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Blockchain for Government Council

CITIES Committee

BLOCKCHAIN FOR LOCAL GOVERNMENT

The Potential | Case Studies | Sector Perspectives

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BIG INNOVATION CENTRE

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FOREWORD

Martin Docherty-Hughes MP

In a world of competing interest, Cities and their Citizens face the daunting task of making their way through a data laden world in which public services and the wider environment will require a far more transparent and trustworthy way to access and secure data.

In grasping the opportunities of Blockchain technology, Cities and all local authorities will be able to rise to the challenges that Citizens will rightfully ask of them, in the delivery of public services, from planning, to education, health and well-being, promoting equality, as well as developing the bedrock of economies through small and medium sized business and critically the protection of our environment.

Blockchain and like technology are essential elements in re-building Cities political, social and economic futures in a COVID 19 world and I hope the report, will enhance the relationship between those who are at the frontline of public service and those with the knowledge to ensure technology, such as Blockchain can be an effective agent for positive change in modern liberal democratic societies.

Lord Holmes of Richmond

I have long been excited about the opportunities presented by the technologies of the 4IR. Distributed Ledger Technologies (DLT) of which blockchain is the best-known example is one that has the potential to deliver the most radical transformation to our lives and the interaction between citizen and state, yet ironically is the one that can still provoke scepticism and remains little understood.

This technology and its application can by reducing data fragmentation and enhancing traceability and accountability reduce costs and drive efficiencies and by ensuring authentication, authorisation and accountability of information also build trust. DLT can play a valuable part in enhancing the delivery of government services to the citizens of the UK, in securing the UK's competitive position as a global leader in technology-based innovation and in protecting the security of government and citizens' data at a time when both are increasingly under threat.

I welcome the work of the APPG in investigating the potential of DLT (blockchain) applications for city councils. Despite the significant potential benefits for local government – particularly around citizen identity verification and distribution of state aid or payments the report shows that challenges dominate. It is interesting to note that the use cases in this report - from Switzerland, the Netherlands, Spain and Russia - all centre on identity and payments.

In many ways the report's recommendations which focus on building awareness at all levels of government and improved knowledge sharing particularly matching private sector expertise with public sector delivery challenges echo the title of my own 2017 report DLT for Public Good; leadership, collaboration and innovation. I have always argued, that as far as DLT is concerned, we should step forward with optimism and evidence-based positivity and I welcome this report as a helpful contribution towards that goal.

EXECUTIVE SUMMARY

Blockchain is one of the most innovative technologies considered in digital government strategies. Its benefits include

- Efficiency gains in any inter-governmental and public-private information exchanges and monetary transaction.
- Reduction of bureaucracy and associated improvement in transparency and accountability in civic services.

At the same time, **blockchain for government use is still nascent in its implementation** with persisting **challenges in the areas of security, scalability, interoperability and efficiency**. Some of these do overlap with other emerging technologies as well. Nevertheless, there is already **a vibrant ecosystem of technology vendors**. Both established companies as well as aspiring start-ups that are offering commercial solutions and are serving as innovation partners to governments and potential enterprise-adopters.

Several municipalities around the world have embarked on blockchain projects with the aim to solve existing issues regarding public administration and urban governance, and less so out of desire to experiment with blockchain per se. **Few of them made it to fully mature solutions that are usable by citizens, but most saw the technology deliver on its promises**. From digital identity to e-voting and smart vouchers, blockchain conferred better public services and helped municipalities gain trust among their citizens. Lessons learned are similar to implementing a rather more innovative digital technology suite and so have to do with public government actors **familiarising with blockchain platforms, creating the right partnerships and behaviour towards co-innovating** with tech partners, and initiating regulatory sandboxes and other testing facilities. As a result, any temporary gaps are accommodated and to make sure that legal compliance is upheld throughout the process.

Currently, most councils in the UK are in the phase of improving IT service delivery. The priority areas under this phase are reportedly consuming most of IT resources in councils. Current digital strategies or ICT policies are pushing some councils to be more innovative, but blockchain technology has yet to enter discussions.

When asked about Blockchain, there is widespread hesitation for experimenting with new technologies due to the fear of the unknown. Many UK councils reported common concerns and challenges around understanding the technology itself, its implementation and access to its use cases. However, there are a few exceptions. National authorities like HMRC and Bank of England are at the forefront of testing blockchain. They could initiate **knowledge sharing across the civil service to build momentum and provide councils with much needed inspiration and guidance.**

For blockchain solutions vendors, the public sector presents special opportunities in use cases spanning digital identity systems, asset management (land registry), e-voting, digital currency, and others. In the UK, there is ample talent available in numerous early-stage ventures and technology companies. There is consensus among these companies that the public sector does present interesting opportunities.

Despite the identified opportunities, private technology vendors believe that the public sector is somewhat behind (or in catch-up position) with the wider market developments due to an overall risk aversion and limited engagement from the leaders and decision-makers. Going forward**, more collaboration, testing environments (sandboxes) and more openness from the public sector is necessary** to achieve further growth beyond proof-of-concepts (PoCs) and reach full operational services. This ecosystem and necessary environment can only be built at a local level, when national authorities lead in supporting such initiatives.

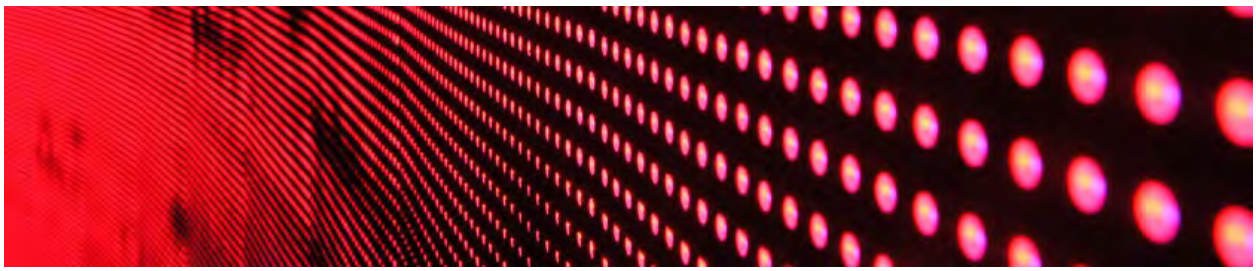
RECOMMENDATIONS

Create awareness at all levels of government: National authorities must involve local governments in the early phase of blockchain awareness and knowledge. Irrespective of efforts taking place at the national level, it is essential that all levels of government start building some level of awareness of newer technologies or initiatives that lie on the horizon. This is the first step in building capability.

Build knowledge sharing consortium: Organisations like Scotim, Government Digital Services (GDS), Local Government Association (LGA) should encourage councils and have **sustainable discussions that will keep local councils updated**. This will build awareness and might spark innovative ideas too.

Stimulate public-private interaction: The private sector must interact more with the public sector to understand needs. Currently, the private sector - as evident from our survey - feels they know what solutions might be needed by the public sector but they are not completely aware of the diversity of needs of the local government and their citizens.

Pilots and Sandbox approaches are the way forward: The study demonstrates the usefulness of unlocking blockchain ecosystems and piloting what can be achieved via Sandbox approaches. This supports implementation, testing, and risk management.



1. INTRODUCTION

SETTING THE SCENE

National strategies for the Government's digital transformation have been circulating for over a decade now. The promises of theories promoting e-governments or digital governments include that '*the digital*' and technology will **streamline bureaucratic processes,** thereby making them **more efficient and cost-effective** to run. It is believed that the way in which digital culture promotes transparency would **improve public trust**. Most recently, technologies like artificial intelligence and blockchain have featured in discussions surrounding transformational policies and innovations.

The Blockchain for Government Council – CITIES committee aims to investigate **the potential of Blockchain applications for city councils**. This investigation seeks to understand better the potential of blockchain-related applications for improving local governance with a particular focus on the organisational capacities of local bodies. **The report will highlight how blockchain can improve operational efficiency and the quality of urban governance.**

The report brings together perspectives of different stakeholders from across the public and the private sectors to understand their requirements and uncover the socio-technical opportunities and challenges of implementing blockchain solutions. **The overall aim of the study is to provide policy guidance for adopting and implementing blockchain solutions at councils across the UK.**

Why do we focus on cities and their local governments?

Because quite simply, **cities are powerful**. According to the UN, it is estimated that **urbanisation will rise to 70% by 2050**. Cities are a hotbed for talent, creativity and experimentation. In addition, with so many people living in the urban world, **cities are powerful stakeholders capable of influencing national conversations and decision-making**. It might be **that local governments of the future are much more than just about delivering services** but are key actors that **help communities build better living conditions** together in more efficient manner.

To harness the collective potential of cities, local governments and city districts will need to **rely on an efficient infrastructure to meet the needs around networking, automation, decentralization and inclusive participation** and they will have do so in a safe and secure way.

Could blockchain contribute to this vision of the future? If so, how?

Our research shows that many national-level bodies are already considering the possibility with more than 200 public sector blockchain initiatives in more than 46 countries (Berryhill, Bourgery and Hanson, 2018). **We have explored what these opportunities mean to local governments.**

The report explores the diverse needs of city governments and reflect on whether blockchain applications can support the spectrum of desired needs, requirements, and standards.

METHODOLOGY

In our research we focus on the following areas:

1) Primary research on:
    - How can blockchain solutions build the organisational capacity of UK local governments in order to improve efficiency?
    - What does the public sector personnel (front and back office) think about using emerging technology?
    - What might be restricting them in doing so?

This research includes **nine interviews with public sector representatives from local government units** as well as **a survey that was distributed to fifteen private sector companies** to understand their:

- Awareness around Blockchain-related uses and opportunities
- Existing challenges and potential of Blockchain-related applications
- Adoption issues and ways to overcome these
- What it means to be a Blockchain-ready government

2) The secondary research, or **literature review**, on:
    - Understanding the existing digital development scenario of the local councils in the UK
    - Documenting current urban governance challenges that might benefit from blockchain solutions.

3) Further, we list **case studies** for blockchain applications in local governments to analyse implementation, contexts, challenges, and to understand the gap between the requirements of local governments and the private sector (solutions and application providers).

OUTLINE

The report starts by understanding what government transformation is, and what it means for the UK, especially for the local governments. In Section two, the report illustrates on the blockchain technology and its role in the government transformation process. The section looks at the possibilities of blockchain to further build the capacity of local councils and supports it with relevant case studies. Based on of the understanding of blockchain for local councils and learnings from case studies in Section three, the second part of the report brings in the perspectives of public and private sector of the UK in Section four. Finally, in Section 5, the report shed a light on the challenges faced by both public and private sector, and recommendations for the policymakers to encourage use of blockchain in government.

2. GOVERNMENT-TRANSFORMATION IS CHANGING THE RELATIONSHIP BETWEEN CITIZENS AND THE STATE

It is without question that technology has transformed many of the services we use in both our personal and professional lives. Since the mid-90s **the rapid increase of digital products and services has altered our expectations of what good service looks like** and has birthed a professional user experience industry that now lies at the heart of user and human-centred design methodologies.

No one is sheltered from the shifting effects that technology has and will continue to have. Organisations worldwide persist on trying to **keep up with innovations,** and governments are no different.

In the following section, we reflect upon what technology and digital transformation has meant for the UK Government.

THE UK IS TAKING ADVANTAGE OF TECHNOLOGY FOR THE GOVERNMENT TRANSFORMATION

As technologies advance and the discussions around them grows, there is a need to take advantage of the potential they offer. **The modernisation and, as if follows, digitisation of public services in the UK is termed 'Transformational Government'** (Stephen King & Sarah Cotterill,2007). Since 2007, the Transformational Strategy has been encouraging the journey into 'the digital', and in 2016 United Nations E-Government and E-participation survey, the UK Government was one of the most digitally advanced in the world.

With the implementation of the Government Digital Strategy of 2012, the UK Government has led a 'digital-by-default' programme focusing on creating robust digital services. Building on these digital-first principles, local governments are increasingly taking giant leaps to improve service delivery by embracing the opportunities that technology has to offer.

The **Government Transformation Strategy 2017-2020** defines how the UK government will look like in the future. At its centrepiece, it **encourages the agile delivery of digital services in order to transform the relationship between citizens and state**. This **implies more power to citizens** and a **more responsive and efficient Government by changing the way it operates**; from front- to back-office, inside and across departments. Under the current strategy, the UK expects governments to be more adaptable to change and to respond faster to changing circumstances by the end of 2020. **Rather than focusing on a specific technology in this fast-developing field, the policy focuses on making Government agile and adaptive**. However, **the ambition of this strategy is for the central government to lead innovation in the public sector.**

This innovation as defined in the Government Transformation Strategy 2017-2020 document focuses on the three broad components, they are:

- Transforming citizen-facing digital services. (I.e. types of public services)
- Transforming the way departments deliver their services, enabled by digital. (I.e. delivery of public services)
- Transforming the way Government execute and implement change. (I.e. transformation strategy)

As we understand from the strategy, **the focus is on transformation and change across departments, at a national level.** It is also about the way the Government governs itself. **The strong organisational foundation will allow it to adopt, test and scale technologies as they advance, which will eventually improve services, increase transparency, and build more trust**.

National authorities leading innovation in the public sector have launched initiatives like the *AI sector deal* and carried out Blockchain pilots (at national level). **Blockchain pilots** have been run in conjunction with Bank of England, HMRC, HM Land Registry, and Department for Environment, Food and Rural Affairs (DEFRA) among others. However, it is critical to spotlight that **despite the strategy is focused on the Central Government**, efforts at national level have, and are, encouraging innovative activity in the Local Governments.

The above discussed **Transformation Strategy is focused on the Central Government**. In spite of this, Local Government bodies have been consistently in the vanguard of using technology to improve services and efficiency. Sector representative bodies such as the Local Government Association (LGA), SOCITM, Local Government Delivery Council (LGDC) and others have been supporting such efforts (LGA, 2014).

There have been efforts at Local Government level through a council's digital or **ICT strategy to aim on digital transformation efforts like the correct use of data, greater efforts in creating shared platforms & service patterns and exploring data security** (LGA, 2014).

Because **local governments have been open to experimentation so far, it is critical to understand their perspective and any delays in using or piloting emerging technologies** especially when they are under the pressures of urbanisation and increasing demands.

All the efforts of transformation in the governments world-wide, including what has happened in the UK, is to **assure enhanced efficiency, transparency and effectiveness of public services delivery**. Since 2017, there has been an active discussion on changing the way governments operate and the role of emerging technology in achieving so (European Commission, 2017). There **is a desire for future governments to be more open, participatory, transparent and efficient than ever before**, and they must do so in a safe way. While there is a great deal of practical experience and evidence of how to harness technology in public services, enormous challenges come with it.

The discussion on challenges continues, and with new technologies, the worries are even more significant.

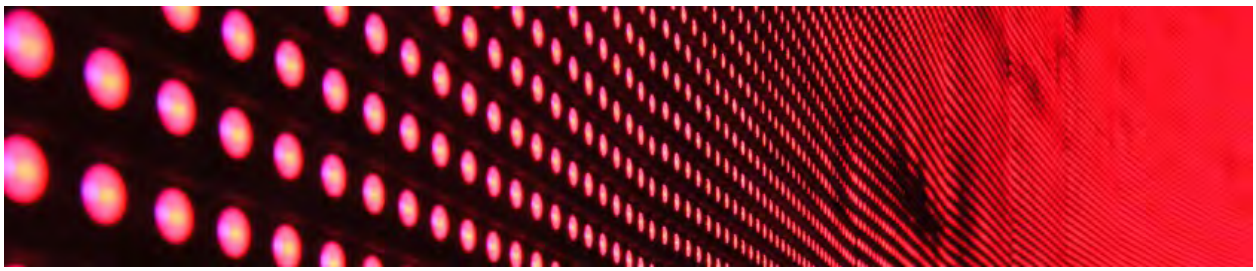
MANAGING TECHNOLOGY IS ONE OF THE KEY ADOPTION-CHALLENGES ACROSS GOVERNMENT

The deployment of powerful, emerging technologies like AI and Blockchain come with **new concerns and challenges, alongside the major opportunities**.

The main **challenges are within the technology itself** (like governing AI/Blockchain, skills, data concerns) and with the u**nderstanding and managing of the communication between people and ICT devices** (governing and controlling technology). It is **also about what changes emerging technology will bring in society and the social, political and environmental impacts** this will have. These aspects of emerging technology and its adoption are already in discussion and are understandingly complex. If we can understand and explain this technology thoroughly, it will be easier to trust it and govern too.

Discussions for uses of Blockchain in the public sector have progressed – hence, this report's focus on its use for Local Governments. **Local Governments are accountable for urban governance in big and small cities**. City administrations negotiate their way through policy processes while being subject to the influence of other levels of Government. They need to constantly co-ordinate with other authorities (across hierarchical levels and laterally), lobbying more senior powers and managing democratic concerns are a few of their day-to-day responsibilities. **If blockchain can build capacity of these local bodies, it will be easier for them to steer cities and provide better living conditions**.

In the following section, we explore the features of Blockchain technology, what it can offer, and discuss the implementation challenges as noted in the literature.



3. WHAT ARE THE BLOCKCHAIN PRINCIPLES AND FEATURES?

Blockchain is the most well-known and used distributed ledger technology (DLT).

"Distributed ledger technology refers to the protocols and supporting infrastructure that allows computers in different locations to propose and validate transactions and update records in a synchronised way across a network."
(Allessie et al., 2019)

In this section we shed a light on the features of blockchain technology and how they can be useful for government bodies. Further, with help of literature study, it explores the current adoption challenges.

In the simplest of terms, Blockchain is an open, distributed ledger that can record transactions between two parties efficiently, verifiably, and permanently (Lansiti, 2017). Its use cases are significant and as such, it has been named a pivotal point of the 4.0 Revolution, along with the Artificial Intelligence and Internet of Things (Economist, 2017). The ability to fully record and track transactions in a decentralised way is expected to have a profound impact on institutions.

The basic principles underlying Blockchain technology are (Lansiti, 2017):

- **Distributed Database**:
  Each party, component, or member of a blockchain has access to the entry database and transaction history.
- **Peer-to-Peer Transmission:**
  Occurs directly, without a central node. Each node has an updated version of the database.
- **Transparency**:
  Any transaction and its associated value is visible to anyone with access to the network.
- **Immutability of Records**:
  Once a transaction is entered, the distributed ledger is updated and distributed to all nodes. This record is linked to the previous transaction in the database. Hence the term chain; the record in the database is permanent and distributed to all others in the network.
- **Computational Logic**:
  Blockchain transactions registered in the ledger can be programmed by algorithms and can automatically trigger transactions between nodes (users).

Blockchain Case Study on increasing transparency with smart contracts

The Municipality of Zuidhorn created the Child Package scheme based on principles of blockchain in November 2017. The scheme is for the children of low-income households and aims to support them through government-provided vouchers.

The new blockchain platform appears to meet the technical, organisational, and legal preconditions. When a parent applies for child vouchers it ensures privacy is maintained between the transacting parent and the commercial shops.

ROLE OF BLOCKCHAIN IS GROWING IN DIGITAL GOVERNMENTS

Digital governments take a step into more innovative, **user-centric public services** by understanding needs, leveraging technology, and using information as an asset. As Allessie *et al.* (2019) illustrate,

"**Blockchain is one of the most innovative digital technologies that shall be considered under the new paradigm of governmental policy-making and service delivery."** The main benefits of applying blockchain technology in governments are:

- **Reduced economic costs**, time, and complexity in inter-governmental and public- private information exchanges that enhance the administrative function of governments.
- **Reduction of bureaucracy, discretionary power, and corruption** induced by the use of distributed ledgers and programmable smart contracts.
- **Increased automation, transparency, auditability, and accountability** of information in governmental registries for the benefit of citizens.

It is well noted that many of these blockchain benefits are dependent on each other and cannot be strictly assigned to a single category. Further, if these are implemented at a local level, benefits might be more extensive than just building the capacity of one government entity.

Blockchain comes in multiple forms and shapes, with an essential **distinction among permissionless or public and, permissioned (private and hybrid) Blockchain platforms**. The technology behaviours depend on its architecture. The details of how Blockchain works, and what the different forms of blockchain are can be found in Appendix A. Depending on the features, the direct application of this technology in Government crosses the following areas:

1. Identity (eg. credentials and licenses)
2. Voting (eg. digital voting)
3. Public Accounting, Contracts and Taxes (eg. managing payments, smart contracts)
4. Law Enforcement and Legal Systems (eg. asset tracking like from creation to multiple stages in the supply chain)
5. Title and Asset Registration (eg. land registration)
6. Certification (eg. managing of personal records like health in hospitals etc.)
7. Democracy and Decision-making

Blockchain Case Study on Digital Identity

The municipality of Zug explored blockchain for digital identity as a means to improve access to digital government services while increasing efficiency, data security and voting accessibility.

Blockchain Case Study on Democracy and Decision-making

In 2014, Active Citizen was launched as an online referendum system that allows citizens to share their voices on urban development issues like parks, bike/ bus lanes, speed limits etc. The system was launched to boost citizen engagement and government accountability for delivering tangible results in urban development. The city government wanted to ensure that citizens were able to see their votes and opinions mattered, so in 2017, Active Citizen went from having a website and mobile app to using blockchain to make vote counting more visible.

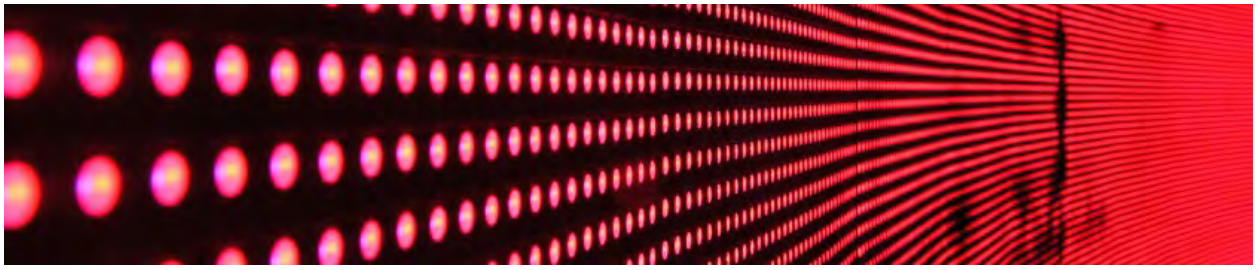
Currently, it is believed that the permissioned form of blockchain is most suitable for governments. Some of the above-listed benefits in the public sector may be useful to reduce or also eradicate corruption and fraud in the Government. **If the promised features of blockchain technology in the public sector can be proved, the technology is likely to gain wide acceptance.** Although, not much empirical evidence is available yet to support the technology.

As noted by the UK Government Office for Science (2016),

> *"One of the greatest potential benefits of DLT is its ability to remove barriers and friction in the market and enable the creation of new forms of information marketplaces... [T]he sharing of information between economic entities through distributed ledgers would enable new forms of innovation to emerge. This would allow ministers to achieve policy outcomes centred on assisting [small and medium-sized enterprises] achieve economic growth through effective use of technological innovation."*
> *(Berryhill, Bourgery and Hanson, 2018)*

As this study focuses on local governments and how blockchain can build organisational capacity, **we categorised the blockchain technology features into five groups – Finance, Organisational, Regulatory/ Environmental and Technology itself.** The categories are based on our understanding of local councils' needs, and their general governance challenges which vary from budget constraints to organisational issues spanning skills, to structure and leadership. In addition, other policy and regulatory environments impact the work of local councils. The above outlined categories will facilitate a comparison of the different technology features and their advantages to local governments.

In the following sections, we will summarise our literature review by listing relevant case studies, the potential benefits, and the adoption challenges with regards to urban governance.



Blockchain has the potential to improve effectiveness, reduce friction within organisations, and share information better but it is not the solution for everything. As we categorise the features and challenges together in table 1, it is easy to see that challenges dominate.

Table 1: Blockchain Technology: Benefits and Adoption Challenges in Governments		
Category	**Benefits**	**Challenges**
Financial	• Reduced cost	• Instant settlements • Reconciliation • Contractual Performance
Organisational	• Increased trust • Transparency and auditability • Increase predictive capability • Increased control • Clear ownerships • Increased resilience to spam	• Organisational readiness • Leadership commitment • Difficult to manage and ensure new rules as a result of Blockchain adoption • Technology-ready governance • Difficult to define and establish auditing principles fit for blockchain
Strategic/ Systemic/ Environmental	• Transparency • Avoiding fraud and manipulation • Reducing corruption	• Laws and regulations compliance • Support infrastructure compliant with internal processes • Accessibility of the Blockchain-enabled services (digital divide) • lack of mechanisms to assess the environmental impact
Informational	• Data integrity and higher data quality • Reducing human error • Access to information • Privacy • Reliability	• Security (cyber threats, trust in tech developers etc.) • Scalability of projects • Usability (Data concerns) • Interoperability/Compatibility • Reliability • Flexibility • Cost-effectiveness • Computation efficiency • General application platform • Immaturity • Design Variables • Data storage and quality
Technological	• Resilience (to malicious behaviour) • Security • Persistency and immutable • Reduced energy consumption (increased efficiency and transaction mechanism)	
Adapted and references: (Ølnes, Ubacht and Janssen, 2017; Batubara, Ubacht and Janssen, 2018; Mergel, Edelmann and Haug, 2019a)		

Technological challenges do dominate. Security, scalability, and flexibility are the main technological challenges identified in most of the literature. It is interesting to see how a few aspects like, security, can prove both an advantage (like tamper-proof record keeping) and challenge (like hacking)**. Most of the challenges listed in the table 1 are dependent on the design of the blockchain**, and there needs and requirements should be carefully examined. The table aims to document the features and existing challenges along side to give a perspective on both, the category in which blockchain has potential and how, at the same time some of its

challenges are already highlighted. So, the discussion should be built further on it, and is the basis of our literature study for this report.

While this technology is still in its infancy, it is critical to understand that challenges categories are weighted equally. We believe the above categories can be used as a framework to assess organisational readiness. Further, we examine a set of case studies implemented at local government level to understand implementation wins and challenges in a given context.

BLOCKCHAIN HAS POTENTIAL TO ENHANCE CAPACITY OF LOCAL GOVERNMENTS

Urban local bodies are often the first point of contact for citizens, therefore there is a constant need to provide services. There are several common challenges faced by councils, including frustration with certain technologies, and its use. A survey that reviewed the current urban governance challenges, by Da Cruz et al., 2018, highlights **insufficient budgets as the most listed challenge, followed by political approaches toward local issues, and policy silos** that do not cover existing challenges.

Barriers to innovation, either towards e-government or transformation, can be structural, like organisational and regulatory, and/or cultural, like behaviour and trust. (See Table A in Appendix). To understand the role of blockchain to overcome existing urban governance challenges of the local councils, **we tabulate the governance challenges along with the blockchain application in table 2**. Based on our interpretation of the literature, in the first column of the table 2 below we list the most common urban governance challenges. These challenges are again categorised in the five categorise we defined in the earlier section **- Financial, Organisation, Environment/ Regulatory**. Here, the technology category is the common parameter for other categories.

These **challenges interact with the blockchain application areas**, as shown in the first row of the table 2 below. Thus, the table gives an overview of the different features of blockchain and how they can be of potential use to overcome the listed governance challenge for local bodies.

Table 2: Potential Blockchain (BC) Applications as solutions							
Common Urban governance challenge category	**Decision making / Citizen engagement**	**Identity (like credentials, licenses)**	**Voting**	**Accounting, Contracts and Taxes (like smart contracts, transactions)**	**Law Enforcement and Legal systems (like transparent data recording, sharing)**	**Title & Asset Registration (like land registry, historical records)**	**Certification (like health, insurance records)**
Finance							
Insufficient public budgets	☐			■			
Regulatory/ Environmental							
Interdependence of policy issues	☐			■	■		
Inflexible bureaucracies/ rigid rules		☐			■		
Uncertainty of funding							
Lack of respect for laws and regulations	☐			☐	☐	☐	
Organisational							
Overlapping responsibilities				■	■	■	☐
Working across different tiers of Government		■			■		
Access to useful information				■	■	■	
Lack of capacity to enforce laws and regulations					■		
Lack of skills in local Government	☐						
Limited scope of responsibilities							
Coordination of different sectors/departments				■	■	■	
Workload of staff	☐						
Systemic							
Politicization of local issues							
Risks of corruption		■	■	■	■	■	■
Limited access of citizens to policymaking	■						
Lack of interest of citizens on local issues							
Lack of trust in local Government	■						
Lack of political stability							
Underrepresentation of vulnerable groups							

■ Direct Impact of BC ☐ Indirect Impact of BC

Blockchain can be a solution where there is need for transparency or information exchange for tamper proof transaction. This will reduce corruption, enhance trust, security with local governments. **Table 2 above clearly identifies areas where blockchain application can make an impact to improve urban governance.** Blockchain solutions can target the challenge directly, as represented by dark filled boxes in the table or can indirectly help mitigate the challenges, as indicated by not filled boxes in the table 2. For instance, as seen in the same table, **one of the most pressing issue for local councils is overlapping responsibilities within or out departments**. **If the information is stored on blockchain, it is easier to share the information safely within government to avoid other departments to collect the same information for other purpose**. This will not only reduce co ordination time, but can also **reduce redoing the same task again**, and **indirectly building transparency** to **reduce overlapping of responsibilities**. As seen in the organisational section, the table try to briefly point at such use, with its filled and not filled boxes. The same table can be further developed, as more and more councils start using blockchain and see the impact. In the following section we look in to such case studies, where local governments have seen an impact.

Despite being much discussed by the experts from various sectors, there are few cases where blockchain has been implemented in the public sector. Furthermore**, blockchain technology case studies at local government level are even more scarce.** More than 46 countries are involved in experimenting and using blockchain; despite this, there is little reporting of how urban governance challenges are being managed. We can only assume that a lot has not been tested yet.

In the following section, we explore some blockchain for local government case studies that will provide us insights into the implementation process and how city managers decided on blockchain technology as a potential solution.

LEARNING FROM EUROPEAN CASE STUDIES

Blockchain application can help mitigate urban governance challenges as pointed by the literature study. However, very few use-cases for blockchain implementation are recorded, they are even less at local government level. The identified case studies focus on improving urban governance and incorporates at least one of blockchain's features (as seen in table 2). We analyse the blockchain technology implementations from Switzerland, the Netherlands, Georgia, Italy, and Russia. The case studies can pave a learning path for the UK councils, and encourage piloting blockchain application.

For the selected case studies, **collected data focuses on what motivated the local government use blockchain, what was the process preceding the implementation, what were the effects and impacts of its implementation.** Again, in our data collection we focused on the previously outlined five categories – budget, organisation, regulation/ environment and technological aspects. We analyse the case studies to understand:

- Urban governance challenges
- Process of adopting technology (any preparations, partnerships, upskilling)
- Implementation processes (technology selection, timeline, expected outputs)
- Organisational transformation (new ways of working, operating model etc.)
- Outcomes and challenges

The case studies guide us to understand the process an organisation has to go through when considering implementing blockchain. This includes managing needs of stakeholder, interact with private sector partners and overall learnings.

We identify five such case studies from four different countries that have implemented blockchain technology within local governments or city administrations. **These case studies cover five identified features of blockchain and have clear overlaps with other features, e.g. the voting project that also featured digital identity.** Table 3 below lists the selected case studies along with the field of implementation.

Table 3: Identified Case Studies

	Name of Case Study	Local Government & Country	Field of Implementation
1.	uPort decentralised identity	Municipality of Zug, Switzerland	Digital identity for proof of residency, e-voting, Payments for bike rental and parking
2.	Stadjerspas smart vouchers	Municipality of Groningen, The Netherlands	Benefit management system for low-income residents.
3.	Child Package	Municipality of Zuidhorn (now Westerkwartier), Netherlands	Subsidiary voucher system for children from low income households.
4.	Digital Democracy and Data Commons	Barcelona City Council, Spain	Transparency, Voting eligibility, Anonymity
5.	Moscow Active Citizens	Moscow, Russia	Transparency, Data record, Voting

A. uPort decentralised identity, Municipality of Zug, Switzerland

PROJECT IDEA AND CHALLENGE ADRESSED: The municipality of Zug explored blockchain for digital identity as a means to *improve access to digital government services while increasing efficiency, data security and voting accessibility*. The six-month pilot project started in November 2017.

The municipality of Zug used an Ethereum based blockchain called uPort. The project's aim was to provide a trusted and self-reliant blockchain-based identity for sharing personal data with a third-party and to authenticate e-government services. Due to the success of the pilot, the municipality plans to expand the services to e-voting, renting and tax declarations. The pilot was initiated on Testnet[1] with the plan to move it onto a main blockchain network as the number of users increased. The municipality created their own identity on the public Ethereum network that gave them the power to sign and verify data. The user interacts via a mobile phone application and

[1] testnet is an alternative blockchain to be used for testing.

conducts a one-off authentication by visiting a municipality office. Users would move through the following process:

1. Download the uPort app on a mobile phone. A uPort ID (a public address of a smart contract on the Ethereum blockchain) is automatically created.
2. Register the uPort ID on the Municipality of Zug's website by adding the current Zug ID number and the date of birth as verifiable personal information. By doing this, the uPort ID would automatically connect to a personal ID in the digital citizen registry of Zug.
3. The citizen uses the app to cryptographically sign the registration request, which is then sent to the municipality. They would then visit the municipality in person to verify the request.
4. The Zug Municipality cryptographically signs the ID and automatically sends the verification to the uPort application.
   (Allessie et al., 2019)

The main interaction point for the user is via their mobile phone application. The digital ID facilitates the access to multiple services without the need for an individual to authenticate every time. The user can also choose how much and what information to share with the selected party.

Access to the Zug city identity was delegated by the city clerk of the municipality, who used their personal uPort identity equipped with specific admin rights. The Municipality of Zug is responsible for pairing the Zug residency number with the uPort address to approve services to be used with this identity. The city registration office has the admin rights in the uPort application, and the verification has to happen in-person at the municipality office.

During the pilot phase only proof of residency is provided as a public service with uPort identity. Since the municipality is responsible only for authenticating and signing off the ID, any upskilling of municipality staff is minimal. The interface used for signing-off did not demand expertise. The maintenance required for the deployment of the technology is also low. The municipality of Zug invested in a one-time integration and installation. Following that, maintenance and operating costs increases with the number of registrations.

As for data, personal data is encrypted and stored on users' mobile devices and personal attestations are sent offline. The attestation can still be verified on blockchain and serve as user authentication for service providers or public institutions, generating efficiency and security gains.

The pilot project solution was a collaboration between the local Government and tech partners: The Institute for Financial Services Zug (IFZ) of the Lucerne University of Applied Sciences, ConsesSys with local partners Consensys-uPort (Zug) and Ti&M (Zurich) and community.

IMPACT AND LEARNINGS

350 Zug citizens registered for the uPort identity which can be used as proof of residency. The administrative cost is low as only one clerk is required for the operation of the system and to assist in generating the ID.

The benefits of the project range from less infrastructure requirements, decreased security risk, cost effectiveness, GDPR compliance and scalability (Kohlhaas, 2017).

This was a pioneering and collaborative initiative between a local government, private sector company and research institution. They acknowledged the importance of a digital ID and tested it together. However, regulatory uncertainty remains. If the Draft Federal Act on Electronic Identification Services (D-eID) is finalised and passed, the regulatory framework will provide legal certainty for the private sector and protect interests of individuals. This regulatory discussion with D-eID has already encouraged the private sector to develop and improve the existing solutions.

The ID tested by the Municipality of Zug is still not used between departments and for other services, so feasibility and further challenges are not well understood.

NATIONAL CONTEXT: The existence of uPort ID is making it easier for the municipality to use it for further initiatives like renting a bike, paying parking fees, registering for elections or digital signatures for e-government services. This will have two impacts: increasing 'smart' initiatives and onboarding new users at a faster pace. There have been discussions regarding D-eID Act, the digital identity approach for the nation. These discussions are focused on encouraging innovation by building state-market relationships and dividing roles and responsibilities between these two institutions. The objective of the state-market partnership is to combine the confidence-building effect of state recognition and private-sector dynamism to facilitate a safe and friendly solution. This bill has been contested but the discussions have encouraged the Municipality of Zug to pilot the Zug ID with support from a local IT company. While discussions at a national level need to continue, this pilot has certainly built local government confidence and encouraged the private sector to innovate for the public good.

B. *STADJERSPAS* SMART VOUCHERS, MUNICIPALITY OF GRONINGEN, THE NETHERLANDS

PROJECT IDEA AND CHALLENGE ADRESSED: The municipality of Groningen launched Smart Pass, a blockchain-based redistribution system of benefits for low-income citizens with the help of the local blockchain company DutchChain. The project did not begin with the aim of using blockchain. The voucher system has existed since 1994, but blockchain now has been considered as a way to enhance the programme. Smart vouchers are used in sports clubs, subsidised initiatives, or other entertainment activities.

Blockchain-based smart vouchers ensure that public money is used for its allocated purposes and also helps in targeting the relevant group of beneficiaries. As described by a European Union study (Allessie et al., 2019), using smart vouchers, governments can monitor detailed spending conditions and eligibility criteria in the form of smart contracts.

The service includes a distributed database, smart contracts and automation technology that can target beneficiaries. The interaction is between user, municipality, and businesses. The process is as follows (Allessie et al., 2019):

1. *The citizen applies for the Stadjerspas at the municipality by providing details like their name and address.*

2. *The municipality checks the eligibility of the registered citizen for a smart voucher. If approved, the municipality sets up an anonymised user identity on the blockchain, linked with personal details stored off-chain.*
3. *The municipality grants the citizen a Stadjerspas, accompanied with a personal QR code referencing her/his ID in the blockchain-based smart voucher system. The municipality also manually assigns smart vouchers to the citizen in its own system.*
4. *The citizen uses a service of the authorised provider. Each provider has an application that scans the QR code on the pass to activate the smart voucher and calculate a discount. Every time a smart voucher is invoked, a smart contract checks whether this user is eligible for the criteria and how many times the smart voucher has been used already.*
5. *There is also an application for the beneficiaries, for browsing offers from authorised providers and making reservations. It is however not a mandatory part of the system.*
6. *After a certain period, payments are done from the municipality to the providers.*

The system now helps to subsidise private services which otherwise were not accessible. The municipality and businesses can interact to provide the eligibility criteria. As the QR code is specific to a citizen they are easily able to check their vouchers on websites or mobile phones. This blockchain-based application uses smart contract functionality and automatic payments.

The blockchain governance architecture that is used is public permissioned, and a centralised consortium governance. Transactions are stored on the Zcash blockchain.

IMPACT AND LEARNINGS

The system is completely operational and used every day by more than 20,000 citizens and service providers. Approximately 4,000 smart voucher transactions happen monthly.

As this was an enhancement of an existing initiative, the municipality noted of the following outcomes. Firstly, they noticed efficiencies in spending; money was spent on specific purposes and by the allocated beneficiary. The municipality had better decision-making tools and increased the accountability of public spending with data recorded on ledgers. A huge amount of paper-based processes was eliminated thanks to automation.

The smart voucher system is free of charge for citizens and easy to use through their mobile phones.

Overall, the system allowed for lower administrative and transaction costs thanks to the technology upgrade. As a government it has improved accountability.

C. Child Package, Municipality Of Zuidhorn (Now Westerkwartier), Netherlands

PROJECT IDEA AND CHALLENGE ADRESSED: The Municipality of Zuidhorn created the Child Package scheme based on principles of blockchain in November 2017. The scheme is for the children of low-income households and aims to support them through government-provided vouchers. Prior to using blockchain, the scheme was costly, difficult to use and admin intensive.

The new blockchain platform appears to meet the technical, organisational, and legal preconditions. When a parent applies for child vouchers it ensures privacy is maintained between the transacting parent and the commercial shops.

To use and apply for the child package vouchers, the parents receive a letter from the municipality with an activation code for their profile on a website. The parents can then check for available offers on the website as well as their individual credit. Payments are facilitated through QR codes.

Applicants shop online on a user-friendly website avoiding physical voucher management and in-hand money exchange. In addition, money is guaranteed to be used for the benefit of the child and no other purpose.

The innovation was driven by senior stakeholders at the local authority who teamed up with an international team of experts, local civil servants and a community of local businesses who accept vouchers in their stores. The support to initiate the pilot came from the Association of Netherlands Municipalities. This boosted the initiative and connected different municipalities to one another.

It was a challenge for the development team, including the authority, to work outside their comfort zone, and there were times when they felt insecure and worried about potential mistakes. It is also reported that learning the required technical knowledge was a challenge for those on the project team who had a non-technical background.

IMPACT AND LEARNINGS

As of January 2018, three months after its launch, the platform had approximately 200 children and their parents on the system and around 500 financial transactions had taken place (Corten, 2018). For citizens, the platform provides user-friendly and easy-to-access vouchers. The service is offered in real-time creating huge advantage over earlier ways of working that included filling out forms and long waiting times.

Participating businesses and other stakeholders accounted lower administrative costs which encouraged more business to join the scheme.

From the municipality's perspective, the blockchain platform offers real-time insight into usage that helps identify needs and monitor supply accordingly. The possibility of fraud is significantly low compared to the physical voucher systems.

The local authority has a workable platform, which is currently at the evaluation stage and can be scaled further to become the standard across local governments in the Netherlands. The local authority has not only successfully built efficiencies but has also encouraged local businesses to engage in the local economy. Further, it has triggered a desire within the municipality to innovate in other areas like parking permits and grant applications.

Trust, open communication and easy access to project leaders and executives enabled citizens and public servants to share their concerns and ideas. In addition, all those involved shared a vision of the same outcome. This created room for experimentation. The municipal authority was an engaged stakeholder and provided the funds that allowed for innovation to happen.

Zuidhorn municipality is known for its innovative approaches. Building a blockchain-based platform for child packages was another successful initiative. The municipality said: "[...]*The power of blockchain is that it lets you speed up administrative processes enormously, and reduce them to what is really necessary. The success of the Child Package scheme shows how a small local government can take the initiative in propelling new technological applications and set an example for others to follow. By seizing this leading role, public-sector organisations can define the playing field for the development of such technology instead of leaving this to commercial providers and ultimately depending on these same commercial providers. Based on the principle of creating public value, they can thus shape the Internet of the future. ...in these processes, the public sector no longer fulfils the central regulatory role. The system takes care of that itself. In countries where the public sector still fulfils a strong regulatory role, using blockchain could generate resistance*". (OPSI Case studies)

D. Digital Democracy And Data Commons (DDDC) , Barcelona City Council

PROJECT IDEA AND CHALLENGE ADRESSED: In October 2018, Barcelona city council launched a 6-month pilot voting project called DECODE (Decentralised Citizens Owned Data Ecosystem) on a platform named Decidim. It was critical for Decidim to ensure privacy, anonymity and eligibility of voters and to ensure there was no link between personal details of the voter and the vote itself.

Barcelona City Council partnered[2] with the Internet Interdisciplinary Institute of the Open University of Catalonia and led the project together with the Nexa Center of Internet & Society, Eurecat Technology Center, CNRS, Dribia, aLabs, ThoughtWorks and DYNE.

The process was as follows:

1. The user requests credentials and is verified by the issuer who is an external actor through their mobile phone.
2. The user's data are only shared with the platform if the user opts-in.
3. If the user is deemed a verified voter; she/he signs the petition with a yes/no vote.
4. The vote is attributed with a unique cryptographically sealed ID which is then shared in the blockchain ledger in the form of a transaction.
5. The platform is updated in real-time with votes and users' participation details.

The pilot supports the participatory democratic goals of Decidim and DECODE and has contributed to various debates and workshops on data policies and potential uses of data commons for public good.

IMPACT AND LEARNINGS

Before integrating with DECODE, the platform had 60, 000 people using it. The feedback from users during the pilot phase was mixed with some evaluating the system as coherent and valuable, and others being concerned with the complexity and not understanding it. Overall, however, users were able to understand and vote without specialised technical expertise.

[2] Under European Union Horizon2020 programme

The key outcome was that the city council enabled a technical solution that verifies votes and at the same time maintains the anonymity of voters. After the pilot phase, as envisioned, the project delivered a Data Commons manifesto.

Ultimately, Decidim and DECODE were initiatives to improve communication with citizens and to enable them to participate in decision-making in a secure way. Like other use cases, the project was not about providing an immediate service to citizens but rather about experimenting with future governance models; like a city council acting as the enabler of a service and not the service provider. Furthermore, the pilot project was about sharing and building knowledge on greater citizen control over data, digital economy, and public policy.

E. ACTIVE CITIZEN, MOSCOW, RUSSIA

PROJECT IDEA AND CHALLENGE ADRESSED: In 2014, Active Citizen was launched as an online referendum system that allows citizens to share their voices on urban development issues like parks, bike/ bus lanes, speed limits etc. The system was launched to boost citizen engagement and government accountability for delivering tangible results in urban development. The city government wanted to ensure that citizens were able to see that their votes and opinions mattered, so in 2017, Active Citizen went from having a website and mobile app to using blockchain to make vote counting more visible.

The project was developed by a specialised IT team. The system used private blockchain on the Ethereum platform as well as a proof-of-authority consensus algorithm. The system makes voting on Active Citizen transparent and at the same time allows anyone to check the results and see how the votes are counted. Every individual who voted can verify that their vote was not changed; either on the Active Citizen website or on their own computer by installing a node. As an incentive to participate on the platform, city officials initiated a points system which can add up and be used to pay fares.

IMPACT AND LEARNINGS

Citizens trust and believe in the process due to the increased levels of transparency. Confidence in the system has increased, too, as citizens believe they are heard. The platform has led to real changes like the implementation of bike lanes and the expansion of pedestrian zones.

The dedicated team has upskilled the capacity of the local government, opened the door to future prospects and allowed for transferable skills to be used on other innovations.

DESIGN BLOCKCHAIN APPLICATIONS FIT-FOR-PURPOSE

All the case studies represent the different challenges that local governments face and different applications of blockchain solutions. While the solutions like e-voting or smart contracts are similar, **the technology always needs to be designed in such a way as to meet specific needs and requirements for the specific purpose.**

To summarise the general characteristics across the five uses case, we list them below and highlight specific categories including stage of the project, user base, stakeholders involved, technologies used and influence of regulatory environment or relevant public bodies.

Table 4: Summary of General characteristics of Case Studies

Use Case	Implementation year + Stage of project	Focused Public service	Primary challenge of local body	Blockchain solution type	Innovation provocation or driving factor
uPort Decentralised Identity	November 2017 Pilot completed	Proof of residency, eVoting, bike, parking payment.	Need of Digital Identity for efficiency	Digital Identity	Digital transformation led by Government
Stadjerspas Smart Vouchers	2016 Production and scaling-up	Providing benefits to low income residents.	Need of efficiency in the system of selection and distribution	Smart contract automation	Inefficient old system that needed an overhaul.
Child Package	2017 Evaluation (post pilot)	Providing benefits to children of low-income household.	Need of efficiency in the old system	Smart Contract	Improved user-experience, decrease fraud. Initiative and leadership of Local Government
Digital Democracy and Data Commons	October 2018 Completed and next steps	Eligibility verification and voting.	Need of verification and anonymity of records	Record keeping, Democracy	Improve government-citizen engagement.
Moscow Active Citizens	2017 Live (being implemented)	Participation and record keeping.	Lack of government accountability and transparency.	Shared database	Improve trust in government.

Our literature review and **case studies demonstrate that blockchain has undoubtedly proved beneficial within local governments in reducing bureaucracy and improving administrative efficiency**. It has had a direct impact

on increasing transparency and accountability, and as a result, has improved trust between transacting parties. **Interestingly, blockchain was not described as a disruptive force in the case study literature but rather as the incremental change needed to improve operational capacities.** This may indeed change as the projects scale.

In four of the five case studies, **blockchain came to be a solution either as per requirement of local body or due to its specific features.** Blockchain was only consciously chosen as a solution at the Municipality of Zug who wanted to test digital identity using the blockchain. Overall, all the municipalities were looking to improve their service using technology in way or the other.

We found that to successfully design and implement a blockchain service, local governments need to be mindful of the following:

- Services require technology partners, in-house upskilling (to an extend), and a risk assessment.
- A work culture that champions user needs, promotes agility and experimentation, and doesn't stigmatise failures are essential. It is worth stating that being pro-experimentation and taking full ownership and accountability of outcomes are not mutually exclusive, both are needed.
- Blockchain-related projects require collaboration of multiple actors and therefore gaining clarity upfront regarding roles and responsibilities will put local governments on a strong footing.
- Matching needs with opportunities that technology offers under the current regulatory framework is key.
- Budgets are often a sticking point but as was discovered in the case studies, these can be managed using different partnership models. **In almost all the case studies, central government supported local authorities.** While the initial investment can be substantial, the benefits reaped from a successful service are greater. **Different models of investment either from the private sector or other sources to fund the initiatives can be explored to encourage pilots and to ease the burden on local governments as they experiment with new technologies.** Sharing infrastructure (during a pilot) and knowledge with technology partners can help to reduce the initial investment cost and in the long-term support continuous learning.

Councils made many considerations before and during the process of implementing their pilots or when deciding to scale up. Based on our research understanding, the below table documents these concerning factors. The factors are grouped into the five governance categories as before. Table **5 lists factors and considerations of local bodies during and before implementation**. While it is not an exhaustive list, it does contain the most important points that we came across during research. Some, as understood from the literate, are critical factors (as indicated under 'High'), some low where they were able to manage it with alternatives. These ratings are entirely based on the literature available for the selected case studies including available interviews of project leaders, research, and project reports.

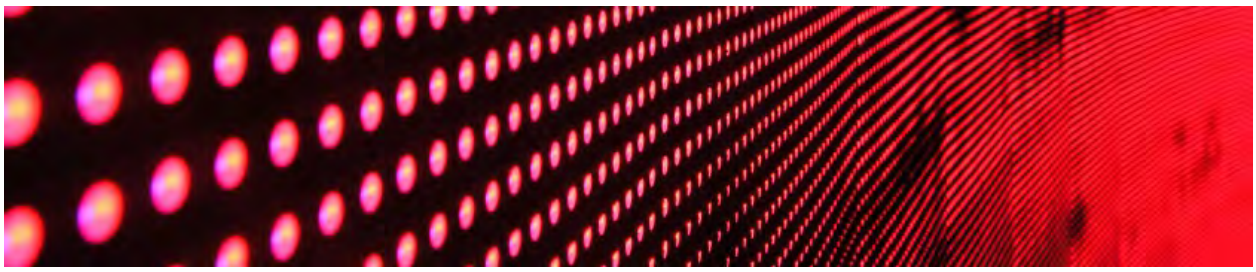
Table 5: Considerations while implementing Blockchain technology by Local Governments				
	Low	**Medium**	**High**	**Observations**
Financial				
Budget allocation and availability			●	
Investment in knowledge (training etc)		●		Councils invested but were not too concerned with becoming 'the experts.'
Was it worth the investment compared to the benefits achieved			●	
Organisational (Changes of local government level)				
Impact on organisation - Local Government		●		
Impact on jobs or functions	●			
Role of leadership			●	Some case studies were initiated by a leader's interest.
Internal cooperation			●	
Knowledge of blockchain		●		Most of them trusted the technology partner with basic understanding. Controlling the environment way key.
Ecosystem creation/ Partnerships				
Looking for partner and experts			●	
Cooperation with others			●	
Stakeholders and Responsibilities			●	Clarity on responsibilities and accountability is essential.
Role of local government		●		Partnership, where government was the orchestrator.

	Low	Medium	High	Observations
Systemic/ Regulatory				
Discussions or presence of any regulatory/policy or even bill presence or discussions			Did impact	Presence does encourage local authorities, and also bring key aspects into discussion.
Defining vision		●		Depends on the autonomy of local governments.
Legal implication of research or pilot				Unclear. Lack of regulation and governance standards hinders development.
Technological Concerns				
Need for in-house skills (within local governments)	●			Understanding and control.
Understanding technology and how it works		●		
Authorisation/ who reads and manages data			●	Local Government was primary stakeholder.
Security (Data and informational)			●	
Scalability		●		It usually is concern after successful pilot, not before
Prototypimg and learning from prior deployment			●	
				© Big Innovation Centre

The above table 5 indicates that **certain concerns are unique to blockchain adoption while others overlap with the adoption of other technology/ IT services as well.** The concerns which are unique to blockchain while designing the project are:

- Privacy and type of blockchain use
- Responsibilities depending on blockchain type
- Scalability and governance of blockchain
- Knowledge and legal implications

Most of the above-listed concerns can be tackled with the development of the technology itself. The project team can design the architecture and decide on the type of blockchain according to need. The design will determine how the service is managed and its implication on privacy. Similarly, the lead project stakeholder can clarify roles and responsibilities and that has a significant impact on the design of technology too. As understood from the case studies, **partnerships are vital**. In all five case studies there existed a **consortium of stakeholders across public and private sectors, academia, specialised experts and users that came together to design a solution that was tailored to needs and worked toward a common goal.**



4. MIND THE GAP WITH CO-CREATION

As the case studies point, the deployment of blockchain technology did not result in a transformative change within local governments but **rather it creates additional value to an existing service**. Moreover, it has an **incremental and measurable positive impact on efficiency, transparency, and automation**. To enable innovation and to utilise the full potential of blockchain there is a need for more focused pilot projects.

We reached out to the UK councils to gain first-hand insights to understand the role of blockchain in the current digital transformation process. On basis of the literature review, we designed **semi-structured interviews and spoke with Council CEOs, IT Heads of Department and also with individuals** from organisations like COSLA , GLA and Improvement Services of Scotland, some of them are at arms distance from government but have thorough understanding of local governments.

LOCAL GOVERNMENTS WANT TO LEARN MORE ABOUT BLOCKCHAINS/DLTS

Many councils in the UK share the same concerns and challenges that have been discussed throughout this paper: paucity of understanding the technology and its use cases, concerns about its implementation as well as unintended consequences.

Currently, **most councils in the UK are in the phase of improving service delivery.** As a result, website development, analytics platforms and data management strategies remain in sharp focus. However, there is another challenge that is taking up considerable amounts of time and energies. A representative from the ICT team of a council highlighted that their current biggest tech challenge consists of cybersecurity threats. **Managing cyber risk consumes most of the resources allocated for IT services in councils.** Current digital strategies or ICT policies are pushing some councils to be more innovative but **blockchain technology has yet to enter discussions.**

Digitisation is not just about developing digital services. Technology has **a major role to play in transforming how councils work, manage and organise themselves, especially with the recent budget cuts councils have witnessed.** Yet, hesitation towards adopting newer technologies persists mostly due to fear of the unknown and complacency. The hesitation was supported by one of the interviewee, "[...] *there's a lot of ways that people are very comfortable on the job. So, we know that it works it's secure and why rip the process by bring in something that we don't necessarily have that great understanding or confidence in.*"

It is clear, there is a dire need to share knowledge on what it means to implement and use blockchain. This needs to include practical learnings in the form of case studies that detail implementation strategies.

Moreover, **the launch of Proof-Of-Concepts (POCs) and working prototypes needs to be encouraged.** It seems that the fear of unknown could be quelled by taking smaller steps building confidence and knowledge - one PoC at a time.

Another solution could be greater support by supplementing resources. A centralised team that manages and explores new technologies and then shares knowledge and working PoCs with councils could be a more efficient alternative to the existing operating model. In London, this is already in motion. The London Office of Technology and Innovation (LOTI) aims to connect city councils so that digital, technology and data efforts can be magnified. Similarly, Improvement Services and Civitech in Scotland help local governments improve their services. Other organisations like the Local Government Association and Local Digital have been working closely with local governments to promote and encourage innovation. **Irrespective of their challenges, councils can experiment and adapt with support from such organisations**. For blockchain, a similar centralised approach of sharing knowledge and implementation support will expediate its application, too.

For the next few years**, most councils will target on delivering seamless services digitally, concentrate on better use of digital tools, and digitise the back office.** This needs to include data sharing and the creation and sharing of common service patterns.

National Authorities like HMRC and Bank of England are at the forefront of testing blockchain and leading on the national digital transformation strategy. **These national authorities could initiate knowledge sharing across the civil service to build momentum and provide councils with much needed inspiration** so that they become better adept at spotting potential use cases. Councils are much better at diagnosing and identifying problems (Benton, M. et al. 2016), hence **pilots at local level can be a valuable learning**.

To summarise, after talking to local government representatives we learnt the following:

- **Local councils have been using ICT, but there has been little to no consideration of exploring the potential of blockchain.** Based on interviews, local authorities are unaware of what is happening at a national level in terms of blockchain, except for a few reports that were published a year ago.
- **Need of a more centralised approach to transformation, including knowledge exchange on blockchain technology** was pointed by almost all council representatives**. A centralised team could make it easier to adopt new technology by sharing resources.**

Organisations who support councils do exist but **what is needed is to take this support and action it through sharing infrastructure** (initiated by some already), **responsibilities, skills and costs.** Only then will we be on our way to creating an ecosystem of connected councils.

THE BLOCKCHAIN INDUSTRY NEEDS INCLUSIVE IMPLEMENTATION

With so many constraints existing in government, how are solution providers forming partnerships? Are they struggling to break-in and partner with the public sector? We reached out to blockchain solution providers in the UK to capture and illuminate their experiences of working with national and local governments.

For Blockchain solutions vendors, the public sector is a customer segment which presents special opportunities and has specific characteristics in terms of maturity of requests, intensity of activity and revenue opportunity. Blockchain-based applications that are fit for public sector adoption are listed below:

- Digital citizens' identity
- E-voting
- Public accounting, contracts and taxes, e.g. digital currency
- Law enforcement and legal systems, e.g. reward schemes for recycling
- Title and asset registration e.g. land registry
- Digital certification, e.g. health records management

Broadly recognised Blockchain's benefits include an overall efficiency increase and cost saving through eliminating the need for multiple stakeholders in any financial transaction or data exchange. The promise of Blockchain for Government is to facilitate services which **citizens can enjoy higher security, fairness, trust and transparency** when interacting with civic services.

What we learned from 15 Blockchain solutions vendors that are based in the UK

For the purpose of this report, we reached out to 14 Blockchain solution and/or technology providers that are active in the UK, and asked them to position themselves with regards to the public sector opportunity, to give us their feedback in terms of their engagement with the local and central governmental services and propose good practices. This is what we found:

1. Citizens identity and digital currency gain traction, for the rest it is still early. All vendors cited a variety of use cases under exploration by the public sector. For most, the progress **with deployments is the initial pilots to proof of concept phase**, while for some the project did never take off. Regarding the popularity of use cases, urban government stakeholders seemed to be interested to explore the case of **digital currency and payments** as well as **digital citizens' identity management**. This is not surprising as digital identity act as the foundation for pretty much all the rest. Whereas digital currency is currently the main application of blockchain.

2. Understanding is still limited and so there is risk aversion to the technology. Reasons for the overall slow progress were primarily **lack of understanding and dedication** from the public sector side. Legacy systems are something that public sector stakeholders tend to think of as working well. For this reason, among most respondents, "there was limited desire to question legacy systems". In addition, public sector actors seem to **realise**

that data silos and multi-parties processes pose risks and in general consist a suboptimal situation that needs to be changed. Blockchain primes to be a catalyst for this change.

3. Leadership support is insufficient but perhaps justified. Blockchain vendors that have interacted with public sector entities, frequently cited that **Blockchain projects do not get enough support by public officials in leadership positions**. What may as well justify this stance, it seems that public sector officials have **concerns about the reliability of Blockchain solutions** and question their potential to **align with relevant laws and regulations**.

4. Moving forward, the public sector needs to be more receptive. Blockchain vendors cited **obstacles related to the procurement process** and a **lack of "open-mindedness"** by governmental authorities who seemed to have **settled for the established market players** when it comes to most tech solutions. At the same time, the availability of talent is high, while commercial solutions are already available in the UK. It is a matter of giving innovative players the opportunity to prove they are able to offer useful solutions.

5. Establish checks and processes that can be trusted. The public sector actors must overcome the fear of the unknown, by placing reliable check processes they can trust, are reliable and do not compromise lawfulness. Adopting the concept of **sandboxes (testing ground) to test new solutions is a way forward to eliminate barriers** related to a lack of clarity in regulation.

WAY FORWARD

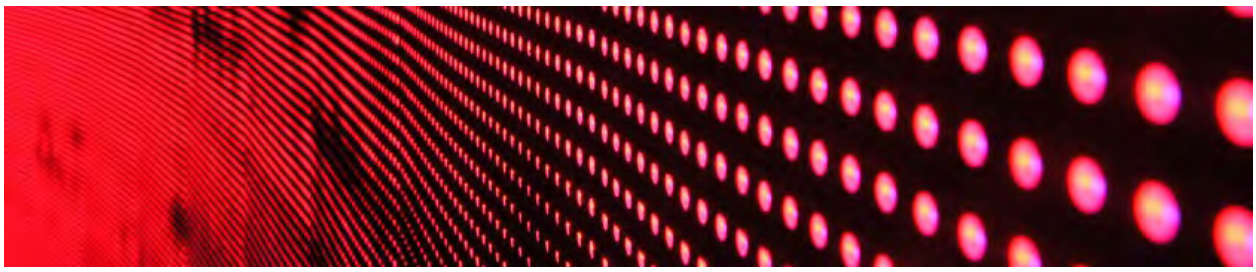
Despite central government's efforts to implement blockchain at a national level, **Local governments still need support. Knowledge transfer and sharing best practice are key to catalyse the implementation of blockchain solutions at the local level.** Knowledge sharing should encourage pilots projects and provide with adapted case-studies to the councils in the UK. Councils also pointed to the need of thoroughly understanding the advantages of using blockchain as **Blockchain is not yet as visible as other emerging technologies like augmented reality and machine learning/artificial intelligence.**

From this, it follows that the **blockchain industry should increase its engagement with the public sector, and vice versa, to understand the needs of local governments**. Certainly, there is a gap in the understanding of the blockchain technology, its implementation and use at the local authority level. This gap makes the blockchain initiative struggle to break through and establish strong ties with local governments. **Future collaborations need to be based on sharing knowledge, testing environments having the willingness and openness to understand this technology and its benefits.**

Proof of concept are needed; however local governments need to go beyond proof-of-concepts (PoCs) by striving to design fully operational services.

Table 6. Recommendations that will encourage use of blockchain in building capacity	
Finding: Blockchain is complex to understand. Councils and several other sectors need more awareness and understanding: o Basic knowledge: More efforts are required to share knowledge on blockchain technology, its application and implementation process. o Works both ways: Public sector need to learn more about technology, and private sector needs more insights to understand needs of councils.	**Recommendation: Build knowledge sharing consortium** Use existing knowledge sharing platforms to encouraging public-private sector interactions. Organisations like Scotim, Government Digital Services (GDS), Local Government Association (LGA) can encourage knowledge sharing partnerships and can continue to play a key role in building awareness and understanding.
Finding: There is hesitation for experimentation: o Need practical examples of blockchain implementation. Pilot projects o Blockchain has technological challenges, use is still nascent in its implementation	**Recommendation: Encourage pilots** at local level by building an ecosystem. More collaboration, testing environments (sand boxes approach) and more openness from the public sector. **Need support from higher authorities**: The ecosystem and necessary environment can only be built at a local level if national authorities lead in supporting such initiatives. **Blockchain industry needs to be included. Industry inclusion is key to provide better solutions and for develop the tech accordingly.**

The above recommendations encourage collaboration to achieve desired goals. **Collaboration is most essential, at the same time, most difficult aspect to achieve.** Collaboration will catalyse the ecosystem building that can encourage sustainable adoption of technology.



APPENDIX

WHAT EXACTLY IS BLOCKCHAIN - DEFINITION & CONCEPTS

Blockchain and Distributed Ledgers

In 2008, Satoshi Nakamoto published a paper called, "Bitcoin: A Peer-to-Peer Electronic Cash System". It was the foundational paper of Bitcoin, a cryptocurrency which allows an Internet-based peer to peer "cash" transactions. Bitcoin imbibed a powerful technology, Blockchain.

Nakamoto's paper (2008) cited the following characteristics for this new technology, at the time called Bitcoin,

- Enables direct transactions without the need for trusted third parties
- Enables non-reversible transactions
- Reduces credit cost in small casual transactions
- Reduces transaction fees
- Prevents double-spending.

Many definitions can be found in the literature on Blockchain. These definitions focus on various aspects such as distributed database, decentralised network, a linked sequence of transactions, or consensus mechanism.

Seebacher, 2017, after carrying out a structured literature review defined Blockchain as, "A distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding timestamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into an immutable record of past activity". Based on Seebacher definition and Nakamoto characteristics, Blockchain is based on the following principles,

1. Peer-to-Peer, "agreed upon peer to peer network."
2. Distributed, "shared among"
3. Consensus, "verified by the network community."
4. Immutability, "it can not be altered."
5. Transparency "shared among"

Peer to Peer, blockchain allows Peer to Peer (P2P) transactions.

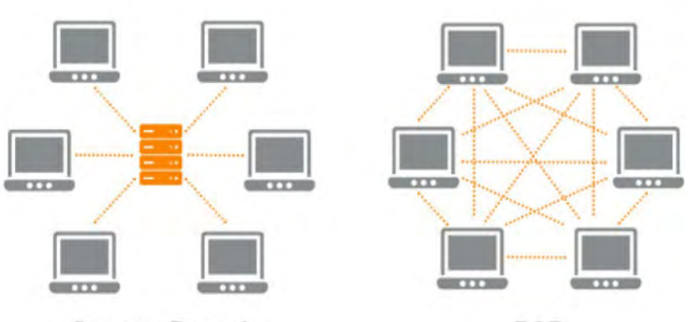


Figure 1 Graphic Representation Server-Based Vs Peer to Peer Network (Streamroot, 2015)

Steinmetz, 2005, defines a Peer to Peer network as "a self-organising system of equal, autonomous entities (peers) which aims for the shared usage of distributed resources in a networked environment avoiding central services". It

is a system with a decentralised organisation, where peers are interconnected through the network. Contrary to traditional server-based systems, peer-to-peer networks do not need a centralised server to host data and transactions.

Peer-to-Peer networks share and distribute all the transactions that occur in the network. Each node gets a new copy of the ledger where the new transaction is approved and included

Distributed and Decentralised, Baran (1964) concluded that communications in a network, e.g. a whole Supply Chain, are formed for several stations (nodes in a Blockchain system), e.g. suppliers, providers and logistic partners in a SC network. Baran classified the networks based on the information interchange between these nodes. Based on this criterion, there are three main categories of networks as shown in figure 1,

- Centralised, where all the stations report to one station
- Decentralised, where several nodes report to different nodes
- Distributed, where all the stations are interconnected with all the station on the system

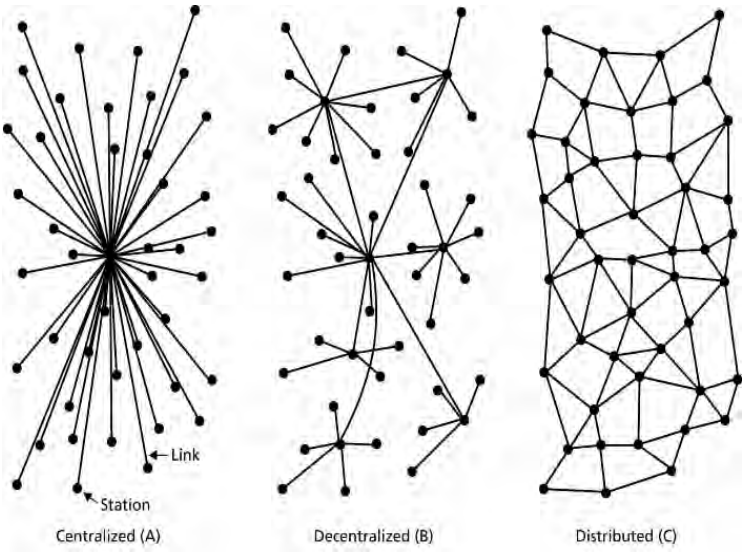


Figure 2 Graphic Representation Nodes System (Baran, 1964)

BC network is characterised as a distributed network, where the peers will have access to the whole network and all transactions that have been carried out within the network. No single entity controls or governs the system. This removes the need for a third-party intermediator. In comparison with the centralised model, a central authority (e.g. a Central Bank to issue money) is no longer in need due to the consensus system among peers.

Consensus, Blockchain, as a decentralised system, does not need a third party to certify the transactions. The approval of each transaction among two peers is not made by a centralised third party (e.g. Central Bank); rather, it is made by the peers themselves. The transactions are approved by consensus among the participants (nodes); once the consensus is agreed the transaction is approved, the block is chained to the chain, and the new ledger is distributed to all nodes.

This mechanism is based on the Nakomoto (2008) proposal for the bitcoin protocol, "Nodes (users) vote with their CPU power, expressing their acceptance of valid blocks by working on extending them and rejecting invalid blocks by refusing to work on them. Any needed rules and incentives can be enforced with this consensus mechanism".

Immutability distributed and "append only" characteristics of the Blockchain makes it immutable and impossible to erase or modify once a new transaction is added to the chain and distributed.

Once the data are recorded, they can not be modified without letting the network finding out, making BC tamperproof thanks to the use of hashes (Tasca, 2017)

Transparency, all members of a Blockchain network or predefined participants are allowed to see the transactions in the system. Every single node gets a copy of the ledger each time a transaction is approved; therefore the records are transparent and traceable.

Blockchain Technology

The combination of existing cryptographic technologies provided to Satoshi Nakamoto the baseline to create the first cryptocurrency, Bitcoin. Blockchain is, therefore, a combination of distributed ledger technology; public and private keys encryption system; Merkle tree hashing and consensus protocols.

Components

Block, A Block is an amount of data that records the list of transactions into a ledger, a transaction counter and transactions log (Zheng, 2017). Apart from the technical and cryptographic components, a block contains data (transactions, certificates, invoices or any related data)

The data contained in the block can be any kind of data. For example in a cryptocurrency blockchain, transactions. Whole transactions history is in the block; this allows to create a ledger.

Hash is a cryptographic function that is produced with the data of the block. The data of the block is arbitrary, and hash allows mapping these data to data of fixed size (e.g. 256 bits in Bitcoin). The main advantage is that a hash can be easily produced and changes in the original data produce a different hash, making it thus infeasible that two different sets of data produce the same hash (Rogaway, 2004). This attribute makes immutable the data set that produces the hash. Blockchain technology uses the hash as a chain or cryptographic artefact that links the blocks as shown in Figure 3-4, a unique hash is produced with the data included in the block.

Nodes, a node is a participant or user, usually represented by a CPU or computer connected to the network.

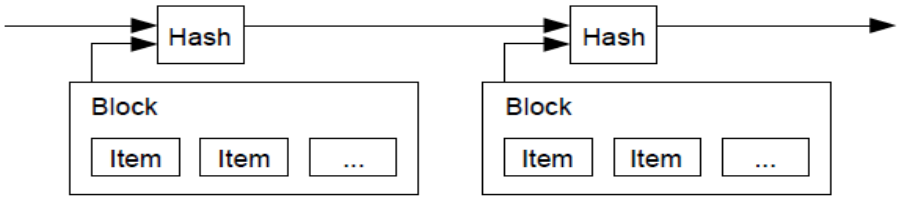


Figure 3 Hash Structure (Nakamoto, 2008)

The Network is composed of the nodes or computers connected with each other in the same Blockchain. The ledger will be distributed through the network each time a transaction is accepted. Once accepted all the nodes will have the new ledger version.

Digital Signatures, Blockchain use asymmetric cryptography (Public Key and Private Key) to validate transactions, thereby allowing trust in an unthorough environment. (Zheng, 2017)

How components work together

The components of Blockchain operate together as follows:

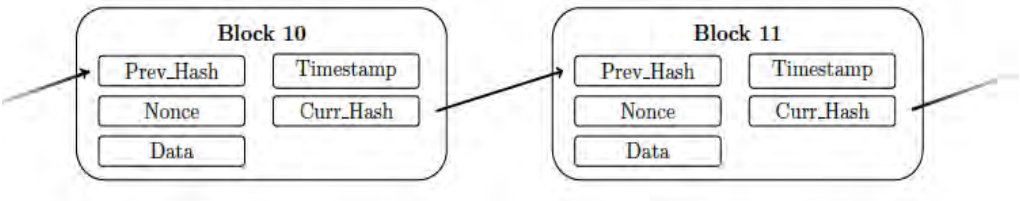


Figure 4 Components of a Block (Bruyn, 2017)

Inside the 'block': Each block contains the following data,

- Block number, a number which the block is identified
- Timestamp, the time the block was created
- Transaction or data
- Hash of the previous Block
- Hash of the Current Block

When a new transaction happens in the Blockchain, the new block with the new data is broadcasted to the network in order to get the approval.

Transaction

Consensus mechanisms in the network approve the transactions. When two peers agree on a transaction, they use their public key and private key to initiate and terminate the transaction. The transaction data are then added to a new block; this block will have the hash of the previous block and the data "modified". The Block is broadcast to the network in order to be approved and added to the chain.

The approval will be carried out by the network the nodes through a consensus mechanism. Depending on the type of platform and the type of Blockchain network, the transaction sequence established by Nakamoto (2008) in the foundation of bitcoin is the following,

1. New transactions are broadcast to all nodes.
2. Each node collects new transactions into a block.
3. Each node works on finding a difficult proof-of-work (**#**) for its block. (Consensus Mechanism)
4. When a node finds a proof-of-work (**#**), it broadcasts the block to all nodes.
5. Nodes accept the block only if all transactions in it are valid and not already spent.
6. Nodes express their acceptance of the block by working on creating the next block in the network.

(#) Proof-of-Work is the consensus mechanism for the Bitcoin platform. The consensus mechanism depends on the configuration of the blockchain and the type of platform used.

Configuration of the Network. Types of Blockchain

Nodes form networks; a node is each computer (user) that form the network. The distinction between the nodes that are allowed to participate in the network, execute the consensus protocol and maintain the shared ledger allows classifying the configuration of a Blockchain network in three types (Jayachandran, 2017),

Public or Permissionless Blockchain | Private Blockchain | Permissioned (consortium) Blockchain

Public or Permissionless Blockchain

In a public Blockchain, the network is open to anyone who wants to participate. Participants are part of the consensus process to approve the transactions, and all records are visible to every node (Zheng, 2017). In this arrangement, building consensus is complicated and needs of cryptographic mining methods known as Proof of Work (Nomura, 2017). Public Blockchain is the standard that underlies cryptocurrencies, having its most prominent exponent in Bitcoin.

Private Blockchain

Contrary to the Public Blockchain, private Blockchains restricted the joining and visualisation of transactions. Only authorised nodes can approve transactions or reach the consensus in even just one node (Centralize) (Zheng, 2017). Building consensus is simple as it is centralised in one organisation (Nomura, 2016). An example of this is a corporate blockchain that works internally within a company or small SC.

Consortium or Permissioned Blockchain

Permissioned Blockchains are a hybrid of Private and Public Blockchains. Only whitelisted participants are allowed to join the network and participate in the consensus mechanisms. Permissioned Blockchains also allow information asymmetries among the members of the network. This mechanism can be used to interact among a group of companies and to build a consensus is easier than in a public Blockchain (Nomura, 2016). Permissioned Blockchains have been used in most of the pilot projects that apply blockchain to the Supply Chain networks (e.g., IBM – Maersk Project, Provenance-CooP, Everledger)

Property	Public Blockchain	Consortium Blockchain	Private Blockchain
Consensus Determination	Consensus process	Selected set of nodes	One organisation
Read permission	All Public	Could be public or restricted	Could be public or restricted
Immutability	Consensus process	Could be tampered	Could be tampered
Efficiency	Low	High	High
Centralised	No	Partial	Yes
Consensus process	Permissionless	Permission	Permission

Table A.1 Comparisons among public blockchain, consortium blockchain and private blockchain (Zheng, 2017)

SMART CONTRACTS

Smart contracts, previously called self-executing contracts, were first introduced by Nick Szabo, 1994 as "A computerised transaction protocol that executes the terms of a contract". What Szabo proposed was translating the legal codes or contractual clauses in technical code defined by software or hardware. Szabo presented the most straightforward smart contract at the time, a vending machine, a piece of hardware that with an agreed fee provides the user with an item without any intermediary. The escalation of this simple idea to more complex contracts is now possible due to Blockchain, as a layer where the transactions are registered and agreed by consensus.

The Blockchain principle of a trust-less network (Casey, 2017) allows the implementation of new software artefacts on the top of the technology. The data source of the event is wholly trusted through Blockchain Layer, which allows building on top of this layer another layer of self-executing contracts, nowadays called smart-contracts.

Smart contract Definition & Characteristics

A smart contract is a software protocol that regulates a transaction among two parts. A "precoded" software automatically moves assets according to arbitrary pre-specific rules or a "piece of computer code that is capable of monitoring, executing and enforcing an agreement" (Freshfield, 2018).

Traditional contracts are formed by two types of clauses (ISDA, 2017),

1) Operational Clauses, these clauses are based on conditional logic. A clause occurs or is executed when a determinate event happens. For examples,
    - A 3PL delivers an asset to the final customer. The asset changes the ownership and consequentially an economic transaction is activated.
    - Logistic provider delays a shipment. It will incur in a penalty as regulated by the contract
2) No Operational Clauses. These clauses regarding broader aspects of the Law Code and legal relationships between the contract parties, e.g.,
    - Jurisdiction if any dispute arises among the parts
    - Applicable laws in the event of a dispute

Both types of clauses can be imbibed into a smart-contract. However, only the operational clauses can be automated to self-execute. No-conditional clauses are less susceptible to be automatized, as legal code system and technical code system are still disconnected each from other, e.g. terms as 'good faith' or 'commercially reasonable manner' have a difficult self-execution at the moment.

Events that define the conditional clauses are recorded as a transaction in the Blockchain layer; these events trigger the smart contracts and execute the code.

Smart contract Benefits and Applications

Smart contracts have the potential to disrupt the legal operations of traditional contracts. Cant (2016) considers that currently, systems and processes of contracts involve much back-office paperwork. A future vision on Smart Contracts will bring a more efficient workflow by providing greater visibility into the state of an asset in the workflow. Next level will be that this happens between a group of companies. Ultimately the smart contracts being admitted in court will close the circle and bring the efficiency to the entire system or supply chain.

The potential benefits of Smart Contracts are numerous (Morrison, 2016),

- **Accuracy**; the smart contracts are self-executed when the requirements (events) are met, so their execution is always assured. Previously, all terms and conditions had to be recorded in terms of operational clauses
- **Transparency**, as the conditions are agreed among the parties before setting up the smart contract, there is no room for the discussion, and the contract becomes autonomous
- **Speed and Efficiency,** Smart contracts, once the conditions reflected in the operational clauses are met, are executed automatically. Third verification parties and lawyers are removed from the process, and checking times are no longer needed, which increases the speed of the execution. Morrison, 2016 claims that traditional contract execution takes and an average of one to three days, the smart contract can reduce this no-added value time in the process to almost zero.
- **Storage and backup**, Smart contracts are stored in the Blockchain network and distributed to all the nodes, so a physical (paper) storage will not be longer in need. Along with it, there is a permeant backup in the network.
- **Savings**. Lower administration cost and legal costs. Morrison, 2016 considers that lawyers can be removed from some transactional contracts.

TYPES OF BARRIER TO GOVERNANCE INNOVATION

TABLE A: Types of Barrier to Governance Innovation

	Government	Citizens
Structural	Legal constraints, lack of finances, shortage of personnel and available skills, limited political and management support, lack of coordination, technological constraints, Leadership	Lack of technological facilities, limited knowledge and competences, shortage of time, failure to integrate innovation in daily routines
Cultural	Resistance to change, fear that innovation undermines the robustness of Government, interference with the bureaucratic culture	Lack of interest, little faith in and negative image of the Government, no perceived usefulness, resistance to technology

Source: (Meijer, 2015), (da Cruz, Rode and McQuarrie, 2019), LSE Cities, UN Habitat

BLOCKCHAIN POTENTIAL APPLICATIONS – CITY GOVERNANCE

TABLE B: Blockchain potential applications	
Blockchain for Democracy and Decision making	Improvement of the participation and involvement of the citizens in political processes at all levels. Blockchain can offer new disruptive models for decision making with functionalities such as: the possibility for citizens to engage and participate more directly in, real-time participation in voting processes, new ways for politicians and experts to build credibility and authority and the possibility to delegate ones votes to authorities within specific areas.
Blockchain Identity	Blockchain can provide solutions for decentralized identities that can identify us without the use of a third-party authority and even without revealing more information than necessary for the specific interaction in the moment of identification. The Digital Identity is a use case for blockchain in government services, as well as a key for the integration and functionality for many other Blockchain services.
Blockchain Voting	Blockchain it is possible to design e-voting systems that are much more secure, transparent and trustworthy, and still capable of preserving confidentiality. In current use cases, the city of Zug has used their Blockchain IDs to conduct their first Blockchain-enabled e-vote. Voting with blockchain has also been done in places like West Virginia in the U.S. and Moscow, Russia.
Blockchain for Public Accounting, Contracts and Taxes	Blockchain can bring total transparency and immutability to the public administration. In accounting, all the incomes and payments can be scanned and registered on a Blockchain for full accessibility to show for what, by whom, and when every single penny has been spent. Smart Contracts can solve taxation in real-time and also show who has and has not paid their taxes. The full information about any public contract, with the conditions, deliverables, and payments can also be shown and followed up in real time. Estonia has a big part of its public administration on blockchain. Many other countries and cities are starting to implement blockchain, and for example, the public administration of Dubai aim to be digitalized, and paper-free by 2021.
Blockchain for Law Enforcement and Legal Systems	The number of registers and record keeping within the law enforcement and the legal systems is enormous, and in many cases, it suffers from lack of transparency, the access to information is slow, and it is under suspicion for manipulation. The registration of data for police records and legal cases on blockchain would add trust to the legal systems thanks to transparency and immutability. Many Blockchain projects for law enforcement and judicial systems have been proposed globally, such as the tracking of the use of police firearms and the registration of police video surveillance to make sure data is both registered and not manipulated.

Blockchain for Title and Asset Registration	To avoid the loss or manipulation of public registers, blockchain has been proposed for the registration of land and other properties. Moreover, with the use of Smart Contracts, the changes in ownership could also be done in real time. The Swedish public land registry has a project using blockchain for land registration, and many other countries are doing the same. Other areas where blockchain has been applied for registration are for example car registers in Denmark or the filing of companies and firearms.
Blockchain for Certification	Blockchain systems can give real-time access to certifications regarding both individuals and organizations. At the same time blockchain can let the individual, or organization, be the owner of their data, but with the guarantee that the information is real and up to date. The potential here is vast, and the importance of these solutions has been widely recognized. An example is Malta that soon will start to issue Blockchain certificates for professional and informal education.

Source: Blockchain Revolution in the Governance of Nations and Cities. https://openledger.info/insights/blockchain-public-governance/

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