



Deliverable D1.2:

**DLT4EU Insights Report:  
Distributed Ledger Technologies  
for Public Good**

D1.2

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DLT4EU Insights Report

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# Revision History

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v1.0	27.03.2020	Liz Corbin	Metabolic	Final review

## STATEMENT OF ORIGINALITY

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

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## Executive summary

The potential for DLT in the public and social impact sector is vast, with 179 companies identified across Europe working within this field. The current landscape of DLT applications within the European Public Sector is only just emerging. Those applications already in use or in development cut across a diversity of market sectors as well as product types and are supported largely by for-profit organisations through a common set of business models. Whilst the benefits for DLT in the public and social impact sector are becoming increasingly discussed by public actors within Europe and small steps are being made, there is little evidence of public or private sector applications that have been fully implemented and scaled. The areas of Digital Citizenship and the Circular Economy within the Public Sector could both receive significant positive impact from DLT, particularly with relation to the traceability and immutability features that distributed ledgers can offer. The aspects of decentralisation and security are also attractive attributes to public sector actors.

Our in-depth research uncovered a number of findings:

1. Blockchain applications are considered for use significantly more often than other distributed ledger technologies within both the public and private sectors.
2. Over 50% of interviewed expert respondents felt that the negative perceptions of DLT, more specifically 'blockchain' were a barrier to early stage exploration of its uses in a public sector context.
3. 86% of expert respondents working in the DLT private sector cited regulatory and legal barriers as a key challenge with regards to wide scale deployment and adoption of DLT.
4. These legal and regulatory barriers were also evident in the public sector, with two thirds of public sector experts working in DLT interviews citing regulatory and legal barriers as a constraint.
5. Over half of public sector officials consulted did not perceive DLT as being essential to realise their legislative priorities.

In order to address some of these gaps and challenges, it is evident that the European public sector requires a de-risked manner of experimenting with DLT, in order to lower the barrier to entry to access cutting-edge solutions. It is clear that Europe must take a proactive regulatory approach, including at a national government level, to ensure that innovation is not stifled, and that innovators are not missing key growth opportunities. Europe needs to act now, or risk lagging behind globally in the next decade. Pan-European initiatives should take place, to foster understanding in the value of DLT use cases within the public sector and support the burgeoning DLT for public good landscape within Europe.

Innovators developing DLT solutions across Europe could benefit from mentorship around key legal, regulatory and technical challenges, and ensuring that DLT architects are cognizant of the regulatory landscape from inception. Equally, due to the general risk aversion of the public sector and its oftentimes lengthier procurement processes, a

structured engagement to allow innovators to work closely with the public sector is likely to derive the most value for both parties.

## Introduction

### What is DLT4EU? Looking at the broader #DLT4Good and #Blockchain4EU programmes

DLT4EU aims to stimulate the development of cutting-edge DLT-based applications that address pressing social and environmental challenges and drive positive change for public good. The project will develop an acceleration programme that will facilitate DLT companies to address technical, legal and business barriers, in order to build public good applications around digital citizenship and the circular economy.

The DLT4EU accelerator programme is built upon Digital Catapult's 'Virtual Field Lab' concept of assembling challenge owners alongside DLT companies and co-developing proof-of-concept prototypes deployed in real-world environments. Each Virtual Field Lab will have a 'Challenge Owner' who will scope, guide and define the problem, alongside a network of mentors and experts. As a result of the programme, innovators will have developed proof-of-concepts and functional prototypes that will be utilised in demonstrating the value of DLTs for the public good sector. These proof-of-concepts will then be evaluated, with 3- 5 applications being awarded follow-on funding.

### Scope and purpose of the report

This early-stage insights report aims to bolster the awareness of the potential of Distributed Ledger Technologies for public good in Europe. It is essential for the strategic design of the DLT4Good acceleration programme, to ensure the most impactful, research and data driven interventions are developed. The findings of this report lay the foundations for the DLT4Good acceleration strategy, highlighting the most pertinent opportunities and challenges which need to be addressed in order to achieve the most impact. The report will address four main areas:

1. The status quo of DLT usage within the public sector domain will be explored in the first chapter. Part of our analysis will take an in-depth look at existing business models, and at which business models could be considered to ensure sustained and scalable adoption of the technology.
2. The second chapter of the report will closely examine why DLT should be useful and valuable to the public sector and for public good applications. While the investigation looks at DLT uses within a public sector context, the parties developing and providing the technology are typically privately owned. We will highlight key case studies that have been implemented across Europe, demonstrating the value that DLT presents for the public sector, to enable governments to deliver public good. While the scope will be around digital citizenship and circular economy use cases, useful and relevant

applications which have the potential to pivot into these areas will also be explored, even if they do not directly currently pertain to those classes of use cases at present.

3. The third chapter in the report will closely address why the DLT sector remains relatively immature, and identify which challenges have precluded its widespread implementation and successful use. In identifying its main hurdles, we map the framework conditions for successful utilisation of DLT by EU public and social sectors. The third section also looks closely at the status of R&D funding for DLT in Europe.
4. The report concludes with key considerations to accelerate the adoption of DLT technologies for use in the public sector across Europe within thoughtful parameters. These insights will also be relevant for policymakers across Europe who wish to accelerate the adoption of DLT for public good.

## Terms and definitions

### What is meant by DLT?

In this report, we will refer to both DLT and blockchain, understanding that DLT is a superset of blockchain. Blockchain appears frequently throughout the report as many expert respondents and use cases explored referred to the use of blockchain as opposed to other types of DLT.

Distributed Ledger Technology (DLT) refers to the technology enabling a cryptographically secured 'database' to be distributed between and maintained in a consistent state by multiple distributed computers connected over a network (usually the Internet). Blockchain is a subtype of DLT that consists of validated blocks of transactions linked into a time-sequenced chain. Distributed ledgers can be public or private, sometimes referred to as 'corporate chains' or 'Enterprise blockchain'. DLT seeks to bring multiple independent and non-colluding computers to agreement on a single shared state of truth. Computers connected to a DLT network are referred to as *nodes*<sup>1</sup>. DLT ensures the validity, consistency, and intactness of data by reaching network-wide mathematical consensus. In a DLT-based system, any attempt to re-write data is an attack on consensus and is instantly rejected. DLT is proposed as a fundamentally important tool for securing irrefutable audit trails, without necessitating a trusted third party or centralised authority.

### Europe

Throughout this report the terms 'Europe' or 'European' will refer to the EU and the United Kingdom. The UK remains an important centre for global blockchain and DLT development, and will generate important spillover effects for the rest of Europe. The UK has been subject to a similar regulatory landscape as the rest of the EU, therefore analysing the status and challenges within the UK market in addition to the EU market will provide pertinent and valuable insights for EU member states.

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<sup>1</sup>This is based on Digital Catapult's definition:

[https://assets.ctfassets.net/nubxhjiwgc091/3Ybaz35Dc4y8WW2CgG68we/da538354ff055227daa8db2552ad4de4/Blockchain\\_in\\_Action\\_report.pdf](https://assets.ctfassets.net/nubxhjiwgc091/3Ybaz35Dc4y8WW2CgG68we/da538354ff055227daa8db2552ad4de4/Blockchain_in_Action_report.pdf)

The DLT4EU consortium has formed as a reflection of the rich culture of research and innovation that Europe represents, and the understanding that to further strengthen Europe's global position as a leader in research, technology and innovation, and to maximise the impact around Distributed Ledger Technology for public good, that it is important to draw upon the consortium partners' knowledge in the relevant fields. The expertise of *Digital Catapult* (United Kingdom) in advanced digital technologies, particularly distributed ledger technologies, *Metabolic* (Netherlands) in global sustainability, and *Ideas for Change* (Spain) in digital citizenship allow for the valuable opportunity to draw upon resources with first hand knowledge and insights on the topic.

## Public good

In this report the term 'public good' will refer to any outcomes that benefit society as a whole, addressing any environmental, governmental, community and societal challenges currently faced in the EU and, ultimately, driving positive change for the common good.

## Research methodology

This paper was compiled from a literature review of whitepapers, reports, blogs and articles issued from governments, top tier business firms, blockchain advisory groups, business leaders, and academics. We chose to use as wide a range of sources as possible given that DLT for the public sector is a large, interdisciplinary activity, with multiple stakeholders.

We conducted an ecosystem mapping exercise to gain a bird's eye view of DLT activity in the public sector across Europe, utilising a number of different databases, including those developed from in-house research conducted by consortium members. This was accompanied by 24 detailed expert interviews.

Given its immaturity, expert interviews were a highly useful approach to understand the many moving parts of the DLT sector, and to identify the players who need to be involved for its public sector implementation. Experts were chosen from across the ecosystem, and included members of the OECD high level expert group on blockchain, senior government officials with DLT focuses from different European governments, startups developing blockchain solutions, and academics from top institutions with a focus on DLT. Experts were intentionally selected from a diverse range of backgrounds to ensure that we had breadth in understanding of the potential use cases and hurdles from all angles. Throughout this report, referencing "experts" specifically refers to the interviews conducted by Digital Catapult in March 2020 for this report.

To ensure we leveraged each expert's individual insights, we employed a semi-structured interview process, based around open-ended stems, from which we were able to tap into each interviewee's domain specific expertise. Informed consent was gained for each interview, opting to conduct the discussions under Chatham House Rule, to ensure that participants would answer in the most transparent way possible.



To achieve rigorous results, with the ability to compare answers and allow us to provide a more comprehensive analysis, a set of stem questions were asked in every interview:

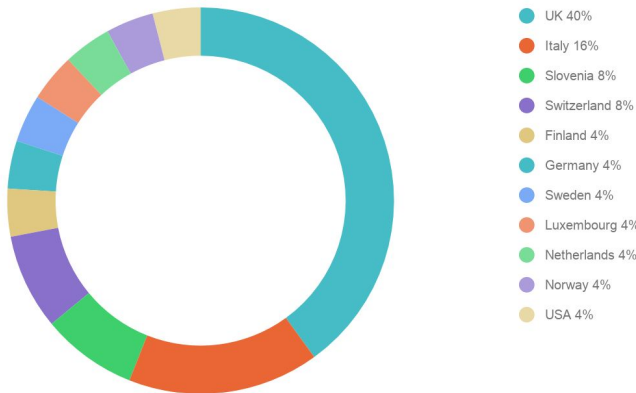
- 1) Their interest and angle on distributed ledger technologies, i.e. in what capacity they engage with blockchain activities, whether that was in developing a startup solution, implementing it in government processes, research into the technology etc.
- 2) The main opportunities they felt DLT presented for: a) any sector b) the public sector specifically.
- 3) The main challenges that emerge with the experimentation and development of DLT solutions within a) any sector and b) the public sector.

This approach allowed us to better understand and cluster the answers around what were cited to be the largest opportunities and challenges that arose by domain and sector.

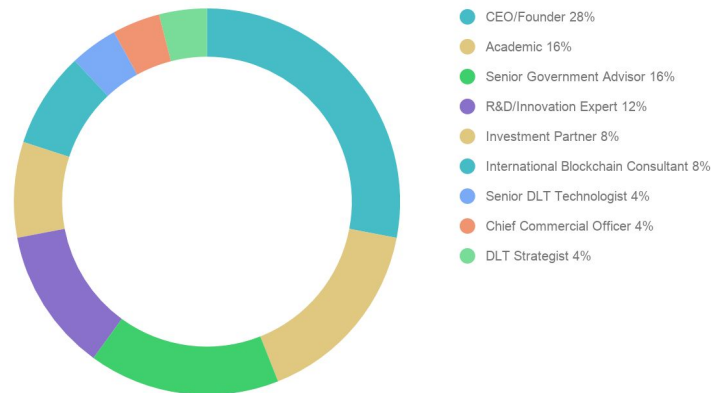
The following infographic provides some insight as to the breakdown of countries engaged and the roles of the experts interviewed.

**Figure: Experts interviewed by location & job role**

Location of experts interviewed



Profession of experts interviewed



## Chapter 1

### Mapping the European DLT Public Sector Landscape

This chapter will attempt to provide a snapshot overview of the DLT ecosystem within the European Public Sector. The analysis is based upon a broad ecosystem mapping exercise - inclusive of desk research and qualitative interviews - which had the scope of identifying as many DLT organisations actively working specifically on DLT solutions for public good in Europe as possible. Building on top of this mapping research, this chapter will present: the overall size (number) of DLT organisations working within the field; the geographic

distribution of where the organisations are located; the nature of the organisation (e.g. for-profit, non-profit, etc.); the typologies of business models being deployed in the sector; and lastly the nature of applications being produced and their level of maturity.

## Chapter 1.1: Key Findings

### Organisational Types

Throughout the ecosystem mapping process, 179 DLT organisations were identified as working specifically on DLT solutions for public good in Europe (defined as either headquartered or with major operational bases in Europe). These organisations are distributed across Europe - with the United Kingdom, Spain, the Netherlands, Germany, and Switzerland standing out as the most concentrated locations in the field. Organisations are adopting a number of incorporation types to formalise their work. At 72%, the leading majority of organisations have chosen to incorporate as a For-Profit company. Within this type the largest majority - at more than 90% - are companies registered as SMEs<sup>2</sup>, a small minority of 4% are registered as Enterprise<sup>3</sup>. The second most common incorporation type is a collection of non-commercial forms including Non-Profit, Foundation, and Non-Government Organisation. In total 18% of organisations identified fell within this incorporation category. The remaining organisations are Public Administrations (making up 2%) and Public-Private Partnerships (making up 2%).

### The nature of DLT Applications

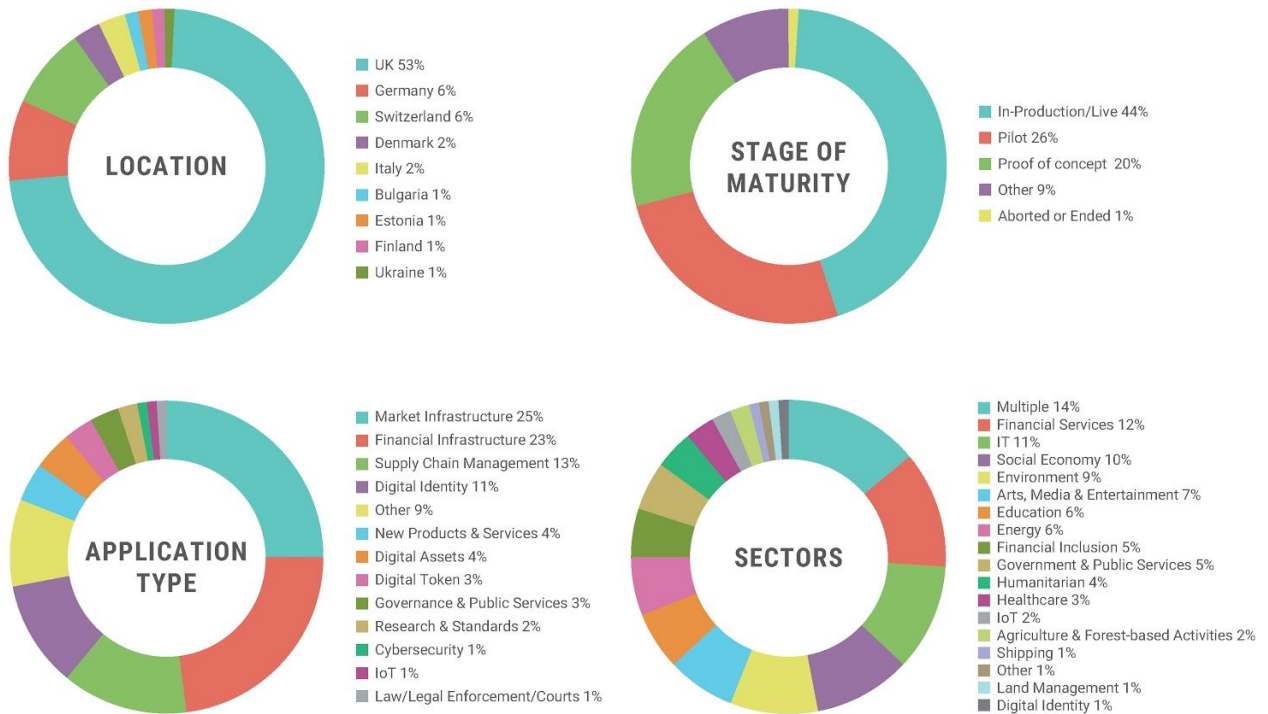
A deeper analysis of the 179 organisations identified and their products / services provides a snapshot into the nature of those DLT applications being produced for the European public sector. The mapping identified 16 leading sectors which DLT applications are being used. The most common sectors include: Financial Services (12%), IT (11%), Social Economy (10%), Environment (9%), and Arts, Media & Entertainment (7%). The mapping exercise also identified 12 leading typologies of DLT applications. The most common typologies include: Market Infrastructure (25%), Financial Infrastructure (23%), Supply Chain Management (13%), and Digital Identity (11%). Lastly, the mapping exercise identified various stages of maturity for the DLT applications within the European public sector -with the majority of applications proving to be within the 'Live' and 'Pilot' stages of their development.

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<sup>2</sup> SME is defined as less than 250 employees.

<sup>3</sup> Enterprise is defined as more than 250 employees.

**Figure: Key statistics of the European DLT public sector landscape**

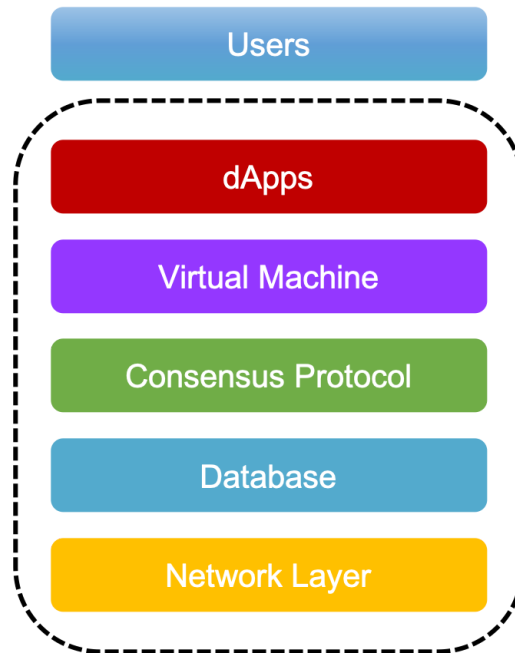


## Chapter 1.2: What business models are most commonly used for DLT apps within the public sector?

This section focuses on business models that are particularly pertinent to the field of DLT for public good. Given the distributed, multi-stakeholder nature of DLT, there is an expectation that new, hybrid forms of business models will emerge in the public good field where ledgers are developed and deployed according to different governance and ownership systems.

Firstly, there are some further core concepts specific to the DLT sector which must be covered before any discussion of business models. Firstly, DLT is an *infrastructure-level* technology, akin to an email service or telephone lines, but once the lines have been laid it is possible to extend the functionality with *distributed applications*.

The ledger comprises a *stack* of components, each with a role to play in creating the overall system. This is illustrated in the diagram below:



**Figure:** The internal components of a Distributed Ledger

A DLT’s *networking* and *databasing* functionalities are fairly self-explanatory, but these can and do differ between offerings.

The *consensus protocol* is the core element that ensures the network of nodes are maintaining mathematically identical replicas of the one common ledger. Again, there are many different algorithms and methods for reaching consensus, some more power-consuming than others (e.g. Proof-of-Work as used by Bitcoin versus RAFT as used by Hyperledger Fabric), but the trade-offs are not always as clear - you would not want to use RAFT for a mission-critical system facing potential adversaries, for example.

Finally, the *virtual machine* and *distributed applications* are where DLTs become extensible. Not all DLTs require these elements to be useful - they can operate purely as consistent distributed databases. But these components of the *stack* provide automated execution capabilities based on stored procedures within the ledger (aka *smart contracts*).

Throughout mapping the field of DLT for public good, two main categories of business models were identified: Software-as-a-Service and Product Provider. Each category, as further defined below, is organised by two sub-categories: *Full-Stack* and *Partial-Stack* offerings. Full-Stack offerings refer to parties creating the underlying ledger with or without tailored functionalities such as user interfaces, internal *smart contracts*, etc. This is similar to laying down a new railway network between towns and providing a few trains. The gauge might be unique to that network, but others might come along in the future and add new interesting trains. Partial-stack offerings are parties who are focused on creating *distributed applications* that execute on existing ledgers - similar to an ‘app store’ where there is some underlying DLT infrastructure. In these early days of blockchain/DLT, this is most commonly the public Ethereum blockchain, but as the early leader in this field, many other blockchains are also compatible with Ethereum code.

Business Model One: Software-as-a-Service (SaaS) Provider		
<p>SaaS models are where an organisation provides a software solution on a service-basis via pricing models such as subscription or licensing, rather than as a discrete product. Importantly, the ownership of the technology is (usually) retained by the technology producer.</p>		
Sub-Category One: Full-Stack Offering		
Description	Developer / User Relationship	Case Study
<p>Most 'private' or 'corporate' blockchain solutions are currently full stack offerings, bundling the blockchain and the application together, because there is no such existing infrastructure between organisations.</p>	<p>The DLT provider relationship here can be long-term as the lead beneficiary will usually buy a subscription or license to the platform.</p>	<p>R3 Corda: A blockchain SaaS developed by a commercial organisation co-founded in 2015 by 9 banks to provide the rails of future financial infrastructure. They have an enterprise pricing model for other parties to build new products atop.</p>
Sub-Category Two: Partial-Stack Offering		
Description	Developer / User Relationship	Case Study
<p>A DLT partial stack (aka a distributed app) service offering is where the main offer of the service is a distributed application, running on a blockchain or fed by data in a blockchain, but separate from it. Software executing on a blockchain is colloquially referred to as a 'smart contract'.</p>	<p>Here providers can help meet a lead beneficiary's need for a specific activity or function, and grow a long-term relationship with the lead beneficiary.</p> <p>Many offerings in this field make use of <i>tokens</i> to operate their smart contracts, in an identical fashion to paying for a subscription service through credits, or interacting with a digital coin-operated machine.</p>	<p>Founded in 2014, Provenance is a platform that empowers brands to take steps toward greater transparency by communicating the origin, processes, and impacts of the products they make.</p> <p>Provenance began with a frustration for how little we know about the things we buy. Opaque supply chains are devastating environments and compromising the wellbeing of people, animals and communities. With Provenance's platform, companies can easily gather and verify claims, and create the story of their products before communicating these to shoppers through their channels, both online and in-store.</p>

## Business Model Two: Product Provider

This model is where an organisation provides a product as a discrete technical solution. The ownership of the technology can often be under an open license, or transferred to the lead beneficiary. Importantly, the end use of the product is often agnostic to the industry or implementation context. For example, a smart contract enabling the execution of a payment can be applied to multiple use cases across different industries.

### Sub-Category One: Full-Stack Offering

Description	Developer / User Relationship	Case Study
<p>Here, often the open source blockchain solutions are full stack offerings. These business models act as a platform that enables users to adopt and build on top of the full stack.</p>	<p>The DLT provider relationship with the lead beneficiaries has less of an emphasis because the technical solution is usually open source and / or agnostic to use cases.</p>	<p><b>DECODE</b> is a Horizon 2020 funded project started in 2017 to explore how citizens could regain ownership of their digital personal data and to provide practical tools to enable this vision. To date, DECODE has built a private and anonymous distributed ledger, to which a range of microservices can be attached. DECODE OS was piloted in Barcelona as a citizen petitions platform under a 'Digital Democracy and Data Commons' theme. The pilot enabled greater privacy, secure data sharing, and with the distributed ledger, ensured transparency for citizens. This platform can be applied to different use cases beyond data sharing.</p>

### Sub-Category Two: Partial-Stack Offering

Description	Developer / User Relationship	Case Study
<p>A DLT partial stack (aka a distributed app) service offering is where the main offer of the service is a distributed application, running on a blockchain or fed by data</p>	<p>The DLT provider relationship with the lead beneficiaries has less of an emphasis because the technical solution is usually open source and / or agnostic to use cases.</p>	<p>Founded in 2015, Slock.it first presented 'slock' - a door lock connected to the IoT using a blockchain. Since then, the company has developed a portfolio of 'tools' including a Distributed Autonomous</p>

<p>in a blockchain, but separate from it. Software executing on a blockchain is colloquially referred to as a 'smart contract'.</p>	<p>Sometimes, DLT providers will provide a professional services / consulting option where they help implement a specific use case of their technology with a client, as an additional revenue stream to their business model.</p>	<p>Organisation framework, and the Universal Sharing Network - a decentralised application that enables peer-to-peer asset sharing. The value of Slock.it products is the flexibility to apply them to multiple use cases - to date this has included solutions for e-charging and mobility, energy, and voting / governance.</p>
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### Chapter 1.3: What is the status of public sector DLT innovation and what are the challenges in accelerating R&D within this field?

R&D intensity, the measure of R&D expenditure as a proportion of a country's GDP varies significantly between European Union member states, with the highest in Sweden at 3.3% and the lowest, 0.5% in Romania. The UK, at 1.7% is below the EU average of 2.1%. Whilst overall R&D expenditure, technically defined as a country's Gross Domestic Expenditure on R&D (GERD) has risen over the past 15 years, the EU remains below that of other global economies such as Israel, South Korea, China (excluding Hong Kong) and the United States.<sup>4</sup>

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While private sector R&D (Business Expenditure on R&D) is the largest contributor to total R&D, the government has an important role in investment. However, government expenditure, which includes research councils (GovERD) on R&D has fallen, with the most recent data showing that current expenditure is below 2009 levels.<sup>7</sup>

#### R&D definitions and DLT

R&D is defined through international agreement between OECD member countries. While this definition is adhered to for measurement of expenditure, there is a debate within economics around a widening of the definition of 'R&D', with concern that the focus on scientific knowledge is excluding ever increasing areas of research in digital technologies that are shaping new sources of knowledge, including research on blockchain and DLT, from being suitably measured.<sup>8</sup> As such, little data exists on public sector expenditure and R&D activity specifically relating to DLTs. The lack of readily available data regarding DLT in R&D activities, is a further example of limited measurement of the wider drivers of innovation.

<sup>4</sup> [https://ec.europa.eu/eurostat/statistics-explained/index.php/R\\_%26\\_D\\_expenditure](https://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure)

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<https://www.ons.gov.uk/economy/governmentpublicsectorandtaxes/researchanddevelopmentexpenditure/bulletins/ukgrossdomesticexpenditureonresearchanddevelopment/2017>

<sup>6</sup> <https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm>

<sup>7</sup> <https://rio.jrc.ec.europa.eu/en/stats/public-government-and-higher-education-rd-expenditure-gdp>

<sup>8</sup> [https://media.nesta.org.uk/documents/innovation\\_gap\\_NnSMXKy.pdf](https://media.nesta.org.uk/documents/innovation_gap_NnSMXKy.pdf)



While an important policy target, an over- emphasis on R&D intensity, without acknowledging the potential narrowness of scope, is detracting from the necessity to incorporate other, complementary measures of tracking innovation to better measure their contribution to European economies.

With public sector investment in innovation moving at a slower pace than private sector investment, at a time when the European Union has not met its target of 3% research intensity by 2020,<sup>9</sup> Europe has an opportunity to take significant strides into exploring the implementation of DLT in the public sector as a means of furthering its innovation activity. This is particularly important to take advantage of now as the technology is still relatively immature, but, as with other emerging technologies, is seeing significant and rapid developments. This would require widening the traditional definition of R&D activity and placement of DLT research on the same level as traditional R&D activities. Investment in DLT implementation as a research activity would as such give an opportunity to help to narrow the gap between private sector activity and public sector activity on DLT.

One CEO that we interviewed noted the European public sector’s strength in funding and conducting basic research and exploration of research activities, but that more importance needed to be placed on the implementation and commercialisation of the knowledge gained from initial research.

Without the availability to sufficiently measure DLT activity by public actors, questions remain on where public actors are putting resources to improve DLT implementation, as well as the ability to track public sector investment in the technology over time.

## Chapter 2

### What are the main opportunities and drivers for adopting DLT in the public sector within Europe?

This chapter will discuss the nature of the various public sector opportunities presented by DLT in the areas of Digital Citizenship and the Circular Economy. We will also explore the drivers behind the growing interest in the topic, and present a comparative analysis of uptake in the EU public sector versus other global public actors.

We begin with a discussion of the perceived disparity between private sector applications and acceleration of DLTs and public sector applications, discussing possible reasons for this gap.

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[https://ec.europa.eu/eurostat/statistics-explained/index.php/Europe\\_2020\\_indicators - R%26D and innovation#R.26D intensit%20in\\_the\\_EU\\_is\\_growing\\_too\\_slowly\\_to\\_meet\\_the\\_Europe\\_2020\\_target](https://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_R%26D_and_innovation#R.26D_intensit%20in_the_EU_is_growing_too_slowly_to_meet_the_Europe_2020_target)



The second subsection will explore some of the more technical aspects of DLTs, and the related benefits that the technology has to offer, with specific reference to the gains that can be realised in the public sector through appropriate application and scaling of the technology.

The third subsection will delve into the area of the Circular Economy, looking at what it encompasses and the ways in which implementation of DLT can help to achieve significant progress in working towards addressing human needs whilst minimising waste, and promoting sustainable usage of resources in a manner that has not been possible with other systems and technologies.

The chapter concludes with an exploration of the ways in which application of DLT in the public sector can support the progression of Digital Citizenship. This will take into account the ways in which the technology can help to remove barriers of entry for participation in civil engagement and public services.

**In summary, this chapter addresses the following topics:**

- 1) The context of DLT uptake within the European public sector
- 2) What are the opportunities for applying and scaling DLTs in the public sector?
- 3) Exploring the potential of DLT for enabling the Circular Economy
- 4) Exploring the potential of DLT for fostering Digital Citizenship

## Chapter 2.1: Contextualising the uptake of DLT in the public sector

### Understanding the hype

Initial high expectations for blockchain and other distributed ledgers, and subsequent slow adoption, mean that the hype around the technology is now approaching what is described by Gartner as the 'Trough of Disillusionment'<sup>10</sup>, in which inflated expectations begin to die down before real world applications have yet to take hold and usher in the 'Slope of Enlightenment'. Whilst DLT is by no means a panacea for all societal challenges, there are an increasing number of opportunities becoming apparent. These opportunities offer both incremental and transformational positive impact in the public sector in a manner that has not been possible with previous data management technologies. Distributed ledgers are likely to become critical infrastructure for public sector institutions, delivering a robust system to ensure data integrity and transparent data management, as well as the potential for enhanced resilience through redundancy. There is significant pressure on the public sector to maintain best practice around data governance, leading a growing number of politicians, technologists, academics and other relevant stakeholders around the world to become interested in distributed ledgers.

### Increasing global interest in public sector DLT

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<https://www.gartner.com/en/newsroom/press-releases/2019-10-08-gartner-2019-hype-cycle-shows-most-blockchain-technologies-are-still-five-to-10-years-away-from-transformational-impact>

In the years since blockchain was first revealed to the world in 2008, a growing number of countries around the globe have set out national strategies for blockchain implementation. The interest in public sector applications of DLT is varied and wide ranging, with countries such as Australia setting out its 2019 National Blockchain Roadmap<sup>11</sup> to address issues affecting specific sub-sectors of its economy, China establishing Blockchain Pilot Zones<sup>12</sup> and passing a series of laws around the related area of cryptography, and Kenya setting out national plans to fully derive the benefits of blockchain-enabled services<sup>13</sup>.

European organisations are taking similar steps to explore and potentially capitalise upon the technology, with the government of Malta<sup>14</sup> committing resources to ensure that its regulatory infrastructure around blockchain is fully accountable but does not create unnecessary restrictions to usage and adoption, and continues to attract foreign investment in the sector. Similarly, Luxembourg’s announcement of a public sector blockchain to allow public actors to benefit from the technology in its digital information and process systems<sup>15</sup> is demonstrative of their stated action plan to become leaders in public sector application of distributed ledgers. Names such as ‘Crypto Valley’ and ‘Blockchain Island’ in reference to specific and concentrated hubs for blockchain and distributed ledger technologies within Europe can be seen as further demonstrative of the increasing interest in DLT by European public actors.

Experts consulted for this report have cited the European Commission’s Digital Strategy as an important and necessary driver for accelerating the adoption of distributed ledgers in the European public sector, in part to address the chasm that exists between private sector acceleration of DLT and public sector uptake. Here, the key pillars of (i) technology that works for the people, (ii) a fair and competitive digital economy, (iii) an open, democratic and sustainable digital society and (iv) Europe as a global digital player are all policy areas that require new approaches that produce different results. DLT’s promise of enhancing transparency, data integrity, access control and security can assist in ‘future-proofing’ and improving European public administration. Furthermore, public sector examples within Europe have acted as drivers to demonstrate their utility to public actors, and although these pilots and demonstrators often exist only at an early proof-of-concept stage<sup>16</sup>, they provide the business case for integration of the technologies into current systems.

### Learnings from private sector demonstrations & investment landscape

Industry experts share a common perception that widespread adoption in public organisations’ usage of DLT applications to streamline and better secure their processes will only come to fruition once there have been successful demonstrations of fully scaled

<sup>11</sup> <https://www.industry.gov.au/sites/default/files/2020-02/national-blockchain-roadmap.pdf>

<sup>12</sup> <https://cointelegraph.com/news/china-launches-licensed-blockchain-pilot-zone-to-further-tech-usage>

<sup>13</sup> <https://www.ict.go.ke/blockchain.pdf>

<sup>14</sup> <https://www.pwc.com/mt/en/publications/technology/pwc-malta-blockchain-alert.html>

<sup>15</sup> <https://chronicle.lu/category/innovation/29323-first-public-sector-blockchain-announced>

<sup>16</sup>

<https://www.biginnovationcentre.com/showcase/live-blockchain-showcase-a-real-demonstration-of-the-uk-blockchain-industry-applications/>

distributed ledgers in the private sector. This follows the precedent of earlier disruptive technologies; despite potentially reaping large benefits from implementing the technologies on a wide scale, the traditionally risk averse public actors often require a large number of differing and successful use cases from the private sector to take learnings from. As such, increased visibility of successful private sector examples and public/private partnerships, with visible benefits and transferable qualities, continue to drive public sector awareness and understanding of the ways in which the technology can be used. Demonstrations of real world adoption of DLTs in the public sector with private sector collaborators at this stage are necessary to determine what is needed for successful scaling, and to determine any ‘teething’ or significant issues that may arise.

With regards to investment into the European DLT sector, it is important to note that the available data primarily refers to investments in blockchain-based cryptocurrencies, which are separate from other applications of the technology. Following a period of increased interest and investment into blockchain globally in the 2015-2017 ‘cryptocurrency bubble’, the 2018 cryptocurrency crash led to the price of blockchain’s most famous application Bitcoin, along with other cryptocurrencies, to fall by around 80%<sup>17</sup>.

This fall in cryptocurrency investment and valuation has had a knock-on effect on non-cryptocurrency blockchain companies that focus on areas such as blockchain infrastructure, services, and applications. Despite recovering some ground in 2019, the landscape surrounding valuations of blockchain companies has not quite returned to pre-2018 levels, leaving more uncertainty for already hesitant investors. As a result of this uncertainty, blockchain and DLT companies often turned to non-traditional forms of investment, with initial coin offerings (ICOs) as the primary alternative.

Within Europe, the UK, Germany and Switzerland are key locations for investment. However the European landscape remains relatively conservative in comparison with its counterparts in China and the USA.<sup>18</sup> Some experts<sup>19</sup> suggest that this could in part be due to a somewhat unclear legal and regulatory framework that leaves European investors hesitant to invest without fully knowing the legal implications.

There is a sentiment from the industry experts we contacted that investment in public good DLT projects is seen as important, but traditional investment pathways prioritise enterprises that will bring the most return, and investment in these projects are unlikely to do so in the near term. From this perspective, investment into DLT for these purposes will likely be a byproduct of investment into DLT ventures that are more financially attractive.

Having said this, it is pertinent to explore non-traditional investment pathways. Both venture philanthropists and impact investors will be more relevant to innovators in this space than more common venture capital firms which solely emphasise financial returns.

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<sup>17</sup> <https://www.bloomberg.com/news/articles/2018-09-12/crypto-s-crash-just-surpassed-dot-com-levels-as-losses-reach-80>

<sup>18</sup> <https://www.cbinsights.com/research/report/blockchain-trends-opportunities/>

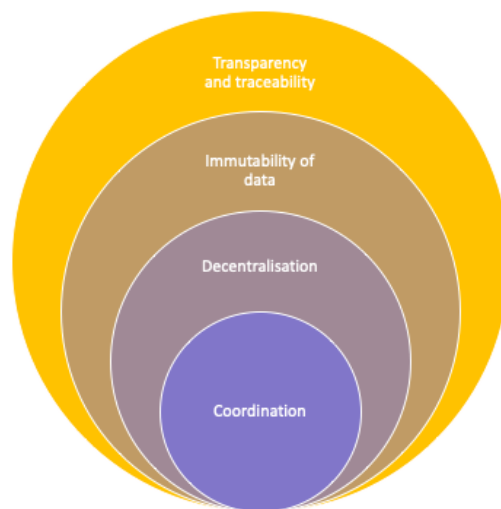
<sup>19</sup> Expert interviews undertaken by Digital Catapult in March 2020.

Venture philanthropy is a form of specialised philanthropy which finances (using grants, equity, debt, etc) to support enterprises with a social purpose. The financial terms offered can be more relaxed as a result of the philanthropic origin of venture philanthropy, and ranges from no expectation of financial return to more typical impact investment returns.<sup>20</sup> Impact investing on the other hand looks to fund companies to generate social impact *alongside* financial returns. Impact investment has more players and capital than venture philanthropy, in part due to the focus of investment around market rate returns. For this reason, impact investment has a low tolerance for risk, shorter investment horizons, and seek clearly defined exit strategies.

As both venture philanthropy and impact investment funds are focused on driving forward public good, it appears difficult to find such organisations which are explicitly interested in DLT. Consequently, identifying companies interested in the two themes of Circular Economy and Digital Citizenship will be more relevant. There are a number of impact investment funds which focus on waste, plastic, metal and energy which are likely to engage with circular economy solutions,<sup>21</sup> as well as a number of venture philanthropists engaged in strengthening democracy and civic engagement, which will be relevant digital citizenship use cases.<sup>22</sup> It is important to engage within this investment ecosystem to propel the funding and resources in these use cases forward.

**Chapter 2.2: What are the opportunities of applying and scaling DLTs in the public sector?**

Rather than wholly displacing the role of public institutions, the use of DLTs can be used as a complementary addition to an institutions’ operations, adding a layer of process alignment and efficiency, and increased trustworthiness of data whilst also allowing it to be retrieved with minimal friction when necessary.



**Figure:** Beneficial features of Distributed Ledger Technologies

**Reducing Costs of Coordination**

<sup>20</sup> <https://tonic.com/venture-philanthropists-and-impact-investors/>

<sup>21</sup> Within Europe, this includes companies such as Stitching DOEN, Invest-NL, Partners for a New Economy.

<sup>22</sup> Within Europe, This includes companies such as Adessium Foundation, BMW Foundation, King Baudouin Foundation.

Distributed and shared systems address the fundamental misalignments that exist between disparate parties trying to act towards a common goal. By creating a common pool of trusted data, and streamlining processes through the use of stored procedures (so-called ‘smart contracts’), the costs of acting as a cohesive whole are vastly reduced, enabling all energies to be put into achieving that common goal. This is particularly relevant for issues in the circular economy and digital citizenship, such as blockchain enabled e-voting or blockchain backed community currencies, where vast numbers of moving parts and individual actors must be somehow coordinated in order to achieve greater societal benefit.

### Decentralisation

The decentralisation aspect of Distributed Ledgers should be attractive for public actors; unlike other data management and storage methods that are often employed within institutions such as cloud systems or some Customer Relationship Management Systems (CRMs), DLTs do not require a third party to act as an intermediary to the data or processes. Due to this decentralisation, redundancy and data integrity is greatly increased. Through the usage of permissioned distributed ledgers, a public institution would decide who can act as a node within the distributed network. The data breaches that public bodies have suffered through attacks on third party hosted systems provide an incentive for decentralised data systems that remove a layer of external intermediation. Breaches such as the 2018 attack on the European Central Bank’s ‘Banks’ *Integrated Reporting Dictionary (BIRD)* website<sup>23</sup> could potentially be made less likely by ensuring all data accesses and controls are visible in real-time and recorded on the shared ledger.

### Immutability of data

An important benefit that DLTs offer to organisations serving the public sector is that once entered, the data within the ledger is immutable: all parties can be assured that they have a factual, up to date and agreed upon history of data. Moreover, when storing this data on a permissioned ledger, the likelihood of outside interference is significantly lowered. This assurance of immutability could be of particular use to state organisations that are required to store citizen data and public records, maintaining the trust of various stakeholders including the general public. This helps to ensure that the data held in the ledger is the most up to date and accurate information and that it has not been unilaterally altered.

The immutability of data in blockchain lends itself well to contracting or agreements, in that once the terms have been agreed to by the parties involved, the terms cannot be altered. The self-executing nature of smart contracts which can be programmed within a distributed ledger allows for the automation of processes without the need for third parties or human interaction. Smart contracts promise to speed up and reduce the costs of deal execution by removing the need for arduous paperwork, providing an optimised workflow and, provided that the necessary code and legal framework is written correctly, ensures that transactions are executed as planned. Should anything occur which was outside the intention of the

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<sup>23</sup> <https://www.ecb.europa.eu/press/pr/date/2019/html/ecb.pr190815~b1662300c5.en.html>

framing of the smart contract, the data and code which led to the adjudication remains completely visible within the ledger to refer to a traditional court for assessment. This enhanced process efficiency is therefore accompanied by an indelible audit trail should anything go wrong.

### Transparency and Traceability

One use of DLT that has the potential to positively impact a large number of people is its use for the storage of public data by governmental bodies, health organisations, insurance agencies, and financial bodies. The traceability of distributed ledgers has the potential to be useful for public sector usage in that it facilitates full visibility of asset movement and ownership, whether in a supply chain or in traceability elements of social welfare and wellbeing.

The transparency aspect of distributed ledgers should be of particular interest to public institutions given that each individual object or asset (virtual or real) can now be catalogued and 'tokenised', giving tangibility to assets that were otherwise intangible, and allowing visibility and knowledge about processes that could not be efficiently tracked with previous technologies.

## Chapter 2.3: Exploring DLT's potential for the Circular Economy

### What is the Circular Economy?

In discussions of the circular economy, we refer broadly to an economy that fairly distributes resources without undermining the functioning of the biosphere or crossing any critical planetary boundaries or social thresholds. In other words, a circular economy is one in which resources are extracted, distributed, utilised, and recycled in a manner that does not cause adverse effects to society or the environment. Importantly, any definition of the circular economy must move beyond sheer material efficiency to include a more holistic set of performance characteristics that are indicative of broader social and environmental wellbeing. To this end, Metabolic developed the 7 Pillars of a Circular Economy<sup>24</sup> which, collectively, provide a holistic framework for defining a circular economy. The 7 Pillars are as follows:

- Materials are cycled at continuous high value
- All energy is based on renewable sources
- Biodiversity is supported and enhanced through human activity
- Human society and culture are preserved
- The health and wellbeing of humans and other species are structurally supported
- Human activities maximize generation of societal value
- Water resources are extracted and cycled sustainably

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<sup>24</sup> <https://www.metabolic.nl/news/the-seven-pillars-of-the-circular-economy/>

Exploration of the ways in which DLT can help to promote the circular economy is extremely timely and of great importance due to the global drive to reduce the negative aspects that can arise out of a linear economy, such as irreparable damage to the environment, humans and animals; and the waste in time and resources that results from a fragmented supply chain.

Distributed ledger applications in the circular economy are extensive and include the topics of supply chain traceability, material passports, ownership transfers in secondary markets, end-of-life compliance, automating environmental audits, and new models of incentivisation for positive impacts.

### DLT usage in the Circular Economy

With citizen engagement around environmental issues at a high, and demand for public bodies to make substantial steps towards sustainability and being more environmentally conscious, the application of DLT in the areas of energy, sustainability, climate, biodiversity and the circular economy is a sphere that has the potential to have the most significant positive impacts in the public sector. The use of distributed ledgers in the circular economy have been highlighted as a legislative priority by the Maltese government, the United Nations and the EU - and it is likely to follow a consistent upward trend across Europe.

The use of distributed ledgers within the circular economy presents more opportunity than traditional information management systems that are often employed for public use, due to the high levels of immutability and transparency that they provide. The decentralisation and coordination aspects of blockchain are particularly relevant for the circular economy in that it offers the opportunity to significantly shift the control over parts of the economy that currently result in an inefficient linear structure, to incorporate more disparate parties and even transfer utility and value from shareholders to stakeholders.

Current centralised management systems have to date been unable to achieve this as they traditionally place power in the hands of a few rather than distributing control and power amongst the varied and necessarily diverse actors that are needed to accomplish a truly circular economy.<sup>25</sup>

### EU Green Deal and DLT

Ensuring a sustainable and efficient circular economy has been hailed as the number one priority for the European Green Deal<sup>26</sup> in its efforts to become the first climate-neutral continent by 2050. With sentiments that the Union should apply more ambitious efforts to fully expedite this transition into a sustainable Europe, DLT offers the potential to apply a new and disruptive method to help facilitate such a transition. The European Union's Circular Economy Action Plan<sup>27</sup> places particular importance on finding new and innovative means to move away from the current behaviours and attitudes that are currently applied towards

<sup>25</sup> <https://www.pwc.com/qx/en/sustainability/assets/blockchain-for-a-better-planet.pdf>

<sup>26</sup> [https://ec.europa.eu/info/sites/info/files/european-green-deal-communication\\_en.pdf](https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf)

<sup>27</sup> <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614>



re-using, recycling and waste disposal. The Green Deal also commits to a ‘smart sector integration’ of the electricity, gas and heating sectors into a single system, a mission in which distributed ledger applications have the potential to play a significant role in facilitating, owing to the decentralisation, immutability, and process automation aspects of the technology.

## Case Study: Lifecycle management of batteries Everledger



Concerns around the safe disposal of batteries have been in public discourse for several decades, with initiatives such as the 1991 *European Council Directive on batteries and accumulators containing certain dangerous substances*, and the 2006 *Battery Directive*.

In more recent years, the discourse has shifted to question if batteries are a less sustainable option than fossil fuels - especially as everyday devices, including cars, are battery charged. However, some argue that the main damage batteries may create in the environment is mainly due to the way in which batteries are sourced, manufactured and recycled - and *if* these processes are handled responsibly, batteries can be sustainable.

Indeed, this is exactly what UK blockchain startup Everledger seeks to address: their DLT solution focuses on enabling better transparency on asset ownership, characteristics and origin. The company committed to supporting the Global Battery Alliance, an organization designed in part to create a sustainable battery value chain.<sup>28</sup>

Everledger is using blockchain to create a fully traceable record of the lifecycle of the component materials in batteries for portable electronics, the metal parts of electric vehicle batteries, and other battery types, with the intention of promoting responsible re-use and recycling of these products. The company is currently piloting programmes with international governmental agencies, large automotive manufacturers and industry membership associations to test the capability, connectivity and market awareness of using the technology in the circular economy.

One of these pilots is a cross-technology project, also using Internet of Things technologies to connect relevant stakeholders across the electronic vehicle supply chain to determine end-of-life compliance and management. Everledger is also experimenting with using blockchain to ensure stakeholders are suitably aware of their product life cycles and to incentivise consumers to recycle both batteries and portable electronics.

By integrating blockchain with other relevant technologies to ensure full traceability of the finished product and its component parts, Everledger provides the products with material passports allowing full and immutable visibility of the product life cycle in a manner that

<sup>28</sup> For the full case study, see <https://www.everledger.io/circular-thinking-the-race-to-trace-battery-lifecycles/>



was not previously possible without this technology. This visibility and traceability helps to ensure that component suppliers within the battery supply chain can be held fully accountable for their part in the process and minimising the damage that this supply chain could cause to the environment.

## Case Study : Pharmaceutical tracking

### Farmatrust



The global healthcare and pharmaceutical sector often contains high levels of falsified and counterfeit drugs for human use - in 2017 officials seized 25 million illicit medicines worth an estimated value of \$51m.<sup>29</sup> These falsified drugs often contain ingredients that are in the wrong doses, are deliberately and fraudulently mislabelled with respect to their identity or source; and/or have fake

packaging, the wrong ingredients, or low levels of the active ingredients, and as such have the potential to cause serious injury or fatalities.<sup>30</sup> Supply chain fragmentation often means it can be difficult to track individual medical packs and as such, it can be difficult to differentiate between genuine products and falsified ones. Regulation such as the EU Directive on falsified medicines for human use<sup>31</sup> has placed more onus on pharmaceutical manufacturers and distributors to serialise and stringently track and trace their products, leaving those in the supply chain needing better methods of tracking their products.

Farmatrust provides blockchain solutions to support the traceability of medication across supply logistics operations and reduce the prevalence of counterfeit and falsified medical products. By using blockchain alongside other technologies such as artificial intelligence (AI), the company aims to improve transparency, efficiency and accountability within the healthcare sector and pharmaceutical supply chain. Through partnering with public actors within government, regulators and other relevant stakeholders, the company's traceability platform helps to improve both good manufacturing practice (GMP) and good distribution practice (GDP), both of which are important aspects of improving connectivity within the currently fragmented pharmaceutical supply chain and contributing to the circular economy. This is particularly timely in light of a recent EU review of healthcare systems which noted evidence of "widespread inefficiency" in Europe.<sup>32</sup> This is echoed by the UK's Carter Review into UK hospital efficiency which discussed the need for better resource management to complement good clinical care.

In operating its traceability platform, Farmatrust's use of blockchain can help to ensure accuracy in the reporting of clinical trials and tests, ensure that serialised medication packs and other treatments are fully trackable when moving between manufacturers, pharmacists, hospitals and other key consumers, and help to better regulate the practice of just in time delivery in healthcare products. This is of importance to both small molecule drugs such as aspirin and to more advanced therapies medicinal products such

<sup>29</sup> <https://www.telegraph.co.uk/global-health/science-and-disease/governments-urged-tackle-scourge-fake-drugs/>

<sup>30</sup> <https://www.ema.europa.eu/en/human-regulatory/overview/public-health-threats/falsified-medicines-overview>

<sup>31</sup> [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L\\_.2016.032.01.0001.01.ENG](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.032.01.0001.01.ENG)

<sup>32</sup> [https://ec.europa.eu/economy\\_finance/publications/economic\\_paper/2015/pdf/ecp549\\_en.pdf](https://ec.europa.eu/economy_finance/publications/economic_paper/2015/pdf/ecp549_en.pdf)

as DNA based cancer therapies. The traceability platform may also help public health bodies to better negotiate the price that they pay for drugs with pharmaceutical manufacturers, allowing the money saved to be reallocated within health services.

## Chapter 2.4 Broader opportunities for DLT in a Circular Economy context

### Addressing the environmental collective action problem through the tokenisation of intangible assets

Collective governmental action is required on a global level to be able to properly address environmental degradation.<sup>33</sup> Despite this need for high-level coordination on climate change, environmental benefits can be achieved through collective action on a microscale, with citizen buy-in at both national and regional levels in Europe.

Preservation of the environment will bring a number of social and public benefits. This preservation can be better fostered by civic engagement - taking place in the form of meticulous recycling and proper waste sorting or disposal, opting for more sustainable transport options, etc. Currently, these citizen actions are 'invisible' within the economy - there is little data to properly understand where and how this civic engagement is taking place.<sup>34</sup> Tokenisation of this participation (assigning transferable digital units of account) utilising DLT solutions might be a valuable method to incentivise enhanced civic engagement, but also to measure where it is happening and to what scale, which is useful for future policy development. With the tokenisation of assets, local governments could more easily provide digital incentives to citizens to further the circular economy and ultimately push for more sustainable habits. Consequently, tokenisation can provide tangibility to intangible assets.

## Chapter 2.5: Exploring DLT's potential for Digital Citizenship

### What is digital citizenship?

Digital citizenship refers to the application of digital technologies to supplement and improve the engagement of citizens in acts such as public decision making, service improvement and social impact initiatives, at any level of government. Specific usage may be applied to areas such as asset registration, personal record keeping, voting, migrant identity and inclusion, financial inclusion, data management, and community participation. Aspects of civil engagement, social inclusion and data sovereignty, to lower any barriers of entry to aspects of engagement within civic society, are of paramount importance for the EU's legislative priorities.

### Digital Citizenship in the context of Europe

<sup>33</sup> [https://bruegel.org/wp-content/uploads/2019/09/Bruegel\\_Policy\\_Brief-2019\\_05\\_1.pdf](https://bruegel.org/wp-content/uploads/2019/09/Bruegel_Policy_Brief-2019_05_1.pdf)

<sup>34</sup> <https://etendering.ted.europa.eu/document/document-file-download.html?docFileId=74662>

The European Commission's Digital Transition Partnership<sup>35</sup> (“*Partnership*”) is an alliance whose objectives are to support European cities in their exploration of digitalisation, providing better public services to citizens, and assisting European businesses to develop the innovations and technological business opportunities that will serve both European and global markets.

This Partnership specifically addresses several elements of digital citizenship that complement the adoption of DLT by public sector actors, such as the implementation of ‘citizen-centric e-government’ and contributing towards generating value through ‘free and fair access to open, public and personal data’.<sup>36</sup>

Exploration of DLT in the public sector for digital citizenship also lends itself well to the stated objectives of the Partnership due to its potential to support the Partnership’s focus on working on the adoption of emerging digital technologies, the transition into a business model approach in cities, and strengthening cities’ capabilities to act within the digital transition.

The European Union’s Blockchain Observatory has already discussed the benefits of establishing a blockchain based digital identity system, as well as the digitisation of national currencies, with the recommendation that sovereign governments within Europe support the development of user-controlled, *self-sovereign* identity capabilities that can enable proof of identity without revealing more personal information than is strictly necessary.<sup>37</sup>

This notion is supported by experts consulted in this report, with some noting that DLT can be implemented by governments and other public partners in areas such as the identity verification aspect of financial interactions.

### Case Study : Financial Inclusion and local currencies

#### MoneyFold



UK startup Moneyfold offers fiat backed stablecoins that are implemented as cryptocurrency, using the public permissionless Ethereum blockchain. Their DLT test case has used Estonia’s state established e-residency system - which provides e-residents with a state issued smart card that can be used to verify identity and sign documents - to enable state level identity authorisation checks for financial

transactions. Each time a financial transaction is needed, a smart contract is triggered on the public Ethereum blockchain to authenticate identity and make a payment. This removes the need for third party banks or institutions to authenticate identities, and

<sup>35</sup> <https://ec.europa.eu/futurium/en/node/1963>

<sup>36</sup> <https://ec.europa.eu/futurium/en/node/1963>

<sup>37</sup>

[https://www.eublockchainforum.eu/sites/default/files/reports/eu\\_observatory\\_blockchain\\_in\\_government\\_services\\_v1\\_2018-12-07.pdf?width=1024&height=800&iframe=true](https://www.eublockchainforum.eu/sites/default/files/reports/eu_observatory_blockchain_in_government_services_v1_2018-12-07.pdf?width=1024&height=800&iframe=true)

therefore removes the barriers to financial inclusion for the most vulnerable in society who may not have access to such institutions such as those without a fixed address and new migrants - an issue that has been raised as a key part of European Union Neighbourhood Policy<sup>38</sup>.

The company could find no other comparable service with a substantial success rate of verifying identity: due to the immutability and smart contracting aspects of blockchain, it is the most appropriate underpinning technology to facilitate this functionality in a trustless and provable manner. As the demonstration service is developed and applied more widely, there is the potential to be able to use DLT to facilitate the use of biometric data such as fingerprints and iris recognition to turn those into a platform to enable equality opportunities to be identified in financial services for all members of society.

The use of blockchain as an underpinning technology to facilitate this is applicable to countries with developed economies, those with economies in transition, and those with developing economies. In developed economies the use of fiat tokens to operate financial services has the potential to lower systemic risk compared to its risk levels when using current financial services infrastructure and has potential uses including procurement processes. In developing and transitioning economies where there may be less mature systems of financial infrastructures, the use of blockchain or other DLTs to facilitate this identity verification can also help to reduce the risk of intermediaries disrupting the process. The implementation of this technology is important in helping those from peripheral communities to participate in civic engagement.

Moneyfold also works with local authorities to explore the potential of blockchain to ensure better transparency and accountability of the *Brixton Pound* - a local complementary currency to British Pound Sterling within the Brixton area of London that aims to support Brixton businesses and encourage local trade and production. The implementation of blockchain to underpin this community currency holds the potential to more accurately track how money is spent in the local economy whilst ensuring sufficient anonymisation and how exactly it generates positive value and economic benefit, both for Brixton and the wider economy. This is particularly relevant as this transparency can better inform public actors of the ways in which resources and services should be allocated to support a fully inclusive European public society.

**Case Study : Digital Identity**  
**LuxTrust & Cambridge Blockchain**



Digital identity firm LuxTrust is backed by the government of Luxembourg and produces solutions to protect the privacy, digital identity and the electronic data of LuxTrust certificate holders. They have partnered with Cambridge Blockchain to develop a privacy-protecting European identity platform to enable both businesses and consumers to exchange and manage sensitive data online within a secure and trusted environment.

<sup>38</sup> [https://ec.europa.eu/neighbourhood-enlargement/neighbourhood/eu-initiative-financial-inclusion\\_en](https://ec.europa.eu/neighbourhood-enlargement/neighbourhood/eu-initiative-financial-inclusion_en)

Applications on the joint platform cover aspects of identity verification and privacy such as know-your-customer (KYC) checks for financial service providers, data from internet of things (IoT) devices, and personal data including health records. The use of blockchain as a means of supplementing the data management offerings that LuxTrust already provided has enabled an enhancement in the security aspects that the EU General Data Protection Regulation (GDPR) requires<sup>39</sup>.

Using blockchain in this platform has allowed the partnership to develop a more secure method of ensuring GDPR features such as fast onboarding, consent management and compliance services for natural persons, legal entities and devices, whilst ensuring that there is full transparency and auditability of transactions relating to the authentication, sharing and management of personal identity data.

This application of using a distributed ledger in data management in Europe is particularly interesting due to questions that often arise with regards to the compatibility of blockchain and GDPR. Whilst people have had concerns that the immutability aspect of blockchains would be incompatible with aspects of the regulation such as the 'right to be forgotten', it is important to note that with carefully-designed use of the ledger to ensure that it embodies the necessary 'privacy by design' aspect of GDPR, appropriate controls on data privacy such as hashing can be implemented from the outset and can ensure the most secure but accountable method of securing data.

## Chapter 3

### What are the main challenges to the adoption of DLT within Europe?

This chapter will address three main research questions. Firstly, as this report highlights, DLT presents numerous opportunities for the public sector across Europe, with DLT providing an interesting solution to a set of complex social and environmental problems. Consequently, the report will explore why there has not been more interest or initial uptake of DLT within the European public sector. This subsection will explore the interest in DLT at its earliest stage, and address why DLT may not be considered a priority. This includes technological challenges, perception issues, or a lack of in-house skills, as well as uncertainty around the regulatory landscape for DLT.

The second subsection explores the hurdles that are experienced by governments, public sector or private sector organisations currently experimenting with DLT. This delves into where there is an identified interest in DLT, and solutions have been explored, however there have been challenges in scaling and promoting the widespread adoption of the DLT solution. The challenges in this subsection typically emerge at a later stage than the first subsection:

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<sup>39</sup> For the full case study, see <https://www.luxtrust.lu/en/article/1276>



it delves into the so-called ‘valley of death’,<sup>40</sup> and which domain specific challenges emerge with implementation and scaling. This subsection will refer specifically to digital citizenship and circular economy use cases.

**In summary the two research questions are as follows:**

1. Why has there not been more initial interest or experimentation of DLT in Europe?
2. After identifying the value of DLT, and DLT is sought to be implemented, scaled, and widely adopted within the European public sector, what are the main hurdles that emerge?

## Chapter 3.1

### Why has there not been more initial uptake or experimentation of DLT in Europe?

This subsection looks at the barriers facing the exploratory phase of DLT uptake. These are the barriers facing the earliest stage of DLT/blockchain. We identified two main challenges at this stage: (i) perceptions of DLT, and (ii) technical skills.

Over 50% of expert respondents referenced perceptions, hype and crypto-centricity as being one of the largest early stage barriers to growing interest and further exploration of DLT. Respondents seemed broadly confident that this will be surpassed as more and more successful uses of DLT are adopted in the public sector. This of course relies on early adopters within the public sector - explorations on how to accelerate this are offered throughout the identified risks, with formal considerations in the concluding chapter. Skills, the second subset of this subchapter, emerged multiple times in literature reviews around the success of DLT in Europe, and was expressed by experts<sup>41</sup> as a concern in terms of hiring and expanding DLT teams.

#### Perceptions of DLT: Skepticism, (mis)trust and demystifying the hype

DLT provokes us to deeply re-evaluate the nature and source of trust: with Goldman Sachs referring to it as ‘the new technology of trust’<sup>42</sup>, other players have been less enthusiastic, with Wired magazine even writing ‘there is no good reason to trust blockchain’<sup>43</sup>.

Perhaps unsurprisingly, the large number of current blockchain enthusiasts exist alongside an equally large number of committed skeptics. It is perceived that the core benefits around blockchain, namely around democratization and decentralisation, are an overestimation of DLT’s capabilities in our social context, as there remain pockets of concentrated market power. Skeptics argue that while blockchain may technologically enable a fully transparent and traceable audit trail, it would require a paradigm shift in the way we traditionally model

<sup>40</sup> [https://www.researchgate.net/publication/228166397\\_A\\_Valley\\_of\\_Death\\_in\\_the\\_Innovation\\_Sequence\\_An\\_Economic\\_Investigation](https://www.researchgate.net/publication/228166397_A_Valley_of_Death_in_the_Innovation_Sequence_An_Economic_Investigation)

<sup>41</sup> Expert interviews conducted for this report by Digital Catapult, March 2020.

<sup>42</sup> <https://www.goldmansachs.com/insights/pages/blockchain/>

<sup>43</sup> <https://www.wired.com/story/theres-no-good-reason-to-trust-blockchain-technology/>

and structure businesses. This raises deep questions around the practical usages of DLT and its compatibility with current market structures and market powers. This is not an unassailable challenge - indeed, somewhere in the centre, between the centralised 'oligarchy' narrative and the decentralised 'blockchain utopia' likely lies a happy medium,<sup>44</sup> but it is important to recognise the potential structural limits that may exist in some industries with regards to adopting DLT.

Skeptics also perceive 'blockchain' as a mere buzzword, with the idea that DLT is not essential to developing use cases around public good, with more traditional centralised systems offering a simpler and equally effective solution. It is viewed that the narrative around DLT is too technology-centric: while the focus is around what DLT is capable of doing, what has been less clear is what *benefits* this technology actually offers. Skeptics view use cases as being fitted to the technology, described as 'retrofitting', as opposed to the technology bringing a fundamental solution to the table which is more efficient, useful, or cost-effective than using a traditional centralised system. These expert interviewees were aware of the innovative use cases around digital citizenship, for instance, but were not convinced that DLT is fundamental to its development. Some senior public sector officials, especially within countries of highly digitised public services, expressed that they did not feel DLT was necessary to enhance their public service offerings further.<sup>45</sup> This occurred where there is already strong citizen satisfaction and trust with current technology systems, and consequently, there is little impetus to be an early adopter of DLT.

DLT, in particular blockchain, has also had significant negative press. Often conflated entirely with cryptocurrency, it has been associated with anarchism, money laundering, fraud, and international scams. While it is not an insurmountable challenge to overcome these current perceptions, it is important to frame the capabilities that DLT can deliver with a dose of realism: ensuring not to over-promise what the technology is capable of offering today, especially in the public sector context. There is no doubt that the opportunities DLT offers the European public sector are significant, but it is important to be aware of these doubts to: a) better contextualise DLT's current status as relatively immature in the European landscape; b) have clear regulation or models for how multiple actors can work together utilising blockchain; c) understand that it is imperative to refine the scope of challenges and opportunities that this technology will bring, realistically, without hype, and clearly positioning how it will deliver key benefits, especially when the public purse is leveraged; d) continue to create forums for the public sector across Europe, and on an individual member state level, to share learnings, promote best practices and dispel blockchain myths.

## Skills

Globally, the blockchain education space has been accelerating, with American universities offering full degrees in blockchain - as of 2019, NYU became the first university in the US to offer students the possibility to major in blockchain. European universities have followed suit, with the University of Nicosia (Cyprus) being the first to offer a Masters degree in Digital

<sup>44</sup> <https://www.forbes.com/sites/stewartsothey/2019/02/03/blockchain-and-the-resistance-of-incumbents/#3bd004424cf1>

<sup>45</sup> Expert interviews conducted for this report by Digital Catapult, March 2020.

Currency<sup>46</sup>, whilst the University of Oxford<sup>47</sup> and University College London (UCL)<sup>48</sup> both offer short blockchain courses. However, European universities do not currently feature prominently in the top 10 list for blockchain studies (the only exception is the Swiss Federal Institute of Technology Zurich).<sup>49</sup>

Given the advanced technology epicentres that exist across Europe, this area has much promise, but there remains room for development and improvement. There are many blockchain networks across Europe, for example the Dutch Blockchain Coalition - established in 2006, or the British Blockchain Association, established in 2017. Globally, formalised expert network groups, such as the 'OECD high level expert group on blockchain', are emerging. This group was officially devised in January 2020, and is sure to create dynamic knowledge transfers, with agglomeration effects spilling over across the European region, and allowing for best practices and 'in-house' European skills to be developed. Having said this, due to the highly sought after set of skills that blockchain technology experts have, and their relative scarcity, it makes it very challenging for them to be hired in the public sector - private companies, especially multinational technology companies, set market expectations, and can offer more competitive packages.

Conversely, looking at the real life challenges that DLT can provide interesting solutions for, (especially with regards to the circular economy and digital citizenship) a blend of interdisciplinary skills with a range of different domain expertise will be required. It may be interesting, on an international European level, to explore ways in which teams can be better upskilled to understand the potential of DLT solutions, whilst similarly exploring how blockchain talent in the private sector could be applied to the public sector. This may be achieved through exploring different topologies of business models, for example, adopting private sector solutions in the public sector through building the correct API access around the technology. This may also include capacity building in the public sector via education programmes and joint ventures, incorporating business models that lower the barrier to entry around the technology, through reduced costs for instance.

## Chapter 3.2

### When trying to implement, scale and widely adopt DLT solutions within the public sector, what are the main hurdles that emerge?

This section explores challenges that emerge during the 'valley of death',<sup>50</sup> wherein the technology might have difficulty in being commercialised or in the case of the public sector, precludes it from being properly implemented and widely adopted. Within our research, these hurdles have created stalemates.

<sup>46</sup> <https://www.unic.ac.cy/blockchain/msc-digital-currency/>

<sup>47</sup> <https://www.sbs.ox.ac.uk/programmes/oxford-blockchain-strategy-programme>

<sup>48</sup> <https://www.ucl.ac.uk/short-courses/search-courses/blockchain-executive-education-programme>

<sup>49</sup> <https://www.entrepreneur.com/article/328256>

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[https://www.researchgate.net/publication/228166397\\_A\\_Valley\\_of\\_Death\\_in\\_the\\_Innovation\\_Sequence\\_An\\_Economic\\_Investigation](https://www.researchgate.net/publication/228166397_A_Valley_of_Death_in_the_Innovation_Sequence_An_Economic_Investigation)



We identified a number of key issues and clustered them into three predominant categories:

1. **Legal:** (i). Reconciling GDPR and DLT; (ii). Uncertainty of regulatory processes lengthening investment cycles
2. **Political:** (iii). Governance uncertainty; (iv). Expectations around DLT from both citizens and public sector
3. **Technological:** (v). Interoperability and intuitive user interface; (vi). Limited throughput; (vii). Consensus mechanisms

The most frequently referenced challenge when looking at both digital citizenship and circular economy use cases was around regulatory and legal: 86% of expert respondents in the private sector referred to regulatory constraints as a key challenge facing the adoption and use of DLT, with two thirds of public sector officials interviewed referencing regulation as a fundamental issue regarding DLT.

## Legal

### Reconciling GDPR and DLT

GDPR mandates that individuals must be able to request that their data can be modified, or completely deleted from the record in many circumstances - this is a concept termed as the 'right to be forgotten'. The regulation not only levies hefty fines for these violations: there is also a strong public sentiment associated with privacy - it is felt that companies, organisations, and governments must be robust in their approach to privacy and consent - it is non-negotiable.<sup>51</sup> This poses a challenge for blockchain solutions. The premise of blockchain and DLT is that the data is immutable and unchangeable in nature. It is technologically possible to change data on a blockchain - albeit not straightforward, but it is possible. Within public blockchains, however, changing data is incredibly challenging due to the requirement to coordinate multiple separate actors to agree to the data revision. The way in which the technology is currently used, there is minimal to zero scope for removing or altering information on public blockchains.

Furthermore, GDPR was designed with the assumption that there is a centralised database or service which controls the rights to an end-user's information, and that in relation to each personal data point, there is at least one legal person who can be addressed to enforce their rights under the law. However, blockchain is a decentralised system, replacing unified, central parties with distributed parties. This makes the allocation of responsibility difficult in terms of enforcing data protection laws, with a lack of clarity surrounding who should be accountable for data breaches<sup>52</sup>. This regulatory landscape adds a level of uncertainty in the adoption of the technology, making it a challenge for solutions which include personal data to be accepted or used, especially for digital citizenship or digital identity.

<sup>51</sup> Article 8 - Protection of personal data, EU Charter of Fundamental Rights.

<https://fra.europa.eu/en/eu-charter/article/8-protection-personal-data#TabExplanations>

<sup>52</sup>[https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS\\_STU\(2019\)634445\\_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU(2019)634445_EN.pdf)

This challenge is by no means insuperable; solutions have been proposed, such as storing personal data off chain, with the blocks only containing information around the verification/transaction. It is imperative that blockchain architects are aware of the regulatory landscape from the onset of their DLT development, and that innovators in this field receive legal guidance and support in order to be compliant and develop promising solutions to leverage the most out of blockchain while respecting privacy laws. Given the risk aversion of the public sector, the difficult regulatory landscape has undoubtedly added layers of complexity for implementing and adopting DLT solutions. The lack of fully operational and demonstrable success of this technology in the private sector has led to a stalemate in the public sector.

### **Regulatory processes, or uncertainty, elongate investment cycles**

Currently, startups operating within the DLT sphere have specific difficulties in securing investment. The regulatory landscape may be sector specific; broadly speaking, startups have reported elongated investment cycles during regulatory clearance. It can become especially challenging for startups to raise investment where there are unclear or murky waters around the future of the laws and regulations around the use of the technology. In some cases, the elongated investment cycle for this reason means burning through seed funds too quickly, presenting cash flow issues for innovators.

This is especially pronounced for DLT use cases which focus on financial or crypto assets, which have a particular potential for financial inclusion within digital citizenship or lowering the barriers to entry to finance.<sup>53</sup> Given the perceived trickiness of reconciling GDPR and DLT, the investor concerns around the general regulatory process prove to be non-trivial, and pose interesting questions about the nature in which governments could utilise private sector solutions in their systems. It is important that regulatory bodies engage and become part of the consultation process in order to reconcile any challenges.

Public bodies may want to consider a) adopting a proactive approach on regulatory issues, having a clear leadership position and perspective of the parameters within which blockchain should be utilized - especially, given this context, to ensure innovators do not lose out on securing investment at the right time and b) providing specific funding opportunities for innovators developing DLT solutions for public good.

## **Political**

### **Governance uncertainty**

The nature of DLT solutions removes the need for a trusted third party for verifying the data integrity of the system; due to DLT's decentralised storage, consensus mechanisms and cryptography, it distributes the decision making process, as well as distributing the data to

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<sup>53</sup> Financial inclusion as part of digital citizenship will continue to be of importance for Europe, as 40 million citizens in the EU are 'unbanked', as well as citizens who have families across the world who lack access to a bank account. See for more information: <https://www.wsbi-esbg.org/press/latest-news/Pages/Close-to-40-million-EU-citizens-outside-banking-mainstream.aspx>

numerous players. Often, the idea around DLT governance is conflated with automated self-governance, meaning that the governance is believed to be embedded within the system via mathematical consensus mechanisms. However, the question at hand here is a superset of that issue - it is not just concerning the 'block to block' operation to reconcile the time sequencing of blocks and valid transactions, it includes questions around the governance of infrastructure development, deployment, system updates, and dealing with failure. The governance debate has been enriched by the immutability of data, lack of organisational or company structures, and presence of unknown actors in permissionless blockchains.

Typically, the governance processes in the public sector are linear. However, the nature of DLT alters the dynamics between the contributors - the responsibility and decision-making is distributed. Typically, each department has a clear line of responsibility - with each department or mandate having clear powers for different matters, (e.g. in the case of the UK, HMRC (Her Majesty's Revenue & Customs) would be responsible for citizens' payment of taxes etc.) However, in the use of DLT for use cases around citizenship, different departments or individuals hold and have access to the same data. This raises important questions around who should be held accountable for failures, and where the liability lies regarding risk mitigation surrounding incidents.<sup>54</sup>

These governance challenges are heterogeneous, and rely on a multitude of factors, including: infrastructure, application, company and country, with different hurdles emerging depending on the stage of the development.<sup>55</sup> It would be important for governments and public bodies to have a clear policy on the rights and responsibilities of managing this infrastructure to ensure that the implementation and management of any DLT-based system is streamlined and effective.

### **Citizen expectations around public services and public sector use of DLT**

Hurdles to use and deploy blockchain emerge from the mixed confederate federal organisation of the EU, but hurdles are evident in the individual member states within the EU and more broadly, including the UK and other non-EU & European countries. Furthermore, levels of citizen trust in the public sector differ from country to country and the success and widespread use of a DLT application may also be predicated on citizen engagement, which is an important consideration.

For instance, Germany offers numerous services to citizens at various governance levels delegated to cities, municipalities and administrative districts within the nation - they are the primary contact for matters around citizen administration. Digital decentralisation may improve connectivity and allow citizens to enjoy reduced processing times for certain administrative matters, but it is imperative for only one single authority to collect data, and ensure a positive user experience, especially as one third of German citizens expect the

<sup>54</sup>[https://pure.tudelft.nl/portal/files/68465733/20191015\\_On\\_governance\\_challenges\\_in\\_decentralized\\_systems\\_final\\_manuscript.pdf](https://pure.tudelft.nl/portal/files/68465733/20191015_On_governance_challenges_in_decentralized_systems_final_manuscript.pdf)

<sup>55</sup>[https://pure.tudelft.nl/portal/files/68465733/20191015\\_On\\_governance\\_challenges\\_in\\_decentralized\\_systems\\_final\\_manuscript.pdf](https://pure.tudelft.nl/portal/files/68465733/20191015_On_governance_challenges_in_decentralized_systems_final_manuscript.pdf)

‘once only principle’<sup>56</sup> i.e. individuals or companies only have to provide data to the government once; but this should not limit the compatibility among other applications. Many citizens in Germany also do not want central entities to store their data<sup>57</sup>, civic resistance may also contribute to slow uptake of the technology further down the line.

Conversely, in Estonia, citizen acceptance was fostered through using DLT-enabled X-Road, a ‘neutral’ technology: with all data stored in a decentralised manner by different organizations. X-Road is a middleware service which secures numerous interlinked government Oracle databases. The particular usage of blockchain in this case, built by a company called Guardtime, ensures the integrity of each record held by the system by creating indelible hashes of the data to detect tampering or intrusion.

More broadly speaking, it is important to consider the general attitudes of citizens within Europe vs other continents. The cornerstone of European values are freedom, equality, democracy, human rights and dignity.<sup>58</sup> There is a central emphasis on individual rights and freedoms, which supersede any kind of utilitarian, society-wide prioritizations. In the context of accelerating the uptake of any advanced digital technology by the public sector (or otherwise), the standards, protocols and processes must adhere to and uphold the core of moral and political values.

Consequently, it is important to consider the ethical and responsible development of any of these technologies from inception: thoughtfully considering unintended consequences, misuses and individual rights in privacy and freedom. It is important to note that while the rule of law is an absolutely essential place to begin to ensure legality of product/service, here, it may also be worth considering areas which are not yet covered by the law or are in a ‘grey area’, and forwardly think about the ethicality and responsibility of DLT deployment. This will ensure the benefits of DLT will be felt across Europe in a long term, sustained manner, and is the most robust way of avoiding technology backlash from the public, and promote citizen buy-in for the long term.

## Technological

### Interoperability, integration and user experience

Interoperability is essential for DLT networks to interact and integrate with each other, as well as interacting with existing legacy systems. Interoperability allows for free sharing of information across DLT systems, a way to ensure items sent from different DLT systems can be easily read and comprehended. Interoperability, coupled with an intuitive user interface is essential for a strong citizen user experience with government services. Previously, in Germany, it was reported that an incompatibility across government applications in digital services lead to a sharp decline in public satisfaction with the services.

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<sup>56</sup> *ibid*

<sup>57</sup> [https://www.researchgate.net/publication/325713561\\_Challenges\\_and\\_Opportunities\\_of\\_Blockchain-based\\_Platformization\\_of\\_Digital\\_Identities\\_in\\_the\\_Public\\_Sector\\_Research\\_in\\_Progress](https://www.researchgate.net/publication/325713561_Challenges_and_Opportunities_of_Blockchain-based_Platformization_of_Digital_Identities_in_the_Public_Sector_Research_in_Progress)

<sup>58</sup> [https://europa.eu/european-union/about-eu/eu-in-brief\\_en](https://europa.eu/european-union/about-eu/eu-in-brief_en)

<sup>59</sup> With other public sector officials highlighting that the design and ease of use in the government services was of paramount importance to ensure high levels of public engagement with the tools or services.

Successful use of DLT will also depend on how it can incorporate different data - it must integrate a number of players across the ecosystem, as little long-term value will be derived from a stand alone application with limited use. Realising this can be especially challenging wherein data is owned or lies within different government departments and remains siloed. One OECD blockchain expert interviewed, reported the immense difficulty in receiving and coordinating the different data from the different public sector departments (who at present operate in silos), and consequently opted to use the application in the private sector where data integration and application was more straightforward.

The manner in which humans will interact with DLTs can be tailored in many different ways - the ledger merely serves as a store of data and processes (smart contracts). With the correct permissions, a wide range of applications can be built to delve into this historic data, process it, and present it back to the user in a useful manner. Similarly, the routes to interacting with the ledger to record new events or to trigger smart contracts can be highly customised.

### **Limited throughput**

Throughput has been identified as a key technological challenge facing DLT. Public, decentralised distributed ledgers require a numerous nodes to reach consensus for verification of any given transaction. In order to process the transaction, each individual node requires access to the entire ledger. Depending on the size of the ledger - over time, this ammasses to a huge database, with multiple nodes - meaning verification may not be instantaneous.<sup>60</sup> Depending on the time sensitivity of the use case, this type of blockchain solution may be unfeasible. In financial services, for instance, one OECD blockchain expert consulted reported that transactions took over 5 minutes to be confirmed in one particular use case, rendering the application commercially unviable.

There are technical design solutions which address this issue depending on the use case, for example through only partially decentralising the distributed ledger (thereby limiting the number of nodes required to reach consensus), confirmation of a transaction could occur in a time efficient way.<sup>61</sup> Wherein use cases require a high volume of verification activity, other enterprise solutions are in the process of development.

### **Consensus Mechanisms**

<sup>59</sup>[https://www.researchgate.net/publication/325713561\\_Challenges\\_and\\_Opportunities\\_of\\_Blockchain-based\\_Platformization\\_of\\_Digital\\_Identities\\_in\\_the\\_Public\\_Sector\\_Research\\_in\\_Progress](https://www.researchgate.net/publication/325713561_Challenges_and_Opportunities_of_Blockchain-based_Platformization_of_Digital_Identities_in_the_Public_Sector_Research_in_Progress)

<sup>60</sup> <https://arxiv.org/pdf/1612.04997.pdf>

<sup>61</sup> <https://wisdom.nec.com/en/technology/2019062501/index.html>

There have been many concerns regarding the nature of consensus models as used by existing DLTs, in particular the energy-consuming nature of 'Proof-of-Work' by the Bitcoin blockchain.

Consensus is the mathematical process of ensuring consistency across a distributed network. The original concepts were invented by computer scientists in the mid 1980s, but never became interesting to the public until Satoshi Nakamoto released 'Bitcoin' wherein the consensus model required the consumption of electricity to find a random number with particular properties - the party who found the right random number was rewarded and became the leader until the next random number was found. This eventually became an industry unto itself<sup>62</sup>, consuming vast amounts of electricity to win the next bitcoin block and receive the reward.

The blockchain industry itself has recognised the inefficiency of this consensus process, and is innovating new mechanisms to allow public blockchains to remain permissionless and decentralised while ensuring high throughput. Examples include Proof-of-Stake<sup>63</sup> and Avalanche<sup>64</sup>.

For permissioned and private blockchains, there exists a requirement to have a closed group of known participants. As a result, the older models of consensus, dating all the way back to the 1980s, can be used. These are all highly energy efficient and can be run on the most minimal of hardware. There are some new models emerging here as well, including Proof-of-Elapsed-Time (PoET) which requires specialised chips with a 'trusted execution environment'<sup>65</sup>.

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<sup>62</sup> <https://ieeexplore.ieee.org/abstract/document/7966966/>

<sup>63</sup> <https://github.com/ethereum/wiki/wiki/Proof-of-Stake-FAQ>

<sup>64</sup> <https://arxiv.org/abs/1906.08936>

<sup>65</sup> <https://sawtooth.hyperledger.org/docs/core/releases/1.0/architecture/poet.html>

## Conclusion and key considerations

The opportunity for DLT to drive good in the European public sector is vast, with DLT offering the ability to create new, more coordinated and equitable solutions for multi-stakeholder issues in the context of the circular economy and digital citizenship. The organic convergence of these two fields - DLT and the public sector - is emerging, but is still in its infancy, for a number of reasons outlined in this report.

Given the social and environmental benefits offered by the use of DLT, it is clear that a Pan-European initiative to de-risk this experimentation, and interconnect the correct ecosystem of players, is fundamental to driving the future of European innovation.

### The European Commission should consider:

1. Ensuring innovators have the correct resources and access to solutions for technical, legal and business barriers.
2. A means to further experiment and develop valuable DLT use cases for the public sector in a de-risked environment.
3. Successful early adopters of the technology are essential for driving the use of the technology forward - these early adopters should be suitably and visibly supported.
4. A pro-active, regulatory approach to distributed ledger technologies, presenting clear permissive parameters for early experimentation and operation (e.g. a regulatory 'sandbox'), in order to not stifle innovation.
5. A widening of the definition of 'R&D', so as to better capture the wider range of innovation activity that occurs within the public and private sectors, which includes development of DLT.
6. Mechanisms to 'nudge' international policy makers to evaluate and understand the impact DLT could have for their national legislative priorities.
7. Strive towards creating 'future-proofed' networks of interoperable DLTs, with highly intuitive user interfaces.
8. Thoughtful DLT development considering potential future unintended consequences of services.
9. Learning from other global regions that have higher levels of investment in DLT than Europe, and have scaled applications of DLT in the public sector.
10. Incentivising public actors to participate in partnerships to increase visibility of DLT's benefits, share knowledge, and help to mature the business environment for distributed ledger technologies.