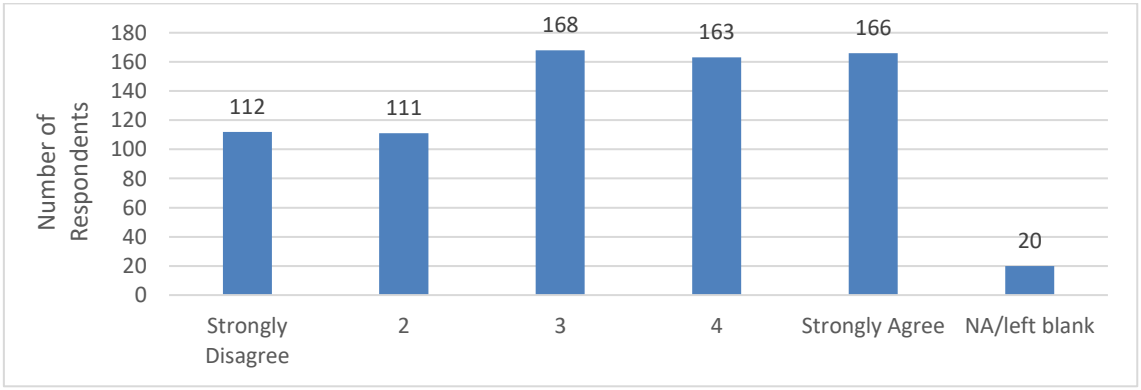

Figure 61: "If I had only one single, secure digital ID, that I could use for all online services, I would use more services"

Since IMPULSE would solve some of these problems, this suggests that it would have a positive effect on the digital economy. How *large* an effect is rather more difficult to say. It depends on how many additional services people might consume, how valuable these might be, and what has hitherto happened when people *failed* to complete a service transaction because of the "hassle" of registration.

When asked to estimate how many online services they regularly used that required a digital identity, 80 percent of respondents gave numbers between 1 and 20. The average number across *all* responses (i.e. including those greater than 20) was 18.7 services (12.3 if the handful of extreme responses [over 100] are excluded). It is hard to say how many additional services people would consume if registration became easier. On the one hand, registration is already not particularly difficult for most services, which suggests that few people consistently forego *high value* services due to registration difficulties. From this perspective, it seems unlikely that widespread use of IMPULSE would increase average service consumption by more than a few percentage points, i.e., "fractions" of services. On the other hand, if people are already consuming most of the high value services that deliver significant benefits to them, those marginal services which are foregone because registration hassle makes them not worth users' while might be disproportionately low-value services. There are many of these. This suggests that the increase in service consumption might be quite large, albeit of perhaps questionable personal and economic value (e.g. distracting and essentially time-wasting social media applications).

As a matter of fact, at least at this point, survey respondents seemed to feel that IMPULSE was more appropriate for particularly sensitive services, such as banking or health care, than low-value services like e.g. social media, as Figure 62 shows. The question for which Figure 62 gives the results had asked users to indicate which services they believed IMPULSE was appropriate for. At the same time, it is important to note that while substantial minorities had indicated the sensitive services like banking or health care, in all cases the majority had *not* indicated the service in question. This suggests that respondents still had only a vague sense of what IMPULSE might or might not be suitable for, and might in future reach quite different conclusions, especially if they began using IMPULSE themselves.

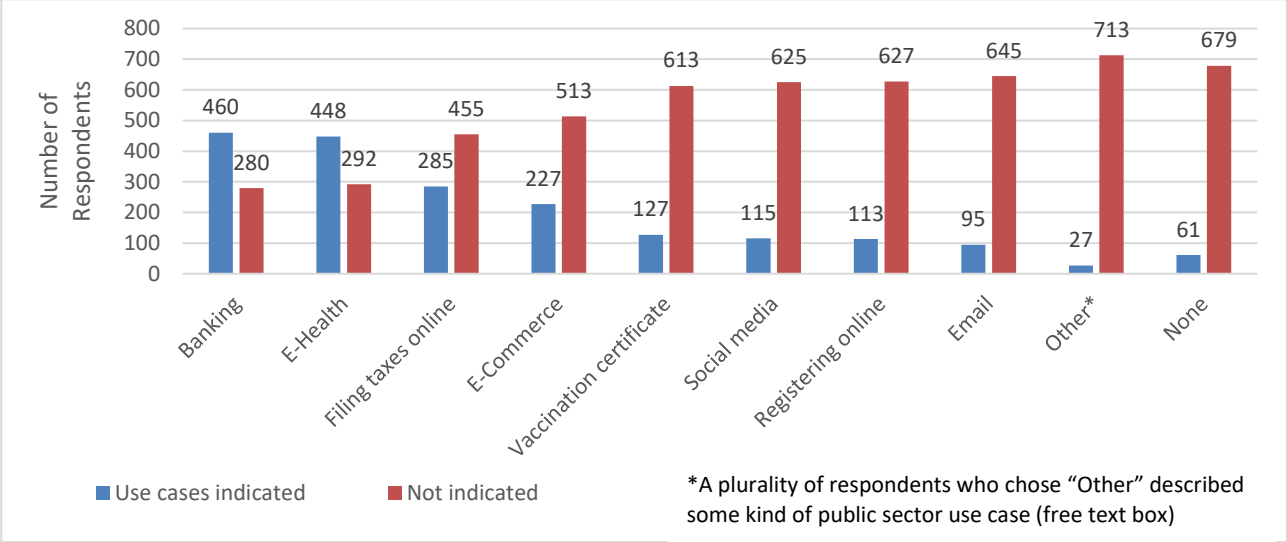

Figure 62: Use cases indicated as appropriate for IMPULSE

5.2 Conclusions about IMPULSE' private-sector economic impact

In summary, we may reach the following conclusions about IMPULSE' potential economic impact in the private sector. Firstly, potential users are at least quite open to IMPULSE. They clearly value the benefits it offers with respect to reducing the need for passwords/usernames, and being able to use it across services. This suggests that if IMPULSE were put on the market, it could enjoy some significant level of adoption, and thus actually *have* an economic impact. Secondly, by displacing username/password-based authentication technologies, IMPULSE could ultimately deliver quite large savings to administration, compliance and

security costs, especially in sectors supplying more sensitive services. Thirdly, there is evidence that IMPULSE might lead to increased consumption of digital services, though it is likely that this effect would be rather mild and mostly confined to lower-value services.

6 Conclusion

With regard to our research questions, the following conclusions can now be offered.

RQ1 and RQ2: What are the specific economic effects of using IMPULSE in the pilot cases and the private sector? How large are the economic effects in the pilot use cases?

The main economic effect of IMPULSE is to enable a variety of efficiency gains for both the public administrations, residents/consumers and the private sector. Savings come about mainly through time saving, and the effects this has on labour costs. Table 13 summarises the possible gains for the use cases where these could be quantified; Peshtera, Aarhus, Ertzaintza and Gijon, including estimates for national level scale up.

	Peshtera/Bulgaria			Aarhus/Denmark			Ertzaintza/Spain			Gijon/Spain	
	Residents Peshtera	**Civil Service Peshtera**	**Civil Service Nat'l**	**Residents**	**Civil Service Aarhus**	**Civil Service National**	**Residents**	**Ertzaintza**	**Police Forces Nat'l**	**For Residents**	**For Civil Servants**
Annual Time Savings (historical data, assuming 100% IMPULSE adoption)	1719 working days (8 hours)	~468 working days (8 hours)	--	64 hours	• social service staff: 2 working days (8 hours) • parish clerks: 2.7 working days	• social service staff: 25 working days (8 hours) • parish clerks: 31 working days	~4863 working day (8 hours)	~3076 working day (8 hours)	--	~196 working days (8 hours)	--
Money Savings over 10 years, Baseline Scenario (30% Adoption)		BGN~26,000 (€ ~13,300)	BGN ~18.8 million (€ ~9.6 million)	--	DKK ~45,000 (€~6000) *minus purchase, installation and maintenance costs for lockers & software*	DKK ~411,000 (€~55,000) *minus purchase, installation and maintenance costs for lockers & software*		€1,9 million	€~40 million		--
Money Savings over 10 years, Ambitious Scenario (80% Adoption)		BGN~57,000 (€~29,000)	BGN ~49.9 million (€ ~25.5 million)		DKK~71,000 DKK (€~9,500) *minus purchase, installation and maintenance costs for lockers & software*	DKK 658,000 (€~88,000) *minus purchase, installation and maintenance costs for lockers & software*		€3 million	€~65 million		

Table 13: Possible savings in Peshtera, Aarhus, Ertzaintza and Gijon

The picture is mixed. The key dynamic is scale: As already should have become clear in the discussion of the pilot cases, the savings achieved in any single transaction are small, counting in the minutes rather than hours. Savings become large only when large numbers of such small savings accumulate, through many transactions. Even then they remain fairly modest. Even if we assume (1) 80 percent adoption of IMPULSE, (2) national-level scale up and (3) aggregate savings *over ten years*, savings only come to €~65 million for the *entire* Spanish police forces (i.e., €6.5 million a year, spread over all Spanish forces) and €~25.5 million (BGN ~49.9 million) for *all* Bulgarian municipal civil services for the use cases explored here. For the Ertzaintza and the municipality of Peshtera themselves, the savings over ten years under this distinctly ambitious adoption scenario would be €~3 million (Ertzaintza) and €~29,000 (BGN ~57,000), or €300,000 and €2900 *a year*. If adoption should remain below the 80 percent assumed here, savings would be commensurably smaller. Of course, if additional use cases could be added to the ones explored here, savings would be greater. A similar patterns is observed in Aarhus. Under these best-case assumptions, Aarhus civil service would save €~6-9500 over ten years; scaled to the whole of Denmark, this would imply savings of about €55-88,000. Of course, all these savings are gross. They would need to be set against the expected upfront investment costs for the system, and ongoing operations and maintenance. Once these costs are factored in, it is likely that only very modest savings would remain.

For residents, the raw time savings (rather than their implicit monetary value) would likely be of greatest significance. Here, potential savings are somewhat greater. Had they all used IMPULSE in the past years, residents in Peshtera would have saved about 1719 working days a year, while Gijon's residents might have saved about 196 working days. Of course, these savings would be distributed across the entire resident body of the municipality. Savings for the individual residents would likely amount to a few hours a year or less. This is not a huge sum, but if delivered to the resident in a "concentrated" form, it may be noticeable: it is the difference between an afternoon devoted largely to government bureaucracy, and an afternoon spent largely with family, hobbies, friends or even work, after quickly completing some forms via one's mobile or desktop.

For the civil services, the time savings might be more valuable than the raw monetary savings, in as far as they allow staff to be redeployed to other tasks. Based on the historical data analysed, had IMPULSE been used by all of Peshtera's citizen, the municipality would have saved on average about 468 working days annually. Assuming 250 working days a year, that amounts to almost two full-time positions. In the case of the Ertzaintza, it would even have been about 3076 working days, about 12 staff positions.

With regard to the private sector, a variety of savings related to administrative, compliance and security costs are anticipated, provided IMPULSE were used in certain particularly sensitive sectors (e.g. finance, health) and received the necessary regulatory clearances. More broadly, it may also mildly increase consumption of online services.

These overall rather modest economic effects are in line with the literature, which expects only limited economic gains from the introduction of "basic" digital identity technology (authentication) in the advanced economies. It must be stressed that these modest savings are also a function of the fact that the pilot cases have only explored isolated use cases. However, it is widely recognised that for digital identity to produce significant economic (and social) effects requires enabling large numbers of public and private-sector use cases in parallel.

RQ3: Does the use of biometrics for authentication give IMPULSE distinct economic effects, compared to other authentication technologies?

The answer here is yes. Many of the time savings that IMPULSE creates for residents depend on the biometric functionality. This reduces onboarding time compared to existing digital solutions (Peshtera pilot) and solves the problem of forgotten PINs (Gijon). Biometrics is crucial to the value proposition of the lockers deployed in the Aarhus pilot: if the lockers relied on traditional physical keys or numerical codes, instead of the IMPULSE technology, they would likely just displace the problem of small, high-value objects getting lost, that is at the core of the Aarhus use case. (Now the locker keys would get lost instead of the NemID cards.)

RQ 4 and RQ 5: What economic effects could adding a Digital Wallet and QES functionality to IMPULSE have? What are the economic effects of their current lack in the IMPULSE solution? Does being an SSI solution give IMPULSE particular economic effects, that other eID architectures will necessarily lack?

These questions could not be explored empirically in the pilot use cases. For the reasons discussed in chapter 3.2.4, it is likely that the addition of the digital wallet and QES functionalities would increase the economic impact of IMPULSE.

Across the case studies, the most important implication is that the digitisation of the public sector and the introduction of new digital identity solutions needs to be well-coordinated across public administrations (as well as private companies), and needs to be ambitious, in order to make it economically worthwhile. Especially basic digital identities only start to deliver significant economic benefits once they are applied very widely. Accordingly, coordination is vital to ensure a sufficiently large volume of intensively-used use cases. Conversely, isolated "island solutions" will likely not deliver significant benefits, and may even be net negative once investment costs are factored in. However, basic digital identities tend to only deliver (generally small and one-off) efficiency savings by way of economic benefits. Larger and more dynamic economic benefits by contrast require more complex advanced digital identity solutions (QES, wallets, etc.). Developing and implementing these requires ambition – and coordination – not only because of the technical challenges, but also because these technologies require wide adoption across ecosystems to produce results. This in turn again requires intensive coordination among relevant actors.

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Annex A List of Interviews

Interview	Date	Interviewees from Case Owner
Aarhus	20 April 2022	Janni Sovang, Lasse Nielsen
Reykjavik	21 April 2022	Kristrun Gunnarsdóttir
Municipality of Peshtera	22 April 2022	Georgi Simeonov
InfoCamere	29 April 2022	Marco Vianello, Nicolo Fassa, Domenico Racantelli
Ertzaintza	13 May 2022	Andoni Osoro
Gijon	27 May 2022	Pedro López Sánchez
Municipality of Peshtera *(further questionnaire)*	31 May 2023	Georgi Simeonov
Ertzaintza *(further questionnaire)*	11 August 2023	Iñaki Gangoiti
Aarhus	5 October 2023	Lasse Nielsen

Table 14: List of interviews conducted

Annex B Questionnaire for Interviews with Case Owners

1. **What is the precise content of the public service of the finalised case?**
   - Who is it for? (Who are the service recipients?)
   - What benefits does it provide them?
   - Among the service recipients (users), are there particular groups who use the service most (e.g. particular age groups, men/women, people in specific family/life circumstances, more educated/less educated, citizens/non-citizens, disabled or people in ill-health vs healthy/fully-abled, people living in urban vs rural areas …)? Is there a "typical" user?
   - Are there particular groups who would be eligible for the service, but seem to use it especially *little*?
   - If so, do you have any thoughts about why particular groups may use it esp. much / little?
   - Are there particular user groups should be better reached with the future solution and why?
   - More broadly, what are the interests and "life situation" of the users/service recipients? What is important to understand about them in order to be able to understand the IMPULSE case?
2. **How is the service delivered at present (pre-IMPULSE)?**
   - What are the individual steps through which it is currently delivered?
   - What mode(s) of electronic or analog authentication is (are) used? How do these work? (e.g. username/password-based, smartcard, 2-factor …)
   - What administrative and IT systems are involved in the current mode of service delivery?
   - Which individuals (public servants) and departments/units in the public administration are involved in providing the service? What exactly do these individuals / units do (what are their tasks?)
   - What are the "interests" and concerns of these individuals and units/departments as regards the provision of the public services? What are the larger framework conditions under which they operate?
3. **What are the main advantages and disadvantages of the current mode of service delivery?**
   - For the users / citizens?
   - For the public servants?
   - For any others? (3rd parties somehow involved in or affected by the service / service delivery)
   - If you as case owners or public servants could change 1, 2, or 3 aspects of how the service is currently delivered, what would you change? Why?
   - What are the 1, 2 or 3 things you would definitely want to preserve? Why?

4. **How is the service to be delivered in the IMPULSE pilot? Please walk us through the individual steps that the users (service recipients) and the civil servants who are involved must take, and help us identify what is different compared to pre-IMPULSE.**

5. **What benefits is the IMPULSE mode of delivering the service expected to offer:**
   - the service recipients (users)?
   - the public servants involved in service delivery?
   - the public administration as a whole?
   - any other stakeholders (3rd parties)?

6. **Could the IMPULSE mode of delivering the service have any disadvantages for:**
   - the service recipients (citizens)?
   - the public servants involved in service delivery?
   - the public administration as a whole?
   - any other stakeholders (3rd parties)?

7. **Do you think there might be acceptance problems, and what would these be**
   - among the service recipients?
   - among the public servants involved in service delivery?
   - Among the public administration as a whole?

Thinking beyond the current use case, are there other applications of IMPULSE (e.g. other use cases) in your organisation or related organisations that you could imagine?

Annex C List of Certificates that be accessed, processed and submitted via the Municipality of Peshtera's digital services platform

	Document Name (English)	Document Name (Bulgarian)
1	Authorizing the development of a sample plan from a detailed development plan	Разрешаване изработването на план-извадка от подробен устройствен план
2	Certificate for the deregistration of a property from the deed books for the properties	Издаване на удостоверение за отписване на имот от актовите книги за имотите
3	Permits for placement of movable objects	Издаване на разрешения за поставяне на преместваеми обекти
4.	Certificates of Current Address issued	Издаване на удостоверение за настоящ адрес при вече регистриран настоящ адрес
5	Issuance of a certificate for the presence or absence of obligations under the Local Taxes and Fees Act	Издаване на удостоверение за наличие или липса на задължения по Закона за местни данъци и такси
6	Issuing a multilingual extract from a civil status certificate	Издаване на многоезично извлечение от акт за гражданско състояние
7	Tax declaration under Article 54, paragraph 4 of the Local Taxes and Fees Act for the ownership of a road vehicle, with the exception of cars and trucks with a maximum technically permissible mass not exceeding 3.5 tonnes	Данъчна декларация по чл. 54, ал. 4 от Закона за местните данъци и такси за притежавано пътно превозно средство, с изключение на леки и товарни автомобили с технически допустима максимална маса не повече от 3,5 тона
8	Issuance of a certificate and a sketch concerning properties subject to restitution located within urbanised areas	Издаване на удостоверение и скица относно имоти, подлежащи на възстановяване, находящи се в границите на урбанизираните територии
9	Granting of a one-time right to lay and/or pass a technical infrastructure facility through a municipal property	Учредяване на еднократно право на прокарване и/или преминаване на съоръжение на техническата инфраструктура през имот-общинска собственост
10	Certificate of heirs	(Издаване на удостоверение за наследници
11	Certificate of administrative address of land properties	Удостоверение за административен адрес на поземлени имоти
12	Authorising the preparation of a complex project for an investment initiative	Разрешаване изработването на комплексен проект за инвестиционна инициатива
13	Issuance of real estate sketches	Издаване на скици за недвижими имоти
14	Registration of bee and colony owners (carried out by town halls)	Регистрация на собственици на пчели и пчелни семейства (извършва се от кметствата)
15	Issuance of a permit for the felling of durable ornamental trees and trees of historical significance	Издаване на разрешение за отсичане на дълготрайни декоративни дървета и дървета с историческо значение
16	Issue of a transcript-excerpt of the death certificate for the second and subsequent time	Издаване на препис-извлечение от акт за смърт за втори и следващ път
17	Certificate of spouse and relationship	Издаване на удостоверение за съпруг/а и родствени връзки

18	Certificate of Marital status	Издаване на удостоверение за сключен граждански брак
19	Issuance of a certificate of no civil status certificate (birth certificate, death certificate)	Издаване на удостоверение за липса на съставен акт за гражданско състояние (акт за раждане, акт за смърт
20	Transcript of a family register kept up to 1978	Издаване на препис от семеен регистър, воден до 1978 г.
21	Termination of category of a tourist site	Прекратяване на категория на туристически обект
23	Certificate of change of permanent address	Издаване на удостоверение за промени на постоянен адрес, регистриран след 2000 година
24	Certificate of children born of a mother	Издаване на удостоверение за родените от майката деца
25	Reports at the request of bailiffs	Издаване на справки по искане на съдебни изпълнители
26	Permission for elaboration of detailed development plans	Издаване разрешение за изработване на подробни устройствени планове
27	Issuance of a permit for the felling of durable ornamental trees and trees of historical significance	Издаване на разрешение за отсичане на дълготрайни декоративни дървета и дървета с историческо значение
28	Issue of a transcript-excerpt of the death certificate for the second and subsequent time	Издаване на препис-извлечение от акт за смърт за втори и следващ път
29	Completion/correction of cadastral plan	Попълване/поправка на кадастрален план
30	Construction of a temporary road to regulated land properties that have frontage at newly designed streets	Прокарване на временен път до урегулирани поземлени имоти, които имат лице по проектирани нови улици
31	Registration of building owners' associations in the municipal register	Вписване на сдруженията на собствениците в общинския регистър
32	Certificate of facts and circumstances on territorial and settlement planning	Издаване на удостоверение за факти и обстоятелства по териториално и селищно устройство
33	Reflection of changes in the inventory list to the cadastral plan	Отразяване на промени в разписния списък към кадастрален план
34	Certificate of ownership of agricultural land from the land registry	Издаване на удостоверение за собственост на земеделска земя от емлячен регистър
35	Issue of a copy of a filed tax declaration	Издаване на копие от подадена данъчна декларация
36	Certificate of permanent address	Издаване на удостоверение за постоянен адрес при вече регистриран постоянен адрес
37	Issuing of a duplicate of already paid vehicle tax	Издаване на дубликат на документ за платен данък върху превозни средства
38	Tax declaration under Article 14 of the Real Estate Tax Act	Данъчна декларация по чл.14 от ЗМДТ за облагане с данък върху недвижимите имоти
39	Tax declaration under Article 54, paragraph 4 of the Local Taxes and Fees Act for a car or truck with a maximum technically permissible mass not exceeding 3.5 tonnes	Данъчна декларация по чл. 54, ал. 4 от Закона за местните данъци и такси за притежаван лек или товарен автомобил с технически допустима максимална маса не повече от 3,5 тона
40	Issuing a permit for the use of medicinal plants	Издаване на позволително за ползване на лечебни растения

41	Certificate of declared data	Издаване на удостоверение за декларирани данни
42	Certificate of marital status, spouse and children	Издаване на Удостоверение за семейно положение, съпруг/а и деца
43	Issuance of birth certificate – duplicate	Издаване на удостоверение за раждане – дубликат
44	Certificate of a presence or absence of a municipal property deed	Издаване на удостоверение за наличие или липса на съставен акт за общинска собственост
45	Certificates of identity of a regulated land property	Удостоверения за идентичност на урегулиран поземлен имот
46	Certificate of tolerability of a construction	Издаване на удостоверение за търпимост на строеж
47	Certificate for the inclusion of newly constructed buildings in the current cadastral plan under Article 54a paragraph 3 of the Land Registration Act, in conjunction with Article 175 of the Planning Act	Издаване на удостоверение за нанасяне на новоизградени сгради в действащия кадастрален план по чл.54а ал.3 от ЗКИР, във връзка с чл.175 от ЗУТ
48	Certificate of a person with different names	Издаване на удостоверение за идентичност на лице с различни имена
49	Consultation of deed books and issuance of certified copies of documents concerning municipal property	Справки по актовите книги и издаване на заверени копия от документи относно общинска собственост
50	Verification that the construction complies with the issued building permits and that the detailed development plan has been applied to the development	Проверка за установяване на съответствието на строежа с издадените строителни книжа и за това, че подробният устройствен план е приложен по отношение на застрояването
51	Permission for placement of advertising and information elements	Издаване на разрешение за поставяне на рекламно-информационни елементи
52	Permission for special use of the road by temporary use of parts of the carriageway and land within the scope of the road	Издаване на разрешение за специално ползване на пътя чрез временно ползване на части от пътното платно и на земи в обхвата на пътя
53	Issuance of an order for the establishment of a right of passing over other people's land	Издаване на заповед за учредяване право на преминаване през чужди поземлени имоти
54	Certificate of changes of present address	Издаване на удостоверение за промени на настоящ адрес регистриран след 2000 година
56	Establishing of housing needs - mapping and issuing a certificate	Установяване на жилищни нужди - картокетиране и издаване на удостоверение
57	Certificate of legal restriction	Издаване на удостоверение за правно ограничение
58	Certificate of marital status	Издаване на удостоверение за семейно положение
59	Revalidation of a building permit which has lapsed due to expiry of the time limit	Презаверяване на разрешение за строеж, което е изгубило действието си поради изтичане на срока
60	Tax declaration under Article 54, paragraph 4 of the Local Taxes and Fees Act for an owned aircraft	Данъчна декларация по чл. 54, ал. 4 от Закона за местните данъци и такси за притежавано въздухоплавателно средство

61	Tax declaration under Article 54, Paragraph 4 of the Local Taxes and Fees Act for ownership of a vessel	Данъчна декларация по чл. 54, ал. 4 от Закона за местните данъци и такси за притежавано плавателно средство
62	Tax declaration under Article 14, paragraph 2 of the Local Taxes and Fees Act for the necessary data for the determination of the real estate tax on a newly constructed building completed in rough construction and the independent objects in it	Данъчна декларация по чл. 14, ал. 2 от Закона за местните данъци и такси за необходимите данни за определяне на данъка върху недвижимите имоти на новопостроена сграда завършена в груб строеж и на самостоятелните обекти в нея
63	Tax declaration under Art. 27 of the Local Taxes and Fees Act for exemption from real estate tax or for use of tax relief	Данъчна декларация по чл. 27 от Закона за местните данъци и такси за освобождаване от данък върху недвижимите имоти или за ползване на данъчно облекчение
64	Tax declaration under Art. 49, par. 3 of the Law on Local Taxes and Fees for taxation of gratuitous acquisition of property	Данъчна декларация по чл. 49, ал. 3 от закона за местните данъци и такси за облагане с данък при безвъзмездно придобиване на имущества
65	Tax declaration under Art. 32, par. 1 of the Law on Local Taxes and Fees for taxation with inheritance tax	Данъчна декларация по чл. 32, ал. 1 от Закона за местните данъци и такси за облагане с данък върху наследствата
66	Request for offsetting or reimbursement of debts and fees unduly paid under the Local Taxes and Fees Act	Искане за прихващане или възстановяване на недължимо платени задължения и такси по ЗМДТ
67	Tax declaration under Article 61n of the Local Taxes and Fees Act for taxation with patent tax	Данъчна декларация по чл. 61н от Закона за местните данъци и такси за облагане с патентен данък
68	Request for cancellation of public municipal receivables, time-barred on the grounds of Article 173, in conjunction with Article 171 of the Tax and Social Security Procedure Code	Искане за отписване на публични общински вземания, погасени по давност на основание чл.173, във връзка с чл.171 от ДОПК
69	Tax declaration under Article 61x of the Law on Local Taxes and Fees for taxation with tax on taxi transport of passengers	Данъчна декларация по чл. 61х от ЗМДТ за облагане с данък върху таксиметров превоз на пътници
70	Declaration under Article 71, item 1 of the Law on Local Taxes and Fees for exemption from the fee for garbage collection and garbage removal	Декларация по чл.71, т.1 от ЗМДТ за освобождаване от такса за сметосъбиране и сметоизвозване
71	Declaration under Article 61p, Paragraph 5 of the Local Taxes and Fees Act for taxation with tourist tax	Декларация по чл. 61р, ал. 5 от Закона за местните данъци и такси за облагане с туристически данък

Annex D Questions asked in the Task 4.1 survey that were analysed in this Deliverable

Prior to Question 10, survey respondents were shown a short animated film that described IMPULSE. The film can be viewed at https://www.youtube.com/watch?v=P3j-xJK5fXA

Question 10: Would you use IMPULSE instead of the digital identity (log-in) systems you currently use (like username/password, smartcard, PIN, etc.), if IMPULSE were available?

Certainly not		…		Certainly yes
1	2	3	4	5

Question 12: For which online services do you think it would be most sensible to use IMPULSE? Please indicate the three most important in your opinion.

- Online banking
- eHealth (e.g. electronic communication with a doctor to get a prescription instead of going in person)
- Digital vaccination certificate for Covid or other diseases
- Social media
- E-commerce (e.g. Amazon, Airbnb)
- Completing tax returns online
- Registering for social services online
- Email
- Other (free text box)
- None

Question 14: Today, many people have multiple digital identities (log-ins), with different usernames/passwords. Please tell us which statements you agree with.

Strongly Disagree		…		Strongly Agree
1	2	3	4	5

- Using multiple digital identities is a hassle, but sensible
- I would prefer to have a single digital ID for all online services and accounts
- I sometimes forget my username/password, or forget which identity to use for a service or account
- I sometimes don't use a service because the sign-up process (when you enter information like your name and address and create a username/password or similar) is too much hassle
- Managing multiple digital identities and ways of identifying myself overtaxes me
- If signing up for services were easier and faster, I would use more services
- If I had only one single, secure digital ID, that I could use for all online services, I would use more services

Question 20: Many online services require you to use a digital identity (log-in), like a username/password, PIN/TAN, Smartcard/PIN or biometric recognition. Please estimate how many private online services you regularly use that require a digital identity (log-in). Such services are e.g. online banking, social networks, insurance, Amazon/online shopping, Airbnb, Booking.com,... Just give us your best estimate.

Freetext box