The City as a Licence. Implications of Blockchain and Distributed Ledgers for Urban Governance.

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Abstract

Distributed ledgers such as blockchain have in recent years started to be seen as a new general-purpose technology that could underlie many aspects of social and economic life, including civics and urban governance. They are expected to play a fundamental role in the management of identities, rights, access, and resources. With the addition of smart contracts, they will automate the processing of data and execution of decisions through algorithmic governance.

Recently, a number of actors have started to explore the application of distributed ledgers, amongst others in smart city services as well as in blockchain for good-projects. The technological assemblages that make up these services will have far-reaching effects on the rights and access enjoyed by citizens while they fundamentally change the (democratic or bureaucratic) processes traditionally associated with them. Positive contributions are expected to (local) democracy, transparent governance, decentralization, and citizen empowerment.

We argue that to fully scrutinize the societal implications for urban governance, a more critical analysis of distributed ledger technologies is necessary. In order to do so, we propose the lens of 'the city as a licence'. This lens brings out questions that relate to governance in relation to public values and social good. Through a technological exploration combined with a speculative approach, and guided by our interest in the rights management and agency that blockchains are claimed to provide to their users, we trace six important issues: quantification; blockchain as a normative apparatus; the complicated relationship between transparency and accountability; the centralizing forces that act on blockchains; the degrees to which algorithmic rules can embed democratic law-making and enforcing; and finally, the limits of blockchain's trustlessness.

1 Introduction

Recently, discussions have emerged around the application of blockchain in the domains of civics and urban governance. These discussions signal a shift in the understanding of distributed ledger technologies. Originally, they were understood mainly as financial instruments, with discussions focusing on the economic opportunities around digital currencies such as bitcoin and venture capital funded corporate blockchain startups. Gradually however, distributed ledgers such as blockchain have started to be seen as a new general-purpose technology that could underlie many aspects of social and economic life, including civics and urban governance (Lipsey et al. 2005; Davidson et al. 2016; Kane 2017). The various 'blockchain for good' projects that have sprung up in are an example of this. At the launch of the European Blockchain Partnership, the European Commissioner for Digital Economy and Society Mariya Gabriel even claimed that "[I]n the future, all public services will use blockchain technology."[1]

In this chapter we want to contribute to this debate by sharing insights gained from a technological exploration of distributed ledgers such as blockchain. We will argue that distributed ledgers can indeed be understood as a new general-purpose technology, not in itself, but as part of broader socio-technological urban assemblages (Farias & Bender 2010) of new technologies that have been described with labels such as 'platformization' (Van Dijck et al. 2018) and 'smart cities' (Cowley 2017; de Waal & Dignum 2018; Kitchin 2014). In these assemblages, distributed ledgers are well placed to play a fundamental role in registering resource production, usage and transactions; keep track of account balances; and manage identities and rights. Moreover, with the addition of so-called smart contracts, distributed ledgers are set to play a role in the automated processing of data and conditional execution of transactions through algorithmic governance.

Although much hopes are projected on the blockchain as a new tool that could for instance contribute positively to civic self-organization or the management and governance of civic, commons-based peer-to-peer economies (Antoniadis 2018; Boiler 2015; Pazatis et al. 2017; Rozas et al. 2018; Pitt & Diaconescu 2014), here we want to contribute with a critical analysis of the affordances of distributed ledger technologies. Given these affordances, what issues and questions should be considered when implementing blockchain in all public services, as the European Commissioner predicted? Following Foth's (2017) call to the research community for exploring possible futures of blockchain technologies and their societal implications, we will take a somewhat speculative approach. We will depart from our own technological exploration and connect it with broader debates about distributed ledger technologies, and various speculative research projects and workshops (Nissen et al. 2017; Nissen et al. 2018; Elsden et al. 2019a; Kera et al. 2018; Elsden et al. 2019b).

As a model to discuss and think through the societal implications in relation to urban governance of distributed ledgers we propose the lens of 'the city as a licence'. This lens will be introduced as an inversion of the current 'city as a service'-metaphor that focuses on the affordances of smart city technologies in relation to the efficient provision of individualized services to urban consumers. Instead, the city as a licence brings out questions that relate to governance in relation to public values.

2 Distributed ledgers as a general-purpose technology, part of socio-technological assemblages

The implications of distributed ledgers for urban governance could best be understood as one aspect of larger socio-technological assemblages that have been described under the rubric of platformization. Recently, a number of studies have pointed to the rise of digital platforms. The main argument is that platforms such as Uber, Airbnb, Facebook, and Amazon are not neutral, digitally enabled remediations of traditional marketplaces and communication channels. Rather they bring out a new logic and, according to some, should be understood as a new type of institution, imprinting

[1] https://ec.europa.eu/digital-single-market/en/news/european-countries-join-blockchain-partnership

their underlying logic on society at large. Srnicek (2017) has shown how the currently dominant platforms can be understood in the context of a shift in capitalism from the production of goods to the analysis of data, leading to a new hegemonic model of smart cities, disruptive businesses and a flexible workforce, dominated by large monopolistic firms. Others have pointed out that platform technologies also have the affordance to stimulate commons-based peer-production. Widening the scope beyond economics, Van Dijck et al. (2018) speak of a nascent platform society in which a small set of infrastructural platforms emerge as the central operators of a new societal infrastructure enabling sectoral platforms to re-organize societal sectors such as health, urban transport, education and journalism. Van de Graaf (2018) proposes to use the metaphor of the platform as a way to analyze and discuss shifts in the governance of cities, speaking of a platform urbanism.

In all these instances, the term platform is used as a pars pro toto of an assemblage of various technologies. Such a 'stack' (Bratton 2016) of recently developed digital technologies include sensor networks and Internet of Things-technologies that can actuate urban resources and measure their usage; algorithmically governed online platforms that act as market places, connecting supply and demand in various domains; and - blockchain based - distributed ledgers that keep track of identities, rights and account balances.

In the context of urban governance, smart city-technologies can be understood as an example of such platformization. Although definitions of smart cities differ widely (De Waal and Dignum 2018), a trait that the many definitions hold in common is that all kinds of urban services can be optimized through the applications of various types of data that are assembled and processed in the city in real-time. The other way around, digital platforms also provide means for citizens to offer their own services as micro-entrepreneurs, or organize themselves around the management of resources in commons-based local economies. For instance, through the systematic collection of (real-time) data, urban services such as transport can be optimized, integrating algorithmic selection, gps-based location data, reputation systems, and electronic payments into a single user experience such as a taxi-app, offering urban consumers a smooth ride, whereas others can offer their services as micro-entrepreneurs. De Waal and Dignum (2017) invoke the metaphor of the control-room, in which all kinds of urban processes can be monitored and managed in real-time, both from a top down perspective, as well as from the perspective of the user. His or her mobile phone becomes a personalized control-room from which a citizen can manage their own urban operations. One way to describe this perspective is 'the city as a service', as introduced by Hwang (2009). Through this lens, the city is understood as a broad range of infrastructural services in the domains of mobility, leisure, entertainment, energy provision or health that can now be consumed in a highly personalized manner. Such smart city approaches potentially form a powerful set of tools that provide new ways to manage and govern urban resources.

For this chapter we take a specific interest in the affordance of distributed ledgers and their smart contracts as one of the underlying technologies invoked in the governance of platform based economic and social systems, with blockchain as a widely discussed current instantiation of such a technology. Blockchain is an emerging technology that is sprawling into different domains with updated characteristics continuously. This means there is no catch-all definition as of yet. However, the blockchain is commonly described along a few main characteristics (Elsden et al. 2018, 1; Wright and De Filippi 2015; Sultan, Ruhi, and Lakhani 2018; Rozas et al. 2018; Ølnes, Ubacht, and Janssen 2017, 356; Kewell, Adams, and Parry 2017, 431–32) that can be summarized as follows: it is a distributed and decentralized network in which each node has an identical and continuously updated copy of a shared ledger. A consensus algorithm works to verify any new additions to the ledger, overcoming the need for human oversight and operating in what is called a trustless manner. These characteristics combined mean that blockchains are considered immutable. Sultan et al. further explain that these characteristics exist to different degrees according to the public or private nature of a blockchain (Sultan, Ruhi, and Lakhani 2018, 53). Whereas first instances of blockchain functioned as decentralized ledgers, newer incarnations include so-called smart contracts. These are algorithmically encoded rules that can automate certain transactions based on pre-set conditions. This means that both performance and enforcement of these rules can be executed automatically, without the need (or possibility) for human interference (Cila et al. 2020; Wright & De Filippi, 2015). With these smart contracts embedded in its code, blockchain run systems can become Decentralized Autonomous Organizations (DAO).

For the purposes of this article four aspects of distributed ledgers are of particular interest. First, distributed ledgers such as blockchain are instrumental in translating all kinds of social and economic behavior into data, as they can store data and make these available throughout the network. Second and third, as records are immutable and due to the trust procedures embedded in its architecture, distributed ledgers are also very well qualified for the management of both identities and rights. Fourth, with the addition of smart contracts and their algorithms, distributed ledgers can conditionally automate transactions, combining account balances, the identities and rights registered in their system and external inputs. Distributed ledgers can thus be understood as decentralized databases with built-in verification schemes that allow for immutable record storage and link these to automatic transactions.

2.1 Distributed ledgers, algorithmic governance & the city as a licence

From the perspective of governance, the rise of distributed ledgers and their smart contracts may pertain an important shift. Distributed ledgers and their smart contracts can then be understood as part of what Yeung (2018) has described as 'the rise of automated data-driven systems to inform decision-making and regulate behavior', and perform what has been called 'algorithmic governance'. Yeung (2018) has described this as

> "decision-making systems that regulate a domain of activity in order to manage risk or alter behaviour through continual computational generation of knowledge from data emitted and directly collected (in real time on a continuous basis) from numerous dynamic components pertaining to the regulated environment in order to identify and, if necessary, automatically refine (or prompt refinement of) the system's operations to attain a pre-specified goal (Yeung 2018)."

Such a perspective means that the introduction of distributed ledgers as a general-purpose technology for accounting and rights management, may contribute to what De Filippi and Wright (2018) have described as, ' a structural shift of power from legal rules and regulations administered by government authorities to code-based rules and protocols governed by decentralized blockchain-based networks.' Various actors may encode particular rules and conditions of particular blockchain set-ups, de facto regulating various domains of urban society, with the actuation and enforcement of those rules delegated to Distributed Autonomous Organizations. According to Wright and De Filippi (2018), this means that increasingly we are subjected to what they call the "rule of code".

As an outcome of a speculative design workshop - in which the authors of this chapter participated - on a future in which such a rule of code has been realized, Elsden et al. (2019b) introduce the concept 'the city as a licence' as a lens to understand and explore what such a shift may entail. The city as a licence, is described as 'a future in which (semi-)autonomous digital systems administer rights and access to a broad variety of urban resources.' For instance, with blockchain-based DAOs, parking places could be programmed to autonomously run a parking service, encoding particular rights and priorities in smart contracts with regard to whom is entitled to use a parking space under what conditions. The city as a whole could then be understood as 'a series of licences to make use of or contribute to the production of particular services such as parking, health, housing, energy or schooling.' (Elsden et. al 2019b) As such, the city as a licence can be understood as an inversion of the city as a service. Whereas the latter would focus on the experience of consumers receiving individualized parking on demand services, 'the city as a licence' directs attention to the politics of such systems. What world view, privileges and other political decisions are encoded in these systems? What are the conditions set, and who will be granted the privileges to make use of these services? Who (or what) makes these decisions, how is this made transparent and how can actors be held accountable? In the remainder of this chapter we will now turn to specific aspects of distributed ledger technologies that further detail this city as a licence-perspective, bringing up both positive and negative affordances of distributed ledger technologies for urban governance from a perspective of 'public values' and 'social good'.

3 Distributed ledgers, public values & the social good

A perspective as 'the city as a licence' focusing on rights and public values matches with a broader discourse emerging around platformization and smart cities. In their book The Platform Society, Van Dijck et al. analyze the rise of public platforms from a public values perspective and enquire how traditional arrangements for the safe-guarding of these values are undermined or substituted by the mechanisms operative in digital platforms (Van Dijck et al.). Likewise, in the Netherlands The Rathenau Institute has called for better protection of public interests in the platform-based sharing and gig economies (Frenken et al. 2017). In discussion around smart cities, various authors have called to apply a Lefebvrian perspective of rights to the city towards smart and digital cities (Cardullo 2019; Foth et al. 2015).

With regard to blockchain and distributed ledgers, various studies have explored how this technology could be applied for social good and provide opportunities for citizen empowerment. The Center for Social Innovation of the Graduate School of Stanford Business made a useful, albeit overly optimistic, analysis of 193 initiatives that aim to operationalize the blockchain for social good in the categories of: health; financial inclusion; energy, climate, and environment; philanthropy, aid, and donors; democracy and governance; agriculture; and land rights (Galen et al.2018, 3). Bartoletti et al. broadly share these categories in their analysis of 120 "blockchain-enabled social good projects", adding digital identity, education, and human rights (Bartoletti et al. 2018 38).

Anticipation about this potential of the blockchain is usually based on one or more of four assumptions about the social consequences of the blockchain. First, blockchains are expected to bring about more secure and trusted (transactional) systems because of their consensus algorithm and distributed, transparent nature. The Dutch Blockchain Coalition understands that the technology "due to its transparency and non-repudiation contributes to fundamental trust in our societal infrastructure" (Blockchain for Good: The Vision and Mission of the Dutch Blockchain Coalition). The top benefit of the blockchain for social good cited in the Center for Social Innovation's report is the technology's contribution to the "reduction of risk/fraud or increase in integrity/transparency" (Galen et al. 2018, 4).

Second, blockchains are perceived as democratizing technology because of their reliance on consensus algorithms instead of opaque central authorities (Ølnes, Ubacht, and Janssen 2017, 363).

While these authorities may be influenced by politics or corporate interests, decisions based on algorithmic calculations are presumed to be more objective or neutral (Galen et al. 2018, 12). Using blockchains in systems that are meant to support democratic processes are seen to be a tool for citizens to hold governments accountable (Galen et al. 2018, 21). By making supply chains transparent, blockchains are also assumed to facilitate fair payment for those vulnerable to exploitation located at the often non-transparent start of the chain (e.g. farmers of coffee beans in the Global South) (Galen et al. 16). Another use case that is mentioned is the recording of land and property rights on the blockchain, especially in countries where such registries are not well-established or considered trustworthy (Pisa and Juden 2017, 28).

Third, the decentralized and transparent nature of the blockchain is understood to give people more control and agency over, for example, their digital identities. Individuals can determine on a case-by-case basis which pieces of personal information are made visible to whom (Kewell, Adams, and Parry 2017, 434; Galen et al. 2018, 27). Some initiatives use the blockchain to provide digital identities (and concordantly control over them) to those who, due to geopolitical or economic reasons, have been left out of these infrastructures traditionally, for example the unbanked (Galen et al. 2018, 3, 29, 40; Pisa and Juden 2017, 25–26).

Furthermore, relying on quantification for its algorithm, blockchain makes efficient and minute bookkeeping possible in domains in which it has historically been difficult to do so, for example the conditional distribution of charity, international aid funds distribution, or the tracking of the impact of philanthropic donations (Galen et al. 2018, 60–61; Pisa and Juden 2017, 31). Not unimportantly, the use of blockchain for the international transfer of money can reduce overhead costs (Galen et al. 2018, 61; Pisa and Juden 2017, 19–20). Another case is made in relation to education, in which blockchain-based accreditation systems could provide more individualized, diversified, and detailed proof of particular comprehension or skills, improving existing homogenizing educational structures (Galen et al. 2018 69).

Last, there is a huge interest in the blockchain from proponents of commons-based peer-to-peer economies. Exactly because of its transparent, precise registration of resource usage and contributions, the blockchain is thought to be well-positioned to support commons-based economies, or other instances of the sharing economy (Rozas et al. 2018).

Taken together, from a city as a licence perspective, blockchain is expected to have a positive outcome for the management of public values and public and collective interests. It provides a tool for local communities to organize their own resource, rights and identity management. Who is entitled to what right to a particular resource can be organized in a bottom-up fashion and the process itself is expected to make these processes more transparent and accountable. Whereas distributed ledgers indeed have the affordances for these kinds of applications, it's also important that we take a deeper look at the underlying technologies, and enquire to what extent distributed ledgers may or may not contribute to a fairly, democratically governed city.

4 The City as a Licence: six traits of distributed ledgers that need to be taken into account

When exploring the technological affordances of new technologies, it's imperative that we go beyond the functionalities and procedures they enable. Mediating sociality and formulating the institutional in radically different ways than before, can be understood as constructing "a new social model" (Bauwens et al. 8). When applied in such a way, new technologies are embedded in, and have an influence on, cultures of use, (in)equalities, democratic participation, power dynamics, and social cohesion. We will now shift our analysis from the procedural analysis that is often used to underwrite the 'blockchain for good' claims, to a further analysis that seeks to explore the aspects of social life that may be affected by the introduction of distributed ledgers. Guided by our 'city as a licence' interest in the rights management and agency that blockchains are claimed to provide to their users, we will trace six important issues: quantification; blockchain as a normative apparatus; the complicated relationship between transparency and accountability; the centralizing forces that act on blockchains; the degrees to which algorithmic rules can embed democratic law-making and enforcing; and finally, the limits of blockchain's trustlessness.

4.1 Quantification

A first important issue is the affordance of distributed ledgers to turn any kind of asset, resource use or social relation into a quantifiable unit. From 'a city as a licence'-perspective, this is exactly what allows DAOs to give or refuse users conditional access to a particular asset or relationship, based for instance on their reputation, profile, status, account balances, prior usage, subscriptions, etcetera that are stored in quantified units on the distributed ledger. To stick with our parking example: a parking place could rent itself out when it can a) measure the usage of the parking place (in minutes or square meters occupied); b) recognize the identity of a vehicle or person seeking access; c) connect this identity with a database that contains particular rights and privileges (e.g. priority or reduced rates for doctors or people who have been carpooling, or perhaps a ban for a car with a particular licence plate due to prior traffic violations), d) tie this is in with external information (e.g. traffic conditions, event happening nearby that may spur an increase in demand) to adjust pricing to expected demand, and e) connect this with a transaction system that allows for payment in any kind of token.

While such a combination of datafication and algorithmic regulation may work for parking, it becomes more problematic when public values and informal social relationships are at stake, as these are not easily converted into measurable units. And if they are, the risk is that these objectified quantifications obscure their underlying values and dynamics with citizens internalizing the logic of the quantified system, rather than subscribing to these underlying values.

To explain this with an example, it's important to understand that reduced to its very basics, blockchain is an administration technology. It is a way to keep track of assets on a ledger. These assets can be anything from currencies to property, traces of provenance, or access rights. In order to create a single unit of account, these assets are represented by tokens on the blockchain, similar to the way money functions as an intermediate between different forms of value. By translating assets into tokens, they are quantified (if they are not already expressed in quantities to begin with). A community aiming to reduce their collective energy use through sharing resources (assets) like an electric car, energy generated from collectively owned solar panels, and a community kitchen could use a blockchain system to keep track of the various uses and contributions of community members. Representing their assets by abstracted quantities of tokens on the blockchain, this community would have to agree on an exchange rate between one cooking session, an hour-long car trip, and one kilowatt hour of energy. The community might also want to reward certain tasks with tokens, like cleaning and upkeep of the system, which will also have to fit into this exchange rate. Based on how much a community member contributes, the blockchain could then automatically distribute their rightful share (a temporary licence to make use of a particular resource) of the community's solar energy or unlock access to the shared electric car.

To understand what such a total datafication could entail, it is instructive to look at existing examples of quantification outside of blockchain applications. Quantification and the counting of social interactions have a longer history and has been analyzed for its effects in different contexts of application (e.g. Andreas 2008; Barsh 1993; K. E. Davis, Kingsbury, and Merry 2012; K. Davis et al. 2012; Espeland and Stevens 2008; Hacking 1999; Bowker and Star 2000; Scott 1998). Sally Engle Merry conceptualizes the phenomenon of creating indicators for social realities through quantification as a technology of knowledge. She writes "[w]hile we assume that [indicators] describe the world, they actually construct that world" (Engle Merry 2016, 33). Developers of systems of quantified representation might be aware of the compromises and choices they made in order to represent a messy social life through categories and numbers, but these decisions are not visible to others. What is represented, gets "stripped of their context, history, and meaning" (Engle Merry 1) in this process. Quantified knowledge, intended or not, carries with it an appearance of objectivity, efficiency, and consistency and is readily operationalized for decision-making and governance as a result (Engle Merry 2016, 209; K. E. Davis, Kingsbury, and Merry 2012, 84), especially in the case of automated, algorithmic processes.

In his book The Tyranny of Metrics Jerry Z. Muller (2018) analyses what such quantification has meant for sectors as diverse as the military, finance, medicine, and education. It is these latter two that provide useful insight with regards to the use of metrics in domains that are understood to exist at least in part outside of the market. Muller describes how during the austerity-ridden 1980s, in an international rush of Foucauldian neoliberal governmentality, politicians and policymakers increasingly steered these non-profit domains towards business-like strategies in order to save money. Performance indicators were developed for universities and hospitals. These quantified performances were then tied to monetary rewards and punishments, and made visible to the broader public so that competition between institutions would occur. Having more information was thought to allow citizens to make informed consumer decisions, ultimately driving prices down and quality up. While in business performance is somewhat straightforwardly assessed in terms of financial gain, organizations that have a central societal purpose often have more diverse and diffuse goals that are more difficult to measure in metrics (Muller 2018, 43–44, 51–53). Holding organizations aiming for a social good accountable according to only that which is quantitatively measurable therefore misses their raison d'être at least to some degree and potentially frames their users as consumers of marketed products instead of as citizens with rights.

Although far removed from the aim for social good, Muller's account of the "short-termism" at work in financial markets in the years before the crisis of 2008 is useful for our purpose also. Quarterly earnings are a main influence on a company's performance on the stock market, and thus are made of central importance in management strategies, linking bonuses or commissions to favorable quarterly reports. This subsequently leads team managers and individual employees to focus their work on achieving goals that can be reached within three months, often at the expense of long term investments like employee education or maintenance (Muller 147–50). By measuring effects immediately and making them visible (transparent), quantification can lead to decisions that favor the short term over the long term, an effect that is amplified by the necessary simplification of social reality as it gets made legible in abstracted indicators (Scott 1998, 19–21). Presenting continuous quantified insights invites continuous action upon that which is visible in the measurement, and only that.

Thus by creating countable representations of contributions and participation in a community, social relations are made explicit, formalized, and are standardized where before they were implicit, personal, and flexible. Hierarchies representing who contributes to or uses most can be made in which the distinction between the things that are countable and counted, and the things that are not becomes consequential. While buying groceries for your elderly neighbor might add to your reputation in a community normally, if it is not counted by the neighborhood system, it will not be visible in its hierarchies

The short-termism Muller describes does more than just disincentivize necessary but less instantly rewarding tasks like maintenance. In the same move, it also discourages innovation and creativity. Using metrics in effect predetermines which kinds of efforts are rewarded and which are not. If the city is indeed understood as a collection of licences that give conditional access to resources, based on prior engagements, reputations and other quantified indicators, the risk is that people will conform their participation to these already existing categories in order to be legible to and deemed valuable by the system. This makes other types of activities, however socially relevant they might be, less valuable and therefore less favorable. This will ultimately lead to a situation in which innovation and creativity are disincentivized, because they stray from the pre-defined categories of value (Muller 2018, 20, 171).

To conclude, blockchains favor things that can be quantified. This tendency stems from the ideological beginnings of the technology. Designed as a way to route around corruptible centralized authority and to facilitate globalized trust through cryptography, it has always relied on the countable and follows the logic of objectivity through quantification. As a result, the influence of human subjectivity and the social have always been minimized in blockchain technology (Terranova and Fumagalli 2015, 154). However, the centrality of the as objective perceived quantification, may actually backfire when such a system is introduced in social domains, or in systems that are to manage licences in relation to public values. As the work of Muller, Scott, and Engle Merry has shown, this emphasis on quantified information can lead to market logics, short-termism, simplification of complex social systems, and unaccountable forms of power. These are worrying trends in relation to the aim for blockchain systems to support social good.

4.2. The blockchain as a normative apparatus

Quantification as described above is not just an act of translation of one type of value into another. Seen through the 'city as a licence'-lens it also becomes an important apparatus to apply particular normative frameworks towards a social and/or economic system. As we've shown above, numbers themselves acquire the agency to shape what they measure when they are deemed important. By linking performance indicators to monetary rewards or other tokens registered on the blockchain, the numbers that influence these outcomes are made to matter. For instance in an imagined blockchain future, access to a city park (a licence to use the park) can be based on an individual's participation in plastic recycling schemes. Thus, numbers that matter have the power to socialize their subjects, to lightly nudge people to conform to norms for example by rewarding good behavior. Theodore M. Porter described numbers as "among the gentlest and yet most pervasive forms of power in modern democracies" (Porter 1995, 45).

The relation between quantification and power is investigated further by Jacqueline Wernimont, who analyzes historical examples of systems that quantify human behavior to reveal their congruence with established power relations (Wernimont 2018, 3). Blockchains can be seen as new instances of what Wernimont calls quantum media, which

> "refract human behavior and bodily action as a stream of numbers. It is a highly lossy remediation that abstracts action in the world into quanta, and is situated in a late moment in liberal thought dominated by notions of personal power and agency." (Wernimont 2018, 162)

This belief in personal agency through numbers persists today, as the popularity of self-quantification through productivity tracker apps or devices like the Fitbit shows. These technologies overrule inherent knowledge of the self one might think to have by claiming that the truth is to be found in the abstracted data. "[S]elf-tracking can quickly be leveraged by others to know those who aren't trusted to know themselves" (Wernimont 2018, 157). It produces a way of knowing the subject that is mediated by categories and indicators that are determined by the interests of those that govern the systems used. Moreover, in blackboxed and often proprietary systems, not everyone has the same access and agency to act on the way they are made visible in them. These differences unsurprisingly follow pre-exiting societal divides, like income, race, and gender (Wernimont 2018, 159, 162; K. E. Davis, Kingsbury, and Merry 2012, 81; Crawford, Lingel, and Karppi 2015).

Following Ananny and Crawford (2018) and Gillespie (2014) in their understandings of technologies as inextricably entangled with human actors and practices, this could produce the existence of multiple data cultures: categories have different meanings for different people, and data practices vary between locations and communities. Looking at data use in cities, Jo Bates analyses data cultures in relation to power. She emphasizes the need to think about how data systems are structured according to existing power relations, how they are potentially differently understood and acted upon by participants, and tensions between these respectively top-down and bottom-up perspectives (Bates 2018, 192). Different people relate differently to the fact that their social lives are represented in urban data systems. They might feel surveilled and try to resist, manipulate, or subvert forms of data capture. Those hoping to gain from the system might try to game it for their own benefit. Alternatively, people might not understand these systems, or feel apathetic towards them, both possibly leading to solely passive participation. Finally, different people have different abilities to participate, whether that be in terms of economic status or cognitive or physical characteristics. Bates describes how these struggles and acts of resistance have an impact on how a social reality is visible in a system of representation (Bates 2018, 197). Whether someone is consciously disrupting it or not, a system just makes visible what it is told it can see, not what is actually there.

This inability of systems of representation to capture their underlying reality exactly can make them vulnerable to corruption and gaming, especially in settings where an idealistic mission is central (Muller 2018, 19, 77–78, 121). This is expressed well in what is known as Campbell's Law:

> The more any quantitative social indicator is used for social decision-making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor. (Campbell 85)

Those who have more agency to distort the system, or to pay to get exemptions from the rules, will be able to get more favorable results. In a city of blockchain-based traffic dispersal for the even distribution of polluting vehicles, we can imagine that a group of well-organized, wealthier neighbors could put political or economic pressure on the administration to make sure that their neighborhood is exempted from the route planning algorithms and therefore does not show up on the map that truckers use to navigate the city. Early examples of these kind of politics are the complaints that citizen in San Francisco have been filing against Waze for directing rush hour traffic through their residential neighborhoods.

The inclusion of normative frameworks in algorithmic regulation also opens up possibilities for a highly flexible and customizable application of rules. With smart contract, the rules encoded in the system can be made conditional of various types of datafied input, from traffic conditions and the weather forecast to user status and reputation systems. Rather than have one particular rule set for the city at large, access to streets, can be regulated through particular flexible right management schemes that for instance gives or declines the right for particular categories of traffic users to use or not use a particular street at a particular time.

For regulators, this opens up the possibility for micro-regulation. Blockchain solutions, aided by smart contracts and cryptocurrencies, likely aim for beneficial social outcomes in highly specific problem areas. To deal with overwhelming numbers of tourists, a city like Amsterdam might put in place tokens that are worth more in less crowded areas of the city, drawing tourists out of the congested city center (Elsden et al 2019b), and perhaps release those conditions in off-season or off-hour periods. Locals on social welfare might at the same time receive their benefits in a specific token that limits their use to particular white-listed outlets or items, an update of current systems of welfare administration that surveil the poor disproportionately (Maréchal 2018). In this way, a city can become host to a rich layering of different systems of value and accessibility, designed and maintained by a decentralized network of institutions, organizations, and communities. Localized value systems have the potential to better reflect local values and specificities.

Such a city as a licence-perspective may be a dream scenario for particular regulators. DAO's with rights management allow them to micro-regulate conditions, even in real time, creating a multiplicity of systems that together make up the city. The right to use certain streets may be revoked for particular types of transport during particular times, access to services can be restricted based on reputations and status, and taxes can be adjusted in real time to stipulate desired behaviors towards outcomes for the public good. However, the same time, such a constellation of systems as a whole has the potential to become too complex and opaque to adequately and democratically govern. Whereas the basic promise of distributed ledgers is one of transparency, such systems may actually result in the reverse and open up possibilities for new ways of wielding influence by third parties and even corruption. How would citizens or consumers know to what regimes they are subjected and why? And what does it mean for citizen's trust in institutions if the underlying rules can change from moment to moment?

4.3. Transparency & accountability in distributed algorithmic networks

Its distributed ledger gives blockchain systems the potential to provide new levels of transparency. These ledgers can make previously hidden exchanges or processes visible, and therefore offer new means to hold others accountable (Rozas et al.2018). Especially for the advance of sustainable food production and fair fashion, logistics is a sector that receives particular attention of blockchain for good initiatives. Here, blockchains are explored for their potential to make supply chains more transparent and honest (Blockchain for Good: The Vision and Mission of the Dutch Blockchain Coalition 2018) by stamping particular certificates or licences (e.g. fair trade) or other marks (proof of origin of a resource) on the blockchain. However, when a blockchain handles personal information, for example in an urban blockchain-based system that handles basic daily needs like transportation, transparency becomes more problematic. Rozas et al. (2018) are concerned with commons communities that share resources using blockchains, and point toward the privacy-related issues, like the clash of a principle like the right to be forgotten with the immutability of blockchain ledgers. On the one hand, local systems that make contributions to the commons transparent could provide an overall trust in the system and undermine the opportunities for free riders. Yet, that would mean that individual members of the commons would have to give up a bit of their privacy by enabling their contributions to be made public. This could become more problematic in cases of algorithmic governance. For instance, if a car sharing system belonging to a local community has rules about priorities (e.g. medical emergencies), this means that members that want to exercise these privileges have to make their cause public to the system. As Cila et al. (forthcoming) have demonstrated, such systems will inadvertently bring up a number of design dilemma's that designers have to consider, as to when transparency is desired, and to what extent infringes on privacy are justifiable.

On the opposite end of the spectrum, dealing with global blockchain infrastructures brings out another problem. The technology does not have a headquarter location, its code is stored across a global network of users, and in cases where applications are co-produced by a network of open source code contributors there is no delineable origin. Because of these characteristics, even if there would be a way to hold a distributed network accountable, the question remains: to which laws? In this sense, DAOs can run their code without adhering to all or even any of the jurisdictions they have an effect in (De Filippi and Hassan 2016, 3). This issue is reminiscent of the way platforms like Facebook or Airbnb operate above or beside local laws either by instituting their own additional rules (e.g. Facebook's nudity guidelines based on American sensitivities that at least in some European localities miss the mark) or denying their local responsibilities and consequences (e.g. Airbnb's refusal to cooperate with Amsterdam's authorities to enforce the city's limitations on the use of the platform). From the City as a licence-perspective, that could be very problematic, as it means that local government may lose control over the actors that set the conditions for these licences in the first place. While certain processes may become more transparent (often at the cost of privacy), it doesn't automatically lead to a better accountability.

4.4 Centralizing forces

One of the important claims in the discourse around blockchain for social good is that distributed ledgers can be organized in a decentralized manner and ran without central authorities. From the city as a licence-perspective, that would give local communities theoretically the possibility to set up their own systems and encode their own rules. Whereas this could certainly be attractive in certain cases, it is far from granted that such a decentralized structure will remain in place.

In that regard blockchain's development may show more historical similarities with that of the internet at large. Just like in the early nineties the internet was for a large part occupied by homepages made by individuals, but is now dominated by multinationals like Google and Facebook. Likewise, the bitcoin blockchain is not as distributed now as it once was (Bauwens, Kostakis, and Pazaitis 2019, 38). For example, due to their own popularity, interfaces had to be designed to make cryptocurrencies accessible to users that are not tech-literate. The necessity of wallets and other interfaces centralizes blockchain usage into particular applications. This is illustrated by the fact that currently only two wallets dominate the cryptocurrency space.[2] On a more societal level, the prevailing economic logics of neoliberal capitalism don't spare blockchain-based systems from their monopolizing tendencies (Herian 2018, 50). Mining power in the bitcoin network is dominated by just a few actors for example,[3] making it increasingly vulnerable to 51% attacks which effectively overcomes the blockchain's immutability.

It is as yet unclear how a distributed network would concretely be implemented in a societal context. How much of a city blockchain would for example be distributed among the computers of user-citizens? And not insignificant: how much agency, control, and opacity is a government or

2 https://blog.blockonomics.co/why-bitcoin-is-becoming-centralized-41f62cc15e91.

3 https://blog.blockonomics.co/why-bitcoin-is-becoming-centralized-41f62cc15e91.

organization actually willing to give up to such a system, even if they have the public good in mind? An extreme example can be found in Facebook's proposed blockchain-based currency Libra, officially announced in 2019. In its white paper, Libra is conceptualized expressly in term of its proposed social contribution, as a way to "empower billions of people", and having "the goal of building more inclusive financial options for the world" (“An Introduction to Libra” n.d.). At the same time, the technology is neither decentralized (the companies that back the currency also control the blockchain), nor permissionless (only certain actors contribute to the consensus algorithm, instead of the whole network). This means it is a stretch to call Libra blockchain-based in reality (O’Dwyer 2019). In a culture of socially responsible entrepreneurialism, blockchain terminology is vulnerable to co-option for corporate interests under the guise of dedication to 'the social good'.

4.5 Code is Law

With 'the city as a licence', the licensing process and its accompanying rule sets are encoded on the blockchain. This means that licences to access or use urban services are automatically given out or revoked without human intervention. The blockchain represents at the same time the regulations as well as their enforcement. Such automated compliance may undermine the democratic right to contest rules (Yeung 2018). The Dutch Raad van State has also warned against the limited opportunities for interpretation of rules in such algorithmic regulation (Raad van State 2018).

These aspects of smart contracts and DAOs have led several researchers to re-investigate Lawrence Lessig's 'code is law' formulation. Lessig's work on the laws at work in cyberspace uncovered the ways in which the code of the internet regulates user's behavior. Lessig showed that computer code functions similar to natural laws. Instead of threatening punishment like the law does, nature, and code, function by making certain acts simply impossible: "[w]e live life subject to the code, as we live life subject to nature" (Lessig 1997, 184). An important difference with nature is of course that code is written by fallible humans with individual biases. Code is also changeable and subject to politics. Because behavior outside of the limitations of code is impossible, this can make political world views into naturalized ranges of possibility (Lessig 1997, 183–84).

Digital rights management technology like iTunes song copy protection software use the laws of code to enforce judicial copyright laws (at least for the not-so-technically-literate). As written laws are captured in algorithmic computer language, a degree of their ambiguity and flexibility is lost (De Filippi and Hassan 2016, 10). It is quite impossible for example, to compose an algorithm that can determine a highly ambiguous and context-reliant exception to copyright law such as fair use. To cede the interpretation of ambiguous laws to formalized code often means to reduce the freedoms that the ambiguity of traditional law provides (De Filippi and Hassan 2016, 7).

When laws, rules, or agreements are captured in smart contracts, they become unbreachable, automatically executed, and possibly tied to physical objects (Wright and De Filippi 2015, 26). Once a DAO has been set in motion, they are in theory unstoppable (Wright and De Filippi 2015, 17). Unless a kill-switch was explicitly designed, or a complete network is shut down, a DAO finishes its code and implements its consequences. In effect, the laws and rules coded into a smart contract (e.g. a speed limit on a road), are interpreted and made to have an effect algorithmically (e.g. sensors detect a car going over the speed limit and charge the owner of the car a fine), irrespective of context (e.g. medical emergency) or other mitigating circumstances (De Filippi and Hassan 2016, 14).

Code is written in advance of real situations happening ('ex-ante'), and so can only regulate for what can be expected. Once the code runs, edge-cases will be unforgivingly dealt with by an algorithm that keeps ploughing on. The way the law is traditionally operationalized grants humans negotiating, intervening and ultimate deciding powers, while smart contracts and DAOs generally do not. While algorithmic decision-making is fast, we must not lose the human democratic debate that is central to interpreting and implementing the law (De Filippi and Hassan 2016, 6, 15, 18). This could potentially be done by designing smart contracts that can be interrupted for human voting on set times, or in specific cases (Wright and De Filippi 50), which is called off-chain governance (Reijers et al. 2018, 3). How this should be done, especially in relation to edge-cases that are not recognized as such, is something to be tested.

4.6 Trustless trust reconsidered

A final theme we would like to address in relation to the application of distributed ledgers in urban systems, is the notion of trustless trust. In the technology community, the word trustlessness is used to indicate that there is no central authority that needs to be trusted, for example in terms of its benevolence and capability. Blockchain is often discussed as a technology that due to its architecture and validation procedures enables cryptographic proof: the rights, identities, transactions, and licences managed can be trusted as valid without the need for a trusted intermediary.

This faith in the technology can be traced back to its origins. Blockchain technology was first described in Satoshi Nakamoto's white paper on bitcoin (Nakamoto, n.d.) amid the financial crisis of the late 00s. Kick-started by rampant subprime mortgages, the crisis featured collapsing banks and a recession that had not been experienced in a lifetime, leading to a widespread wish for alternative financial systems. Nakamoto's technology eliminated the need for central authorities in economic transfers, and found fertile ground at a time when mistrust of banks was at a high point in recent history (Sapienza and Zingales 2012, 130). Nakamoto's bitcoin would, supported by its blockchain, replace banks and governments with a distributed and 'trustless' network, giving individuals autonomy over their money.

Blockchains theoretically achieve their trustlessness by randomly assigning the power to validate transactions across a network of non-hierarchical participants. In abstract, this does indeed overcome the need to trust a central authority but in the real application of these theoretical systems, there are caveats. As a case in point, cryptographer and legal scholar Nick Szabo prefers the term 'trust-minimized', stating that trustless is "exaggerated shorthand" (Szabo 2014). Jaya Klara Brekke provides an in-depth analysis of how the political is mediated through the blockchain, showing that blockchain systems are not neutral carriers of mathematical proof.

Licences after all can only be given out by trusted and legitimate institutions. Outsourcing this process to the blockchain presupposes trust in the legality, validity, fairness, impartiality, and robustness of the code of that blockchain (Al Khalil et al. 2017, 515; Hawlitschek, Notheisen, and Teubner 2018, 57). This becomes especially pertinent when dealing with a user-base that does not have the technological skills to investigate the inner workings of the system they are using (Hawlitschek, Notheisen, and Teubner 2018, 60). When code is not readable by the average human being, participation comes down to trusting other people (e.g. programmers) to do their job according to standards and values you agree with (Ølnes, Ubacht, and Janssen 2017, 363). Blockchain-based systems that are implemented in administrative systems that citizens rely on for basic needs require maximal care in terms of the legibility of their systems by diversely educated and technically-capable citizens. In the case of cryptocurrencies, we see a proliferation of wallets, or digital interfaces to manage blockchain-based coins. All of these wallets have their own terms of service, privacy statements, and business model, as well as vulnerabilities to hacks. Interfaces like these will need to be designed for any blockchain system to allow citizen-users to interact with the technology, and these need to be trusted by their users for them to be taken up (Hawlitschek, Notheisen, and Teubner 2018, 51).

Taken together with our earlier concerns around the centralizing tendencies in blockchain systems, the patchwork of user agreements and third-party interests that potentially make up an urban blockchain assemblage endangers their trustlessness. Referring to blockchains as trustless runs the risk of concealing these very real threats to their trustworthiness.

Conclusion and discussion

In this chapter we aimed to contribute to debates about the application of blockchain in the domains of civics and urban governance. We have shown that distributed ledgers - of which blockchain is an example - can be understood as a new general-purpose technology, that could play an important role as an administrative layer and actuating agent in various assemblages of technologies and use practices. These systems allow for new models to monitor, manage and actuate all kinds of urban processes. Examples vary from smart city services such as the management of parking spaces to the organization of local, commons-based peer-to-peer economies.

We introduced 'the city as a licence' as a lens to explore these platforms or smart city services from a perspective of governance. As such we proposed to think of automated blockchain-based platforms as actors that give out licences to temporary make use of resources, based on conditions encoded in smart-contracts through algorithmic governance.

In terms of civics and urban governance, there is a hope that such systems could contribute to fairer, democratic systems and empower citizens in various ways. This direction is currently explored in various 'blockchain for good' process. Whereas we value this approach, we also argued that to fully scrutinize the implications of distributed ledgers for urban governance, a more critical analysis of distributed ledger technologies is necessary.

We set out on that course through a technological exploration of distributed ledger technologies. In combination with a speculative approach, we thus explored a broad array of possible implications of distributed ledger technologies for urban governance. The themes brought up here as an outcome of that process are not conclusive nor exhaustive, but they do point to a number of important points that should be of concern to policy makers, designers of blockchain-based systems as well of citizens.

The use of blockchains in situations where social relations are at stake is risky, as informal social relations need to be quantified and therefor become part of formal economic systems. The transparency that could make these systems and the contributions of their users accountable, could at the same time undermine the privacy of its users. In addition, these formal systems can be seen as normative apparatuses that are highly likely to nudge citizen behavior. This may give regulators and system operators the opportunity to implement highly flexible micro-regulations, leading to a multiplicity of systems and value sets operative in the city. In turn this could make the governance of these systems highly opaque and open them up for intransparent influences by outside actors or even corruption. The automatic encoding and enforcement of rules can also become problematic, as such automated systems leave no room for interpretation of the rules, and may be not be prepared to accurately deal with unforeseen situations at the time of encoding the rules. Whereas blockchain-based ledgers are envisaged as empowering to citizens because of their decentralized character, and their architecture that can invoke 'trustless trust', there is also a risk that these networks will become dominated by a few central actors again, not unlike the internet itself. How these actors and their code could be held accountable by local legislators is not directly clear. Likewise, the trust that citizens may have in these systems could be undermined by their multiplicities and opaque form of algorithmic governance.

All this is not to say that nothing good can be expected from distributed ledger technologies. On the contrary, we think that an approach to the blockchain that focuses on public values and social good is highly desirable, as long as it situates these technologies as part of specific social, political, and economic realities. Much more research is needed to further explore the affordances of distributed ledgers in relation to urban governance, both from a perspective of technological explorations as well as from a design-perspective in which experiments with distributed ledgers can shine more light on the desirability of certain features. Yet, researchers and designers should not be naive, and we hope that the lens of the city as a licence introduced here provides points of departure for further critical investigation of distributed ledger technologies for the public good from a governance perspective.

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