



Are emerging technologies helping win the fight against corruption? A review of the state of evidence [☆]

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ABSTRACT

Information and Communication Technology (ICT) is often thought of as a uniformly positive tool making governments more transparent, accountable, and less corrupt. However, the evidence on it is mixed and often misunderstood. Hence, this article carries out a systematic stocktaking of ICT tools' impact on corruption, offering a nuanced and context-dependent assessment. The tools reviewed are digital public services, crowdsourcing platforms, whistleblowing tools, transparency portals, distributed ledger technology, and artificial intelligence. We scrutinise the evidence both on ICTs' anticorruption effectiveness and misuse for corruption. Drawing on the commonalities across technologies, we find that ICT can support anti-corruption by impacting public scrutiny in numerous ways: enabling reporting on corruption, promoting transparency and accountability, facilitating citizen participation and government-citizen interactions. However, ICT can also provide new corruption opportunities through the dark web, cryptocurrencies, or the misuse of technologies such as centralised databases. The introduction of ICT tools does not automatically translate into anti-corruption outcomes; rather, impact hinges on the matching between ICT tools and the local context, including support for and skills in using technology.

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1. Introduction

The rapid spread of Information and Communication Technology (ICT) and digitalisation as one of the forces shaping the 21st century gives an impression of great promise for revolutionising societal relations and public service delivery (Lindgren et al., 2019). In the field of anti-corruption, ICT has been widely perceived to offer new effective means for the prevention, detection and prosecution of corruption. As numerous studies assert, ICT can promote transparency, accountability and citizen participation. It can also facilitate advocacy and closer interaction of government and citizens. The most widely praised tools include websites and mobile phone applications as well as newly emerging Distributed Ledger Technology (DLT), big data analysis and artificial intelligence (AI). These tools serve the fight against corruption by enhancing ac-

cess to public information, monitoring officials' activities, digitalising public services and enabling corruption reporting (for example, see Bertot et al., 2010; Davies and Fumega, 2014; Kuriyan et al., 2011; Subhrajyoti, 2012). However, the existence and availability of these tools does not automatically translate into their use, which crucially depends on the content provided and user characteristics (Torero et al., 2006). ICTs for anti-corruption operate against the background of given societal divides and power relations which are often supported by corruption. They risk further entrenching these unless their design and implementation take into account corruption and associated power imbalances. Hence, it is arguable that the success of ICT interventions against corruption hinges on their suitability for local contexts and needs, cultural backgrounds and technological experience (Helbig et al., 2009). However, the effective combinations of contextual characteristics, ICT features and corrupt behaviours remain under-explored. For example, how can a digital public service best contribute to fighting petty corruption in a society with highly variable connectivity?

Although ICT is commonly studied as an anti-corruption instrument, it can also lead to the opposite effect when such tools are used for instead of against corruption. Emerging technologies can provide new corruption opportunities through the dark web,

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cryptocurrencies, or the misuse of well-intended technologies such as digital public services and central databases (World Bank, 2014). While relevant research is scattered in this area, some studies point to the potentially adverse use of ICT for corruption: for instance, €2 million (ca. £1.8 million) disappear every year from Croatian tollbooths due to officials entering false data into the new digital information system (ReSPA, 2013). Similarly, investment into ICTs can itself be corrupted representing a major negative impact (Charoensukmongkol and Moqbel, 2014). Such examples underline the fact that ICT is not *per se* a panacea against corruption, and it can also play into the hands of corrupt officials. However, it is yet unclear based on the available literature under which conditions do ICTs facilitate rather than inhibit corruption. How can ICTs avoid being captured by corrupt elites reinforcing the very societal divides they were meant to diminish?

Given ambiguous and context dependent theoretical predictions and conflicting empirical evidence, it is imperative that scholars and policy makers gain a systematic and balanced assessment of the current state of evidence and evidence gaps. Our systematic review hopes to guide future research and contribute to better policies by exploring the following questions:

- What are the main applications of ICT tools against corruption?
- What are the impacts and of ICT tools, both positive and negative?
- What are the facilitating and limiting factors of ICT-based anti-corruption tools?

To answer these questions, we systematically take stock of the academic and policy literature on the six most commonly discussed types of ICT-based anti-corruption interventions: (i) Digital public services and e-government, (ii) Crowdsourcing platforms, (iii) Whistleblowing tools, (iv) Transparency portals and big data, (v) DLT and blockchain, and (vi) AI. While these types are not mutually exclusive categories, they distinguish between different ICT-enabled tools according to their corruption impact mechanisms. While a synthesis is drawn whenever possible, most of our findings point at a nuanced landscape; that is the need for carefully matching ICT features to contextual enablers to fight a specific corrupt phenomenon. We find no panacea to corruption, very much in line with the broader anti-corruption scholarship (Marquette and Peiffer, 2018; Mungiu-Pippid, 2011).

Our contributions are both conceptual and empirical, pointing at key findings as well as further areas of research. First, we develop a systematic conceptual framework carefully grouping ICT types and outlining the main theoretical mechanism impacting on corruption. This framework can serve as a guidance to link new studies to the existing body of literature. Second, applying our conceptual framework and thoroughly reviewing the available evidence base, we point at major evidence gaps and wherever possible we make recommendations as to how the gaps could be addressed. Crucially, we find that in most areas, studies look at different tools, and corruption outcomes, using different methodologies. Hence, it is rarely possible to directly compare results. Moreover, a number of highly policy-relevant tools are acutely under-researched such as the role DLT or AI can play in the fight against corruption. Third, there is a tacit optimism about the role of technology in the fight against corruption, that is most research considers ICTs as an only or mainly positive force while largely neglecting corrupt capture of new tools or the strategic responses corrupt actors give to ICT-enabled reforms. In addition, many ICT reforms under-appreciate contextual constraints and limitations both in terms of administrative capacity and power relations. A few high-quality studies systematically explore such interactions and heterogeneous impacts. Finally, we find that ICTs have been most effective against low-level or petty corruption, while their effects on grand corruption are often negligible due to elite cap-

ture and the lack of interest by the powerful to address systemic corruption. These findings underline the importance for successful ICT-enabled anti-corruption reforms to clarify the impact mechanisms which underpin the expected anti-corruption impact and a specific definition of the targeted corrupt behaviour (Pyman and Heywood, 2021).

The below first outlines our review methodology and conceptual framework. Then, the main section of the article reviews each of the 6 ICT tool groups. Conclusions are offered in the last section.

2. Methodology

To answer the above guiding questions, we systematically and comprehensively searched, filtered and assessed the available literature on applications of ICT tools against corruption. Like other systematic reviews in the field of e-governance (e.g. Mackey and Cuomo, 2020; Mergel et al., 2018), this review involved five methodological steps (Moher et al., 2009). First, we screened and collected all potentially relevant studies using common search engines such as GoogleScholar and Web of Science. We applied search term combinations: names of each of the 6 ICT tools (including their variants) and corruption-related keywords such as “corruption”, “integrity”, “accountability”. Second, we identified *relevant* studies for in depth-analysis applying complex criteria: i) whether the study assesses the corruption impact of one of the ICT tools we review; ii) whether the study is empirical (qualitative or quantitative), but also applying a solid theoretical framework; iii) geographical context of the study to maintain a global focus, giving particular attention to studies on less-studied developing regions. Third, we extracted key characteristics of the study such as bibliographic data, country/region focus, ICT type, corruption type, research question, methodology, unit of observation, data used, key findings, and policy implications. Fourth, we assessed the *quality* of evidence presented by each relevant study by looking at aims, quality of methodology, validity of measurements used, causal analysis and consideration of counterfactuals, and robustness of findings. We only filtered out apparently low-quality papers at this stage. Finally, we carried out an in-depth appraisal and synthesis of the complete set of studies deemed both relevant and good enough quality.

3. Conceptual framework

To provide a framework for reviewing the use of emerging technologies in the fight against corruption, we outline the definitions for grand and petty corruption as well as the different types of ICT tools reviewed while also discussing the theoretical impacts mechanisms linking the two.

3.1. Understanding corruption

Corruption is documented to bring about a range of detrimental outcomes for society. It tends to reduce public trust in government as it diverts funds from goods and services supposed to benefit citizens and weaken the functioning of public institutions and the rule of law (Chêne, 2014). It is also likely to discourage investment (Mauro, 1995), create economic inefficiencies and contribute to income inequality (Gupta et al., 1998).

Nevertheless, the concept of corruption is used to encompass diverse phenomena in many contexts which differ in the prevailing norms of good conduct. Hence, many characterisations of corruption are normatively charged and context-dependent (Johnston, 1996). In addition, corruption can take many shapes, including bribery, fraud, extortion, embezzlement and nepotism (Elbahnasawy, 2014). For discussing the relevant definitions of corruption for our analytical goals, we rely on the rich literature on

the topic. In order to better understand ICT impacts on corruption and to help organise the diverse literature on corruption, we distinguish between grand at petty corruption and associated anticorruption theories.

First, one of the most commonly used definitions of corruption is: “the misuse of public office for private gain” (Rose-Ackerman, 1978). This definition understands corruption within a bureaucratic context and associates corruption with bribery of public officials, in other words petty corruption. Such petty corruption often refers to street-level bureaucrats being corrupted during public service delivery (Bardhan, 2006; Charoensukmongkol and Moqbel, 2014). In this framework, corruption can be conceptualized as a principal-agent problem, with citizens usually being principals and government officials being agents that act on citizens’ behalf. The officials possess asymmetric information and discretion on the distribution of resources, which potentially allows room for corruption. Consequently, strategies to fight corruption in the framework of the principal-agent model commonly focus on decreasing discretionary power of government officials and establishing better oversight and accountability mechanisms (Klitgaard, 1988). Most of the ICT-enabled tools we examine fall into this category as they aim to lower the incidence of petty corruption by improving oversight and accountability.

Second, corruption can be defined as a collective action problem when there is no principled principal, rather different groups of actors in government, the private sector or civil society fail to organise in pursuance of their collective interests. As a result of failings of collective action unable to overcome individuals’ self-interest, society as a whole remains corrupt (Marquette and Peiffer, 2018). Many societies are characterised by particularism, meaning that people’s treatment by the state depends on their position in society. Therefore, corruption in particularistic societies essentially reproduces the existing structures of inequality and uneven distribution of power (Mungiu-Pippidi, 2006). Strategies to fight this type of corruption require a more comprehensive approach that focuses on fostering anti-corruption norms and building coalitions against corruption – for example, by educating people or creating tools fostering collective action and coordination.

The corruption as collective action problem often gets associated with grand corruption. Grand corruption occurs when a public official or other person deprives a particular social group or substantial part of the population of a state of a fundamental right or causes the state or any of its people a loss greater than 100 times the annual minimum subsistence income of its people as a result of bribery, embezzlement or other corruption offence (UNODC, 2016). In other words, grand corruption is perpetrated by corrupt leaders who control state institutions in order to expropriate the state’s wealth with impunity. Corrupt leaders need not only be the leaders of a whole country, they may also be local politicians such as mayors or they may be leading key institutions in a particular sector (e.g. head of a public electricity utility). Grand corruption is inherently difficult to fight with the help of ICTs since corrupt elites design and control the system in which they operate (e.g. provide data on government actions). Few ICT tools can help in such a difficult situation: those which help organise collective action (e.g. identifying which officials are responsible for imposing corruption costs on society) or weaken the informational monopoly of corrupt public actors (e.g. blockchain-based public registries operated independently of government officials).

3.2. ICT tool types

ICT generally facilitates the processing, transmission and display of information through digital devices. This includes radio, television, mobile phones and computers, as well as network technology – the most important one being the internet

(Charoensukmongkol and Moqbel, 2014). ICT tools can be grouped in a number of ways, but we opted for a categorisation driven by the literature discussing the ICT-corruption linkage. Thus, the below list is not comprehensive, while we managed to keep the tools largely distinct from each other. (1) Digital public services are a sub-form of electronic government (e-government), that involves the use of ICT tools such as web-enabled devices or electronic data management systems to provide public services to citizens (UN Department of Economic and Social Affairs, 2014). (2) Anti-corruption crowdsourcing platforms allow a large number of citizens to publicly report corruption incidences via the internet or telephone and are primarily intended for sharing cases of petty corruption in the public sector. (Charoensukmongkol and Moqbel, 2014). (3) Whistleblowing tools are designed for gathering detailed reports of individual cases of grand corruption with the aim of supporting criminal prosecution. (4) Transparency portals are online platforms run by governments or NGOs that publish information on government operations. Examples include freedom of information portals or open data portals (Gandomi and Haider, 2015). (5) Distributed ledger technologies such as blockchain represent a decentralised and synchronised database maintained by a peer-to-peer network where each user holds a copy of the data. All information is transmitted, verified and saved in permanent and secure records giving rise to cryptocurrencies, smart contracts, or file storage (Natarajan et al., 2017; Walport, 2015). (6) AI technologies, such as neural networks, are learning algorithms which infer patterns and relationships from large volumes of examples in order to best achieve pre-set goals. Their ability to cheaply and quickly predict and uncover hidden relationships make them valuable in policy making and policy implementation such as directing policing effort or corruption risk red flagging (Legg and Hutter, 2007).

3.3. ICT and corruption: impact channels

ICT may decrease or increase corruption depending on the type of intervention, impact channels, and context. ICT facilitates the information flow between government and citizens, across government institutions, and among societal actors. Potentially, these foster transparency, vertical and horizontal accountability and citizen participation (Chêne, 2012). ICT can aid the fight against corruption by reducing information asymmetries, facilitating collective action, automating and standardizing government processes, limiting public officials’ discretion, reducing red tape (Grönlund et al., 2010), and increasing the likelihood of punishment (Bhattacharjee and Shrivastava, 2018). Conversely, ICT can also have a corruption-enhancing effect as the use of digital technologies introduces new opportunities for concealing wrongdoing and conducting corrupt exchanges. ICTs may introduce new layers of complexity making it easier to hide corrupt acts, that is increasing information asymmetries; they may also create databases and administrative systems that can be hacked or manipulated easier; moreover, as ICTs can reduce information asymmetries for those seeking details about relevant officials to bribe, the amount of bribes, and the process of bribe paying.¹ These may make bribery markets operate more efficiently, with uncertain effects on the total amount of bribes paid. Additionally, ICTs can also enable a global web of corruption making law enforcement that is largely nationally bound ineffective.

Furthermore, as discussed in Section 5.1, the framework of the World Development Report (World Bank, 2016) underlines that the power of ICT to improve public services by enhancing integrity, transparency and accountability crucially varies by the type of service and activity and their amenability to improvement through ICT.

¹ For example, the ‘I Paid A Bribe’ platform provides such information, see: <http://www.ipaidabribe.com/>.

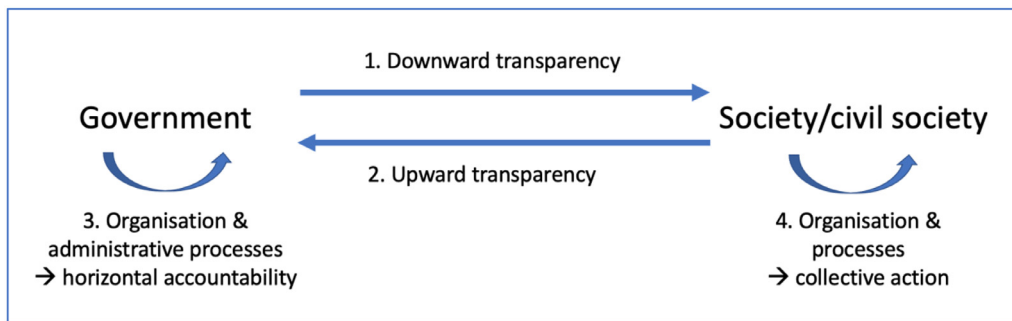


Fig. 1. Four impact mechanisms for the effect of ICT on corruption
Source: own illustration.

We develop a framework comprehensively capturing most major impact mechanisms of ICT on petty and grand corruption, based on the understanding that corrupt deals take place between public and private actors and that ICT can influence both the interactions among these 2 sets of actors as well as the interactions within them. In other words, ICT can have different types of impacts as it can impact on the flow of information, i.e. from or to government (Kossow and Dykes, 2018), the administrative processes used by governments, and the organisation of civil society. Hence, our analysis centres around four main impact channels (Fig. 1): First, we outline the impact of ICT on corruption via downward transparency as governments provide information to citizens (Kossow and Dykes, 2018). Second, we discuss upward transparency of citizens providing information to governments (while arguably some ICTs affect both directions of information flows). Third, we look at the impact channels based on ICT directly intervening in administrative processes, officials' discretion and power relations within government. Fourth, we discuss the impact of ICTs on the organisation and processes within society in terms of enabling collective action to counter corruption.

3.3.1. Impact via downward transparency

ICT can facilitate the detection and prevention of corruption, particularly petty corruption, through downward transparency, where government activities are made public to citizens which improves vertical accountability and reduces corruption (Bauhr and Grimes, 2017). Since not all information is equally useful to citizens, government transparency can be operationalised using situational characteristics, in particular paying attention to the purpose for which information is to be used, as well as the intended users, i.e. the principals (government offices, voters, and non-state actors acting outside of electoral institutions) (Bauhr and Grimes, 2017). Downward government transparency enabled by ICT can provide citizens, for example, with information on their rights, on public administration procedures, and on cases of corruption. In sum, as the power over information becomes decentralised, petty corruption becomes riskier to commit (Castells, 2000; Soper, 2007).

Nevertheless, digitalisation can also create new vulnerabilities for hacking and manipulation at a scale simply not possible in paper-based administration, or it may shift petty corruption to other areas of government activities that are not yet digitalised. ICT may concentrate new, system-wide corruption opportunities in the hands of those few who have the right tech skills; and increased transparency can also facilitate corruption, for example, in public procurement by enabling bidders to more effectively identify which official to bribe (Bac, 2001).

3.3.2. Impact via upward transparency

Emerging technologies can foster upward transparency i.e. information flows from society to government. Supervisors receive

citizen feedback on public officials' performance, for example, through digitalised public service delivery. Such feedback loops create complaint channels that can lead to prevention, detection and punishment of corruption within government, that is making horizontal accountability more effective. (Grönlund et al., 2010; Kossow and Dykes, 2018).

Nevertheless, false information might be spread too. Digital means of interaction among citizens and businesses may also render corruption easier to organise and maintain by lowering transaction costs and allowing for more efficient monitoring within criminal groups.

3.3.3. Impact via administrative processes

ICT can also directly affect petty corruption through automating and standardizing administrative processes within government which limits the scope of officials' discretion and increases the possibilities for oversight, hence contributing to horizontal accountability. ICT can also reduce direct contacts between citizens and public officials, therefore removing petty corruption opportunities altogether in some cases. In addition, if the adoption of ICT in government is accompanied by new regulations designed to restrict public officials' discretion and to generate information for monitoring public officials' behaviour, the effect could be even larger.

Yet, ensuring de facto compliance with de jure administrative rules is challenging throughout developed and developing countries because rules need to allow for some discretion and because monitoring is costly (Jain, 2001). Importantly, as for example Kelman (2005) highlights, reducing public agents' discretion through ICT can have adverse consequences by also curtailing desired behaviour. Tighter rule-enforcement may impose additional compliance costs on honest officials and demotivate them. Higher risk of audit can increase risk-averse behaviour (Gerardino et al., 2020), slowing bureaucratic processes and stifling innovation, potentially outweighing the benefits of better controls. Further adding to the potential downsides of reducing official discretion, Carril (2021) finds that the threshold below which US federal procurement contracts can be awarded using fewer procedural rules and less oversight should be raised. This is because compliance costs associated with reduced discretion are higher for government than the benefits of waste prevention. The impact of regulations that inhibit discretion crucially depends on the public sector capacity of a country. Tighter regulation is effective in countries with low public sector capacity, and detrimental in countries with high public sector capacity because it inhibits the socially optimal exercise of discretion (Bosio et al., 2020).

3.3.4. Impact via collective action

ICT can contribute to the fight against petty as well as grand corruption by drastically lowering the cost of coordination and

information exchange within (civil) society which can facilitate collective action for holding government to account. For example, platforms for information sharing, such as crowdsourcing platforms and social media, can greatly foster civil society's information exchange about corruption and serve as a tool for cheaply organising and uniting losers of corruption (Grönlund et al., 2010).

Nevertheless, ICT tools such as social media also carry the risk that false and confusing information might be spread. In addition, online activism might give people the impression that they are taking action against corruption while the virtual activity does not translate into impact (Shirky, 2011). It has also been documented that increased awareness of corruption can lead to citizens' resignation when the avenues for ousting corrupt leaders are largely locked (Cheeseman and Peiffer, 2020).

In sum, the reviewed literature points at both positive and negative impacts of emerging technologies on corruption, depending how impact mechanisms interact with contextual factors. For example, in a study on the effect of ICT diffusion on corruption in Africa, Sassi and Ben Ali (2017) found that anti-corruption effects of ICT adoption only materialise once a threshold of rule of law is reached. This emphasises the importance of comprehensive reforms of law enforcement and state building (Sassi and Ben Ali, 2017). Similarly, Charoensukmongkol and Moqbel (2014) find a U-shaped relationship between ICT investment and corruption. This implies that, while increased investment in ICT can lead to reduced corruption, overinvestment in ICT tends to result in increased corruption, as the distortion of such funds through a non-transparent procurement process easily create corruption opportunities. Bhattacharjee and Shrivastava (2018) stress that ICT laws moderate the effect of ICT use on corruption, suggesting that ICT investments may have limited effect on corruption, unless complemented with appropriate ICT laws. As this illustrates, ICT's potential anti-corruption use depends on political, infrastructural, legal, social and economic factors. The risk of misuse needs to be carefully considered.

4. Assessment of individual technologies and tools

This section discussed each ICT tool and reviews the evidence for its impact on corruption in depth. For an overview of the studies reviewed see Table 1.

4.1. Digital public services

Digital public services are a sub-form of electronic government (e-government), that involves the use of ICT, particularly the internet, web-enabled devices, and electronic data management systems, for the provision of public services to citizens (UN Department of Economic and Social Affairs, 2014). Governments aim to improve performance by automating services and simplifying recurrent bureaucratic processes (World Bank, 2016).

In line with the literature on impact mechanisms, we expect that digital public services reduce corrupt behaviours rooted in the principal-agent problem by enabling government supervisors to monitor other public officials' activities more effectively. Such within-government monitoring role of digital public services is especially important when a powerful elite coalition (e.g. newly elected government) genuinely interested in anti-corruption aims to clean up the hitherto systematically corrupt state. These tools also increase downward transparency impacting the government information available for citizens and other actors such as development aid donors² to hold governments to

account (Pathak et al., 2007; Shim and Eom, 2008). Digital public services reduce face-to-face contact between public officials and citizens, lowering bureaucratic discretion and removing opportunity to interact and build trust necessary for corruption; both of which are expected to reduce corruption, especially the petty type (Charoensukmongkol and Moqbel, 2014).

Nevertheless, digital public services do not in themselves ensure improved transparency and accountability (Barata, 2001). E-government projects in developing countries often fail due to weak administrative resources and low capacity, as well as inappropriate designs which do not match on-the-ground realities. One such example is the computerisation in a national Epidemiology Service in Central Asia the design of which assumed the use of a broad range of software and hardware and IT-skilled staff, however the initial reality was manual operations using typewriters, phone, fax and post (Heeks, 2003; Schuppan, 2009). A major impediment for the widespread use of digital public services in many countries is the digital divide – that is, the inequality in public access to ICT (and basic requirements of electricity and internet connection) and the capability and motivation to use them as intended.

Instead of enhancing oversight, digital public services may introduce new opportunities for systematic misuse. They could potentially shift petty corruption towards remaining paper-based areas or enable concealing corrupt actions by individual tech-literate officials (Pacific Council on International Policy, 2002). For instance, public administration employees in Bosnia-Herzegovina, following the introduction of an electronic citizen registration system, misused their access and forged data to sell false ID cards and passports (ReSPA, 2013).

4.1.1. Empirical evidence

There is a diverse body of literature on the relationship between e-government and corruption, with a number of medium-quality empirical studies that lend support to the suggested effect of e-government mitigating petty corruption.

In a high-quality regression analysis of 127 countries, Shim and Eom (2008) find that different e-government measures account for 77% of total variation of corruption perception levels. They appear to be more influential on corruption reduction than the tested conventional anti-corruption factors, including bureaucratic professionalism and law enforcement. In a study with a similar setup, Andersen (2009) finds that, in non-OECD countries, increases in e-government maturity resulted in reduced corruption levels from 1996 to 2006, even when controlling for GDP per capita and press freedom. His most conservative estimate is that moving from the 10th percentile to the 90th percentile of the e-government measure reduces corruption by 13%.

In a later regression analysis covering similar variables, Mistry and Jalal (2012) confirm that, as the use of e-government technologies increases corruption perceptions decrease, namely a 1% change in e-Government Development Index leads to a 1.17% decrease in corruption perception, with a greater impact in developing than in developed countries. Garcia-Murillo's regression models (2013) add telecommunications infrastructure to the equation, concluding that an increased online government presence – through e-government and telecommunications infrastructure – reduces the perception of corruption around the world. Nam's path analysis (2018) confirms that e-government service maturity contributes to controlling corruption and adds national culture as an important factor that moderates the anti-corruption effect of e-

atically corrupt elites if they see the benefits outweigh the costs of ICT adoption. For example, recent European Union enlargement in Central and Eastern Europe have convinced otherwise corrupt governments to adopt digital public services, such as electronic procurement platforms, in return for accession and the associated financial benefits from trade and subsidies.

² Anti-corruption and state modernisation reforms driven by external actors often include ICTs, such as digital public services, which may be adopted even by system-

Table 1
Overview of evidence reviewed (in the order of appearance in the paper).

Study	Technology type	Methodology	Sample	Observed impact of ICT
Shim and Eom (2008)	Digital public services / e-government	Regression analysis	127 countries	Different e-government measures account for 77% of total variation of corruption perception levels.
Andersen (2009)	Digital public services / e-government	Regression analysis	non-OECD countries	Increases in e-government maturity resulted in reduced corruption levels from 1996 to 2006: moving from the 10th percentile to the 90th percentile of the e-government measure reduces corruption by 13%.
Mistry and Jalal (2012)	Digital public services / e-government	Regression analysis	global	1% change in e-Government Development Index leads to a 1.17% decrease in corruption (CPI) and developing nations benefit most from improvements in ICT.
Garcia-Murillo (2013)	Digital public services / e-government	Regression analysis	global	Increased online government presence – through e-government and telecommunications infrastructure – reduces the perception of corruption.
Nam (2018)	Digital public services / e-government	Regression analysis (path analysis)	global	E-government service maturity contributes to controlling corruption and national culture is an important factor that moderates the anti-corruption effect of e-government.
Kim, Kim and Lee (2009)	Digital public services / e-government	Case study	Seoul	Electronic government service system reduced corruption significantly.
Krolkowski (2014)	Digital public services / e-government	Case study	Tanzania	Mobile payment for public water bills reduced petty corruption.
Kossow and Dykes (2018)	Digital public services / e-government	Case study	Kenya	After initial success, an online citizen complaints system was an additional burden for staff.
Elbahnasawy (2014)	Digital public services / e-government	Regression analysis	160 countries	E-government is a powerful tool in reducing corruption—via telecommunication infrastructure and the scope and quality of online services—which is strengthened by greater internet adoption.
ReSPA (2013)	Digital public services / e-government	Case studies	Balkans	Public officials adapt to new digital systems by circumventing them or using them for their own benefit by falsifying, illegally obtaining or destroying data.
R.D. Pathak et al. (2007)	Digital public services / e-government	Descriptive statistics	Ethiopia	E-government is more likely to be effective when several factors linked to corruption mitigation are explicitly considered in the design of digital public services.
Charoensukmongkol and Moqbel (2014)	Crowdsourcing platforms	Regression analysis	42 countries	Increase in ICT investment provides technology infrastructures that can effectively monitor and control corruption, more investment itself can also provide an opportunity for corruption to occur.
Kossow and Dykes (2018)	Crowdsourcing platforms	Case studies	Colombia, Vietnam, Kenya, Philippines	Crowdsourcing platforms when sufficiently used reap the benefits of upward transparency and collective knowledge, increasing the threat of exposure which deters corruption.
Ang (2014)	Crowdsourcing platforms	Case studies	India, China	Crowdsourcing opportunities are limited in authoritarian states, not only due to external constraints but also to weak civil society.
Asimwe et al. (2013)	Crowdsourcing platforms	Case studies	Uganda	Impact was achieved as the project providers and voluntary action committees verified reports on the ground and held dialogue with the relevant public service bodies.
Hellström and Bocast (2013)	Crowdsourcing platforms	Case studies	East Africa	5 out of 6 crowdsourcing platforms have a less than 100 reports and thus seem to be of limited use.
Zipparo (2001)	Whistleblowing tools	Descriptive statistics	New Zealand	Lack of proof and the absence of legal protection deter public sector employees from whistleblowing.
Kossow and Dykes (2018)	Whistleblowing tools	Case studies	Kenya, Indonesia	Publicity of a whistleblowing platform is key to its success.
Brito (2011)	Transparency portals & big data	Case study	US	Data on US government's transparency portals is technically available but often not available in reusable formats.
Open Knowledge Foundation: Open Data Barometer	Transparency portals & big data	Mixed methods (peer reviewed expert survey, self-assessment, secondary data analysis)	global	Open data use for better governance is prevented by three obstacles: data is hard to find, not user-friendly, and not openly licensed.
Correa et al. (2019)	Transparency portals & big data	Automated website checks	Brazilian capitals	Many data appear to be developed with the classic website model in mind, which provides access to data only through user interaction with web forms, and not as data catalogues for reuse.
Davies and Fumega (2014)	Transparency portals & big data	Case studies	13 developing countries	Due to frequent mismatch between the supply and demand of open data in developing countries, examples of the direct use of open data and its outcomes are limited.
Cuillier and Piotrowski (2009)	Transparency portals & big data	Descriptive statistics	US	As more people gather information online about their governments and communities, they increase support for government transparency and the right to request public records.

(continued on next page)

Table 1 (continued)

Study	Technology type	Methodology	Sample	Observed impact of ICT
Srimarga (2010)	Transparency portals & big data	Case study	Indonesia	Open budget data allows civil society to participate in decision-making, but data provided are sometimes inconsistent, deficient or not provided in useful formats.
Bauhr and Grimes (2014)	Transparency portals & big data	Regression analysis	global	Increase in transparency in highly corrupt countries tends to breed resignation and reduce political interest and institutional trust, rather than fostering indignation, oversight and collective action
Li and Juhola (2014)	Artificial intelligence	Machine learning	56 countries	Self-organising maps can be a new tool for mapping criminal phenomena through processing of large amounts of crime data.
Swiderski et al. (2012)	Artificial intelligence	Regression analysis and machine learning	global	Applying an AI method to the assessment of the financial condition of companies shows superiority compared to classical approaches.
Olszewski (2014)	Artificial intelligence	Machine learning	global	Self-organising maps help to detect fraud in credit cards or telecommunications.
López-Iturriaga and Sanz (2017)	Artificial intelligence	Machine learning	Spain	AI can help to calculate the probability of corruption in different provinces and the conditions that favour it, providing time frames to predict corruption up to three years in advance
Lima and Delen (2019a)	Artificial intelligence	Machine learning	global	AI models show that government integrity, property rights, judicial effectiveness, and education index are the most influential factors in defining the corruption level.

government. Culture encompasses unequal power distribution and uncertainty avoidance, both of which decrease the anti-corruption effect of e-government.

At the micro-economic level, Kim, Kim and Lee (2009) studied the single case in great detail of the development of an electronic service system in the Seoul Metropolitan Government that enables citizens to monitor the progress of their applications in 54 common procedures. The study found that petty corruption was reduced significantly as the points of interaction between citizens and public officials were reduced (impact via administrative processes). In a case study of the Dar es Salaam Water and Sewerage Corporation in Tanzania, Krolikowski (2014) examined the use of mobile payment methods for public water bills and found that this reduced the incidence of petty corruption and promoted improved financial management by making transaction data more transparent, promoting horizontal as well as vertical accountability,

To the best of our knowledge, no quantitative studies have been published about the adverse effects of digital public services on corruption. Regarding qualitative evidence on digital public services, in Kenya, an online citizen complaints system – designed to enhance administrative oversight by enabling co-operation between five government bodies and one non-governmental organisation (NGO) to re-route complaints to the appropriate body – was first hailed as a success, with 184 out of 199 cases referred in the first year. One year later, this dropped to only 12 cases, and staff reportedly perceived the new technology as an additional burden (Kossow and Dykes, 2018). Complaints emerged that the platform was sometimes not accessible or very slow, there was a high staff turnover without system knowledge being passed on, lack of feedback from partner organisations, and too little outreach (Huter, 2018). Elbahnasawy (2014) also points out that, in many countries, some e-government services may be offered online, but the full processes may still require citizens to meet with government officials in person, hence the benefits of e-government in the sense of changing the administrative processes involved would be limited. Moreover, some, albeit limited, impact of ICTs on diminishing grand corruption has also been documented. For example, when systemic change was driven by popular uprising and governing parties were elected on an anti-corruption ticket (e.g. Estonia, Georgia, or Ukraine). The incoming non-corrupt elites used such tools to fight systemic corruption throughout the state and lock-in reform achievements (see for example on Ukraine: OECD, 2017).

The main impact mechanism of these tools relied on weakening the informational monopoly of corrupt public actors, improving accountability relations vis a vis other organs of the state and the wider society. The cases presented by ReSPA (2013) were specifically selected to illustrate the ingenuity with which public officials adapt to new digital systems, hence they are not representative for digital public service impact in general. Nevertheless, they give real-life examples of how public officials circumvent digital systems or use them for their own benefit by falsifying, illegally obtaining or destroying data. For example, officials manipulated data in a new electronic road toll system re-registering trucks as cars to keep the price margin for themselves, leading to an annual loss of €2 million (ca. £1.8 million) from Croatian tollbooths. They conclude that, while digitalising the public sector can enhance transparency, it can also enable much wider abuse than without ICT. Recognising such risks, Asogwa (2012) investigates the challenges of e-records management as a component of efficient digital public services in Africa. The research shows that the benefits of digitalisation can only be realised if appropriate infrastructures, regulations, finance and trained staff are available. Furthermore, Pathak et al. (2007) use a correlational analysis of Ethiopia's e-Governance programme to show that it can help not only in weeding out corruption but also in the establishment of sounder government citizen relationships.

In sum, the empirical findings underpin a clear, statistically proven relationship between different measures of e-government adoption and reduced petty corruption. This supports the theory that digital government, often driven by public efficiency concerns and implemented by government itself, impacts via upward transparency by expanding information access and accountability which raise the risk of detection. Moreover, e-government also impacts by changing administrative processes as it limits bureaucratic discretion and face-to-face contacts between citizens and bureaucrats hampering corrupt exchanges. Nevertheless, as the qualitative evidence indicates, digital public services can also enhance corruption, depending on a range of factors linked to the quality of design and implementation of interventions and whether it explicitly incorporates corruption mitigation measures. Further studies are needed on different kinds of digital public services to help us understand which areas are most cost effective to digitise, what types of corruption are mitigated or enabled, and in what kind of public administration context. Future research should also shed light

on the enabling conditions to promote digital public services and their impact on corruption.

4.2. Crowdsourcing platforms

In general, crowdsourcing is a sourcing model in which individuals or organizations obtain goods or services, including ideas, voting, micro-tasks and finances, from a large, relatively open and often rapidly evolving group of participants. In the context of anti-corruption efforts, crowdsourcing platforms gather reports from citizens on petty corruption incidences, typically via internet or telephone. These platforms are primarily intended for collecting incidences of petty corruption in the public sector as experienced by a large group of citizens (Charoensukmongkol and Moqbel, 2014). They can be driven by government or civil society concerns to reduce petty corruption and inefficiencies in the public sector and are sometimes state-run, or set up by local civil society or international organisations.

A widely used anti-corruption crowdsourcing platform is I Paid A Bribe which was first introduced in India and adopted in over 10 other countries. Users anonymously share their corruption experience, including the nature, location and value of a corrupt act, but also cases where they declined to pay a bribe or interacted with honest officials. Similar platforms have emerged around the world such as Yosoborno in Colombia, Toidihoilo in Vietnam, or Ushahidi in Kenya. Some anti-corruption crowdsourcing platforms focus on specific issues such as the Check My School project in the Philippines where citizens report on the use of public funds by schools (Kossow and Dykes, 2018).

According to the literature on impact mechanisms, we expect that, when used extensively, crowdsourcing platforms reap the benefits of upward transparency and collective knowledge, increasing the threat of exposure which deters corruption. The data gathered on crowdsourcing platforms paint a detailed picture of how and where petty corruption happens and what amounts are involved. Watchdog organisations or government authorities can follow up on this information by tightening regulations and oversight in critical areas and prosecuting corrupt public officials. For example, the state of Karnataka in India used I Paid A Bribe data to push through anti-corruption reforms in the motor vehicle department, including online applications and video monitoring (Kossow and Dykes, 2018). Crowdsourcing platforms can also raise public awareness, educating citizens about their rights and the illegality of corruption. Bundling of isolated cases demonstrates the pervasiveness of corruption and potentially fosters solidarity, connects citizens and creates an anti-corruption community capable of collective action (Mungiu-Pippidi, 2013). It can therefore enhance upward transparency as citizens provide information to the government enabling horizontal accountability, they may also contribute to overcoming collective action problems by strengthening anti-corruption norms among victims of corruption.

Crucially, the value of crowdsourcing platforms depends on user participation. A number of factors influence the extent of crowd association and participation in a crowdsourcing initiative: accessibility and quality of ICT infrastructure; skills and abilities of the crowd; mutual expectations and trust among individuals; perceptions of the other users; vision and strategy of the crowdsourcing initiative; and external environment in terms of governance support and socio-economic circumstances (Bott and Young, 2012; Sharma, 2010). Flaws in user access, capabilities and trust, or shortcomings in platform design and organisational and technical support, can easily result in reduced value or failure of crowdsourcing initiatives.

Additional concerns revolve around the fact that crowdsourced data are often submitted anonymously. Consequently, information is hard to verify, opening up possibilities for false allegations and

complicating follow-up action. The risk of security loopholes in the protection of users' data can cause mistrust and put them at risk (Asiimwe et al., 2013). Conversely, anti-corruption crowdsourcing platforms might also have the involuntary effect of actually enabling petty corruption as they provide information for people seeking to bribe officials, for example, to speed up a procedure, or to find out who can be corrupted where and at what price.

4.2.1. Empirical evidence

High-quality, empirical evidence on crowdsourcing platforms' impact on corruption is largely missing. The existing evidence is limited to a number of case studies indicating and explaining specific platforms' success or failure in terms of participation, data generated and follow-up actions (for example, see GISWatch, 2012). Kossow and Dykes (2018) examine the crowdsourcing platform I Paid A Bribe in India which generated large numbers of reports –162,130 reports since 2010 from more than 1000 Indian cities with an average of 25–50 reports per day (I Paid A Bribe, 2020). For example, the Transport Commissioner in Bangalore found that his department had the highest instances of bribe-taking in the state. He consequently worked with the Janaagraha Centre, the NGO responsible for the platform, to re-engineer the process for issuing drivers' licences to reduce loopholes for rent-seeking.

Ang (2014) contrasts the success of I Paid A Bribe in India with the failure of similar initiatives in China which were plagued by internal organisational problems. These included mismanagement, opportunism to use the platform for personal vengeance, and a narrow understanding of anti-corruption as a principal-agent problem; the focus was on exposing and arresting corrupt individuals, rather than addressing structural issues. In India, such problems were comparatively absent as the Janaagraha Centre offered the autonomy and professionalism necessary to channel crowdsourced information into constructive policy engagement and public education. China's case points at the limits of crowdsourcing activism in authoritarian states, not only due to external constraints but also to weak civil society.

Asiimwe et al. (2013) provide a case study on two projects in Uganda that aim to fight public service petty corruption in low-resource communities by enabling citizens to report on it by phone, radio, SMS or e-mail. The track record exhibits real change achieved as the project providers and voluntary action committees verify reports on the ground and open dialogue with the relevant public service bodies. The authors find that enabling factors for this kind of reporting include efficient and effective reporting processes, convenience, direct links to service delivery outcomes, privacy and affordability. The challenges were poor infrastructure facilities, mistrust towards project officials, misuse, gender issues, and economic sustainability and finding the right scope for operations (Asiimwe et al., 2013).

In contrast to these optimistic reports, Hellström and Bocast (2013) compare a number of anti-corruption crowdsourcing platforms implemented in East Africa. They find that five out of six have such small number of reports (less than 100) that their utility seems limited. Only the I Paid A Bribe initiative in Kenya successfully generated more than 3500 bribe reports between 2011 and 2013. These were used by civil society organisations to argue for improved governance procedures and tighter regulation (Hellström and Bocast, 2013). However, not much is known about the initiative's impact and it ceased operations in 2015. Hellström and Bocast (2013) subsequently conducted a detailed qualitative investigation into the Ugandan anti-corruption crowdsourcing platform, Not In My Country, designed specifically for recording and publicising petty corruption at universities. The platform received broad support on social media and had more

than 15,000 unique visitors. However, only 10 corruption reports were submitted at the time of research. They found that peripheral factors such as limited internet access, a non-intuitive website, and fears of government surveillance inhibited students to report corruption. It appeared that, while most respondents shared the long-term goal of reducing corruption and have experienced repeated incidences of corruption, they also recognised some benefits of corrupt practices such as buying exam questions in advance. They also indicated that engaging with anti-corruption initiatives that accord with local communication customs would be preferable – for example, through radio call-in shows, anti-corruption petitions, or using peers to file a report (Grönlund et al., 2010).

In sum, the evidence base for the impact of anti-corruption crowdsourcing platforms on corruption is quite thin and more quality studies are needed. In particular, this calls for quantitative, empirical work evaluating crowdsourcing platforms' impact on petty corruption (both frequency and bribe amounts), for example using a randomization technique (for such methods in corruption research see: Lagunes, 2021) or a smart exploitation of staggered implementation of the platform (for a similar application looking at e-procurement platforms see: Lewis-Faupel et al., 2016). There are a few success stories and qualitative investigations into success factors. It appears that crowdsourcing platforms can help tackle corruption when implemented well, but can have no impact too. Many platforms remain experimental and seem to have limited added value as the number of reports remain low with no documented impact. This points to the fact that crowdsourcing platforms need to be embedded in a broader initiative and it is important to consider the short-term needs and modes of action and communication for target participants. The ease of use, guarantee of anonymity, adaptation to the context, and follow-up action involving public servants appear to be crucial to reap the benefits of collective knowledge and action.

4.3. Whistleblowing tools

Whistleblowing tools using ICT are similar to crowdsourcing platforms as they enable people to report wrongdoing by public officials. The difference is that whistleblowing tools are usually designed for gathering detailed reports of individual, larger cases of corruption, including grand corruption (e.g. Panama papers³), with the principal aim of supporting criminal prosecutions, while sometimes also leading to voter mobilization against corrupt elites. Whistleblowing tools can be run by governments or by civil society and seek lower numbers but greater depth and reliability of reports, thus impact is expected through upward transparency enabling horizontal accountability. Examples of ICT-enabled whistleblowing systems include: *GlobalLeaks*, an open-source software that can be adopted to different settings; and the *BKMS®* compliance system, mostly for internal whistleblowing, which encrypts and forwards reports to an internal examiner.

Based on the literature, whistleblowing tools are expected to aid the fight against corruption by competent and empowered law enforcement bodies and other organisations. They provide invaluable information on corruption cases that would otherwise remain secret and hence enable honest anti-corruption institutions to act on detailed, relevant information. When whistleblowing reports result in prosecution and cases become widely known, they increase the perceived risk of detection hence prevent corruption.

These positive effects are, nevertheless, contingent on a number of technological and institutional conditions. The technological design of ICT-enabled whistleblowing platforms needs to ensure anonymity and protection, as the possibility of a breach of pro-

tection could strongly discourage potential whistleblowers. This includes disguising whistleblowers' IP addresses and safeguarding data transfer and establishing legal frameworks which protect anonymous whistleblowers (Salbu, 2001). At the same time, these platforms should enable follow-up communication between officials and whistleblowers. In some cases, officials try to encourage whistleblowers to reveal their identity – for example, in order to act as witnesses in a trial. The platform providers should carefully consider this option, realistically assessing the risks involved for whistleblowers (Kossow and Dykes, 2018). Another challenge is finding the right balance between broadly raising awareness and limiting the volume of reports to ensure quality and capacity for handling them promptly and professionally.

4.3.1. Empirical evidence

Given the unique nature of high-profile and often complex cases resulting from whistleblowing reports, there is a general paucity of high-quality evidence on effectiveness. For general insights on enabling factors for whistleblowing in the workplace environment, Zipparo (2001) conducted a large-scale survey of more than 800 public sector employees in New Zealand to investigate what deters them from reporting workplace corruption. The most common concerns were not having enough proof and the absence of legal protection. The author also found that respondents from lower-income groups were significantly more likely to be deterred from reporting corruption in the absence of encouraging factors.

With regards to the use of ICT-enabled whistleblowing platforms, Kossow and Dykes (2018) offer some qualitative insights based on in-depth interviews with key informants working on whistleblowing platforms from developing countries. One is Kenya's anonymous whistleblowing platform operational since 2005 which records all necessary information and enables anonymous interaction with a whistleblower. The platform was embraced by the public in the first years and thousands of reports were submitted. The numbers have dropped in recent years, supposedly due to insufficient publicity (Kossow and Dykes, 2018). A similar platform in Indonesia supports the argument that publicity is an important factor to success. On the global level, a number of recent high-profile leaks (Luxembourg Leaks, Paradise Papers, etc.) have unearthed excruciating details about corrupt political and business elites. For example, the Panama Papers leak, facilitated by whistleblowing tools and amplified by the investigative work of ICIJ (International Consortium of Investigative Journalists⁴), have harmed large corrupt businesses as well as corrupt politicians across the globe (O'Donovan et al., 2019).

In sum, ICT-enabled whistleblowing tools can facilitate reporting on cases of grand corruption with sufficient detail for follow-up legal action. This generates impact through the upward transparency impact channel that enables horizontal accountability. The protection of whistleblowers' identities, appropriate follow-up action e.g. by the public prosecutor, and publicity for the platform are crucial to their success. If security measures are not properly implemented, hacking or leaking of identity information can endanger users and deter others from reporting. If a whistleblower faces repercussions, it could greatly discourage other potential whistleblowers and thus weaken anti-corruption efforts. At the same time, platform providers need to follow up on reports, evaluate their accuracy and act – otherwise, potential whistleblowers might lack the motivation to report corruption. If we are to understand the direct impact of upward transparency from whistleblowing platforms on corruption through scientific evidence, much more high-quality research is needed, going beyond simple statistics of use and anecdotal evidence.

³ <https://panamapapers.org/>.

⁴ <https://www.icij.org/>.

4.4. Transparency portals and big data

Transparency portals are online platforms usually run by governments or NGOs that publish information on government operations. They include open data portals where government datasets are compiled and freedom of information portals which facilitate citizens' information requests (Bagozzi et al., 2021). The Argentinean *Dinero y Política* presents data on political party finances, for example; OpenSpending.org provides data on government budgets by mapping money flows; or DIGIWHIST's OpenTender.eu publishes information on public contracting along with corruption risk indicators (Fazekas et al., 2018) which aim to analyse and bring to light cases of grand corruption. Transparency portals ideally provide government information as open data, meaning that data are freely and easily accessible, machine-readable, and explicitly unrestricted in use (Gurin, 2014). Open data may be, but are not necessarily, big data – that is, very large amounts of heterogeneous and complex data, requiring special data-processing and analytical tools (Gandomi and Haider, 2015).

In line with the literature on impact mechanisms, we expect that transparency portals open new opportunities for citizen oversight of 'street-level bureaucrats' as well as political elites. For example, when information on public budgeting is published, citizens can more easily hold officials to account for spending decisions (Wickberg, 2013). Transparency portals can help to tackle corruption by enhancing the information flow from governments to citizens which fosters downward transparency and can also mobilize losers of corruption, for example to protest for the removal of corrupt leaders. The existence of such platforms can discourage public officials from engaging in corruption as the risk of punishment increases.

Critics argue that downward government transparency is generally a dubious concept since it is provided by governments themselves – meaning that 'inconvenient' information may remain undisclosed or removed from public scrutiny (Suleiman, 2017). Governments might 'whitewash' themselves – for example, by joining initiatives such as the Open Government Partnership – without actually making the substantive changes that would increase transparency and accountability. Furthermore, transparency portals are only as good as the data they use, which depends on government willingness to be rigorous about data collection, even in the absence of corrupt intent. If government agencies release incomplete, inaccurate, or purposeless data, the information most valued by the public could remain undisclosed. Besides, the mere existence of open government data does not ensure any impact on corruption. Limited resources and numerous logistical issues obstruct the effective use of transparency portals by citizens as well as the public sector (Adam et al., 2020). Many countries lack key data and face gaps in technology and skills, have patchy legal frameworks, or lack access to finance for open data initiatives.

4.4.1. Empirical evidence

Empirical, high-quality evidence on the direct effect of transparency portals on corruption is scarce. However, assessments of the state of open data are common, pointing out that often what is claimed to be open data is, in fact, not or only partially open. For example, Brito (2011) reviews the US government's transparency portals and finds that the data that is technically available is often not available in reusable formats, e.g. when documents are only uploaded as scans and so are not machine-readable and searchable. *The State of Open Government Data in 2017 report* (Lämmerhirt et al., 2017) demonstrates that the challenges to open data use have remained since Brito's study. They identify the three critical obstacles preventing open data use: data is hard to find, not user-friendly, and not openly licensed. Despite an increasing number of countries providing open data, politically sensitive informa-

tion and other datasets that would be key to accountability were found to be among the least likely to be published. In many countries, crucial datasets such as company or land registers, are simply not available digitally due to the administration's lack of capacity or digitization (Barometer, 2017).

Using an automated website checking method, it was found that many data portals, particularly those of local governments, appear to be misimplemented and developed with the classic website model in mind, which provides access to data only through user interaction with web forms and not as data catalogues for reuse (Correa et al., 2019). A qualitative case review by Davies and Fumega (2014) on open data programmes across 13 developing countries finds that, although there is evidence that open data is being used in some new applications or analysis, examples of the direct use of open data and its outcomes are limited. This is due to frequent mismatch between the supply and demand of open data in developing countries.

Cuillier and Piotrowski (2009) show through a large-scale survey that, as more people use the internet for gathering information about their governments and communities, they increase support for government transparency and the right to request public records. This implies that, in countries with less internet use for information-seeking, there is less demand for public access to government records. Nevertheless, Davies and Fumega (2014) highlight that transparency portals can create new spaces for civil society to pursue government accountability. Such intermediaries are vital for the successful supply and use of open data.

Srimarga's (2010) detailed case study analyses the transparency portal for national budget data in the Ministry of Finance of Indonesia and suggests that the initiative allows NGOs to participate more in public decision-making as more opportunities for evidence-based advocacy arise from the improved budget transparency. Nevertheless, the NGOs criticised that the data provided are sometimes inconsistent, deficient or not provided in useful formats and so cannot be used for investigative purposes.

At the same time, the notion that greater transparency enables citizen action against grand corruption is brought into question. In a high-quality regression analysis, Bauhr and Grimes (2014) find that an increase in transparency in highly corrupt countries tends to breed resignation and reduce political interest and institutional trust, rather than fostering indignation, oversight and collective action. If citizens lack institutional avenues to hold office holders accountable with the information gained through increased transparency, their civic engagement may be deterred (Bauhr and Grimes, 2014).

In sum, rigorous evidence on the impact of big and open data on transparency portals is still relatively scarce. Its effect via the downward transparency impact channel appears to hinge on a variety of factors connected to context, implementation, and avenues to use data-driven insights. Transparency portals are only as good as the data they provide and the engagement of an active civil society or business community to be able to use the data as effective remedies for corruption. As a result of an effectively implemented transparency portal, governments may change the documentation of public data, enabling oversight and sanctioning wrongdoing. However, the mismatch between the supply and demand of data, lack of resources and sanctions, and few user communities weaken such portals' anticorruption effect. Overall, we need a more nuanced and detailed understanding of how transparency portals providing open data can have an impact on corruption.

4.5. Distributed ledger technology (DLT) and blockchain

Blockchain, as one type of DLT, is a decentralised and synchronised database maintained by a peer-to-peer network where each

user holds a copy of the blockchain. All information is transmitted, verified and saved in the distributed ledger as blocks that cannot be changed or deleted. Therefore, permanent and secure records are created which can be used for cryptocurrencies, smart contracts, or file storage (Natarajan et al., 2017; Walport, 2015). In terms of expected impact, on the one hand, blockchain can be used by governments to manage all types of public information, offering full transparency. It could be applied by governments for storing public transactions and documents, for tracking budget spending, saving land records and company foundation documents, or reshaping contracting and payment systems. This might be driven by a motivation to mitigate some of the risks associated with central government databases that could be hacked or manipulated. Hence, using blockchain technology can increase transparency and prevent fraud and petty corruption, enhancing possible oversight and accountability (Kshetri, 2017).

On the other hand, blockchain technologies can be used to establish direct links between societal actors, eliminating the use of government registries and hence reduce the need for individuals to interact with bureaucrats. Eliminating public administration from record keeping reduces the chances for bureaucrats to extract rents from citizens and also removes the informational monopoly of the state which it can exploit for corrupt means. In international development co-operation, for example, blockchain technologies bring about innovative ways of establishing a direct link between donors and recipients. For instance, a South African start-up has established a platform where donors can fund utility costs for South African schools using the blockchain-enabled bitcoin cryptocurrency. This circumvents the allocation of funds through organisations or public administrators where petty corruption and mismanagement occur frequently. Another example is the African TruBudget platform where international donors can see ministries' spending decisions.

However, blockchain is not a panacea and without well-planned policy and a holistic, co-ordinated effort of all stakeholders, it appears unlikely to "be realized on a large scale anytime soon due to the resistance of the existing leadership and lack of infrastructure" (Kim and Kang, 2017). At the most basic level, blockchain technologies are as good as the data entered into them. Where people record transactions improperly, enter inaccurate data or deliberately falsify records, no significant positive impact can be expected. On top of that, blockchain technology may even pose a threat to anti-corruption efforts as it enables fully anonymous and encrypted cryptocurrency transactions that may be used for embezzlement or fraudulent deals by corrupt actors. Furthermore, the complexity of DLT technologies may raise suspicion in citizens especially in countries suffering from endemic distrust in government.

4.5.1. Empirical evidence

Unfortunately, a lot of potential interventions are only being developed and piloted and there are no mentionable studies on their effect on corruption. In Ghana, for example, two start-ups, Bitland and Benben, aim to introduce blockchain-based land registries and real estate transactions. The Swedish and Georgian governments experiment with blockchain technology for land registries. In the Ukraine, the government plans to move its farmland registry and state property and land registers to a blockchain-based system (Huter, 2018). As examples of blockchain applications that are already mature, it is too early to assess the impact of blockchain applications as anti-corruption tools; more experimentation and innovative cases should be developed and rigorously tested. It is crucial that governments continue to turn paper-based processes into digital ones. The digital processes could later be moved to a blockchain application, if blockchain is found to add value on top of digitisation. Additional research is also needed to establish

if cryptocurrencies facilitate corruption and money laundering because, unlike banking transactions, they are not subject to regulation and government oversight. While cryptocurrencies allow for highly secure payments with publicly visible transactions. The parties to the transaction, however, can remain anonymous, and the technology could be used to move, launder and protect illegitimate funds.

To sum up, blockchain technology can impact via downward transparency as it offers increased levels of information and vertical accountability of the public sector, while also changing the administrative processes, cutting out the 'middlemen' with discretion over resources, thus reducing petty corruption opportunities. Nevertheless, blockchain's anticorruption impact is largely untested. It also poses a challenge to data security and regulation, and could possibly even enable the transfer of corrupt funds.

4.6. Artificial intelligence (AI)

AI technologies, such as neural networks, are learning algorithms which infer patterns and relationships from large volumes of examples in order to best achieve pre-set goals. Their ability to cheaply and quickly predict and uncover hidden relationships make them valuable in policy making and policy implementation, such as directing policing effort or corruption risk red flagging (Legg and Hutter, 2007). One such neural network tool is a self-organising map that can extract patterns from large data sets and visualise them to predict corruption (López-Iturriaga and Sanz, 2017). This could be employed by public authorities tasked with uncovering collusion and corruption to enable them to work more efficiently and effectively, e.g. anti-corruption authorities, public prosecutors, public auditors, or competition authorities. In as much as AI technologies make law enforcement more efficient and allow for a appropriate targeting of scarce anti-corruption resources, we expect them to lower corruption. However, such technologies are only as good as the data they are based on. They may replicate past biases and miss new developments. Criminal groups can also use AI tools to increase their own efficiency and better predict threats to their organisations and business models.

4.6.1. Empirical evidence

The literature on AI and corruption is scant, but previous research used data-mining techniques and neural networks to predict patterns in fields such as crime (Li and Juhola, 2014), credit risk evaluation (Swiderski et al., 2012), and fraud detection (Olszewski, 2014).

One notable application for predicting corruption was developed in Spain at the University of Valladolid as an early warning system based on a neural network approach creating self-organising maps (López-Iturriaga and Sanz, 2017). The researchers used media and court data of corruption cases from the various Spanish provinces between 2000 and 2012. Their findings indicate that corruption is stimulated by the taxation of real estate, economic growth, the increase in real estate prices, the growing number of deposit institutions and non-financial firms, and the same political party remaining in power for long periods. They argue that their computer model can calculate the probability of corruption in different provinces and the conditions that favour it, providing time frames to predict corruption up to three years in advance (López-Iturriaga and Sanz, 2017).

On a broader level, a recent study by Lima and Delen (2019a) employed contemporary machine-learning techniques to discover the most important predictors for Corruption Perception Indexes across 132 countries for the years of 2017 and 2018. Based on enriched/enhanced nonlinear models with a high level

of predictive accuracy, the Random Forest (an ensemble-type machine learning algorithm) is found to be the most accurate prediction/classification model, followed by Support Vector Machines and Artificial Neural Networks. The variable importance results indicated that government integrity, property rights, judicial effectiveness, and education index are the most influential factors in defining the corruption level of significance (Lima & Delen, 2019b). The advancement of such machine learning techniques to predict results with the highest possible accuracy and unearthing hidden patterns of data is likely have many future uses for anti-corruption authorities and other tech-savvy users in the fight against corruption. However, at the current state of development, and with the lack of broad-based scientific evidence, the impact of AI on corruption is difficult to assess. Future developments should be accompanied by rigorous assessment and build on existing evidence from other areas of application.

5. Conclusions and policy lessons

ICT has affected the work of all actors involved in or against corruption, including public institutions, civil society organisations, the private sector and the media. While many see great promise in this development, the effectiveness of ICT tools, as well as their drawbacks and potential misuse, vary widely with the type and extent of corruption. Depending on the degree of corrupt public officials' control over key government institutions, including law enforcement, ICT's anticorruption impacts can be weakened or reversed altogether. Hence, ICT can only be effective against corruption, especially grand corruption, when sufficiently conducive conditions are given. Some technologies may facilitate corruption in the hands of powerful corrupt actors, especially when they can capture the ICT reform itself.

While this review was able to draw on an acceptable quality and diverse literature in terms of methodology, data, and interpretations; the quality of evidence was found to be poor in some areas and tools. A number of ICT tools widely promoted by policy makers are acutely under-researched such as the role DLT or AI can play in the fight against corruption. A lot of the reviewed literature relies on small-scale case studies which are hard to generalize from even if they offer thorough accounts of impacts. Moreover, many of the large-scale quantitative studies apply standard regression analysis on the country level which are typically ill-equipped to uncover causal relationships rather than broad-based conditional correlations between independent and dependent variables. More advanced methods such as field experiments are unfortunately rare, even though ICT interventions are uniquely well suited for experimentation and targeted quantitative assessment. Following our systematic conceptual framework cataloguing ICT types and the mechanism impacting on corruption can serve as a guidance to link new studies to the existing body of literature.

Having taken stock of the available academic and policy literature, we identified a tacit optimism about the role of ICTs in the fight against corruption, that is most research considers them as a positive force, while largely neglecting potential corrupt capture of new tools or strategic responses corrupt actors to anticorruption interventions. Against this background, we aimed to shed light on the characteristics of six different ICT tools used both *against* as well as *for* corruption. E-government is broadly found to be a useful tool for strengthening downward transparency and change administrative processes, however, depending on the design, digital public services are often not effective and can even provide new corruption opportunities – therefore, their implementation needs to be embedded in broader administrative reforms. The evidence base for the impact of anti-corruption crowdsourcing platforms, usually run by civil society or anti-corruption institutions, on corruption is quite thin. However, selected case ev-

idence suggests that they can foster upward transparency and foster collective action when implemented well, including easy use, guarantee of anonymity, and follow-up action by the relevant anti-corruption institutions. Similarly, ICT-enabled whistleblowing tools provided by anti-corruption institutions have limited evidence to show that they can facilitate upward transparency leading to horizontal accountability. Again, the guarantee of anonymity and appropriate follow-up action is crucial to impact. In some cases, civil society-run whistleblowing tools have shown remarkable impact when coupled with detailed and well disseminated investigative journalism (see e.g. the Panama Papers' global impact). Concerning government or civil-society-run transparency portals fostering downward transparency, impactful examples are still relatively rare and the mismatch of supply and demand of data, a lack of resources, insufficient means of sanctions, and logistical challenges commonly appear to hinder effective implementation. The newly emerging DLT/blockchain technology is anticipated to have great potential for enhancing upward and downward transparency and accountability in the public sector as a means of direct and transparent exchange that circumvents potentially corrupt middlemen. However, it also raises concerns about data security and, for instance, enabling untraceable flows of money. Likewise, while the application of AI technologies carries great promise for the detection of corruption patterns by researchers and institutions tasked with the discovery of corruption and fraud, at the current state of development and with the lack of scientific evidence, the impact of AI on corruption and its potential is difficult to assess. Nevertheless, we can argue that AI is only able to exert any positive influence if it contributes to existing anticorruption efforts rather than being misused by the corrupt themselves.

While we find that in most areas, studies look at different tools, and corruption outcomes, using different methodologies. It is possible to directly compare some results and draw out commonalities across different technologies. ICT can support anti-corruption in a variety of ways: it can enable the promotion of transparency, accountability, while also facilitating advocacy and citizen participation. It has also proven to enable a closer interaction between governments and citizens – for example, by enhancing access to public information. ICT can genuinely impact public discretion and scrutiny by digitising and monitoring officials' activities and public services, and enabling corruption reporting. However, ICT can also facilitate corruption. Emerging technologies can provide new corruption opportunities related to the dark web, cryptocurrencies, or simply through the misuse of well-intended technologies such as digital public services. ICT can also contribute to the centralisation of corruption, for example when a corrupt group controls the central database holding all record for financial transactions in a country. These aspects underline the fact that ICT is not *per se* a panacea against corruption, and it can also play into the hands of corrupt officials. The availability of these tools does not automatically translate into impact, rather anti-corruption effects are mediated by the socio-economic context and the broader accountability framework.

Moreover, ICTs tend to be more effective against low-level or petty corruption, while their effects on grand corruption are often negligible due to corrupt elites blocking anti-corruption reform. By implication, successful ICT-enabled anti-corruption reforms need to clarify the impact mechanisms which underpin the expected anti-corruption impact; and they need to develop a specific definition of the targeted corrupt behaviour in its sectoral context (Pyman and Heywood, 2021).

5.1. Context-sensitive policy making

We find that, the success of ICT interventions against corruption hinges on their suitability for local contexts and needs, cultural

backgrounds and technology experience. These mediating factors can largely be grouped into 3 groups: the degree to which citizens have the incentives and skills to monitor the service and provide feedback; the extent to which the processes for the production and delivery of the service or activity are based on tasks that can be made routine and standardized; and the measurability and extent to which the outputs and outcomes from the task can be attributed to particular public actors or actions (World Bank, 2016).

First, a favourable public governance area to target with ICT should be characterised by a demand for information and motivation from citizens to use them, e.g. for public goods or services that they use frequently such as registration services or tax filing, thus they care about the activities in question. Else, transparency without users does not lead to accountability and improved public governance. In addition to having an incentive to monitor their governance, citizens also need to have the capacity and skills to interpret information provided; and the use of many ICT tools requires connectivity and a certain level of ICT proficiency which cannot be taken for granted in many countries (not included in the graph). In this context, the digital divide between different social groups is crucial (Bimber, 2000; Gillwald et al., 2010). For example, the proportion of women in Africa using the internet is 25% lower than the proportion of men (International Telecommunications Union, 2017).

Second, the application of ICT tools for improving public governance needs to carefully consider whether the tasks that will be affected (e.g. by becoming digitised or automated) are routine tasks that are more amenable to improvement through digital technology than exceptional or highly discretionary tasks, on which policy makers have less influence over the providers responsible. Such tasks are much more dependent on the quality of existing institutions and improvements through the application of ICT are only incremental.

Third, governance areas that are measurable and attributable to the efforts of specific government officials is likely much more amenable to improve with the use of ICT. When citizens can assess the service improvement and can attribute this improvement to actions by policy makers and providers. The quick, easily visible, and easily attributable service improvements to citizens can yield political benefits that even clientelist politicians might have an interest in supporting, though the political economy considerations vary by activity.

More generally, the variation in the nature of the governance areas amenable to ICT-enabled improvements to transparency, accountability, and integrity, calls for a careful consideration, yet it opens reform possibilities and can be a guide for policies in different country contexts.

Declaration of Competing Interest

None.

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References

Adam, I., Fazekas, M., Tóth, B., 2020. Measuring the Benefits of Open contracting: Case studies On Mexico, Paraguay, and Slovakia. Government Transparency Institute, Budapest GTI-WP/2020:01.

- Andersen, T.B., 2009. E-Government as an anti-corruption strategy. *Inf. Econ. Policy* 21 (3), 201–210.
- Ang, Y.Y., 2014. Authoritarian restraints on online activism revisited: why “I–Paid-A-Bribe” worked in India but failed in China. *Comp. Polit.* 47 (1), 21–40.
- Asimwe, E.N., Wairagala, W., Grönlund, Å., 2013. Using technology for enhancing transparency and accountability in low resource communities: experiences from Uganda. In: *ICT For Anti-Corruption, Democracy, and Education in East Africa*. Stockholm University, Stockholm, pp. 37–52.
- Asogwa, B.E., 2012. The challenge of managing electronic records in developing countries. *Rec. Manag. J.* 22 (3), 198–211.
- Bac, M., 2001. Corruption, connections and transparency: does a better screen imply a better scene? *Public Choice* 107 (1/2), 87–96.
- Bagozzi, B.E., Berliner, D., Almquist, Z.W., 2021. When does open government shut? Predicting government responses to citizen information requests. *Regul. Govern.* 15 (2), 280–297.
- Bardhan, P., 2006. The Economist’s Approach to the Problem of Corruption. *World Dev.* 2 (34), 341–348.
- Bauhr, M., Grimes, M., 2014. Indignation or resignation: the implications of transparency for societal accountability. *Governance* 27 (2), 291–320.
- Bauhr, M., Grimes, M., 2017. Transparency to curb corruption? Concepts, measures and empirical merit. *Crime Law Soc. Change* 68, 431–458.
- Bertot, J.C., Jaeger, P.T., Grimes, J.M., 2010. Using ICTs to create a culture of transparency: e-government and social media as openness and anti-corruption tools for societies. *Gov. Inf. Q.* 27 (3), 264–271.
- Bhattacharjee, A., Shrivastava, U., 2018. The effects of ICT use and ICT Laws on corruption: a general deterrence theory perspective. *Gov. Inf. Q.* 35 (4), 703–712.
- Bimber, B., 2000. Measuring the gender gap on the internet. *Soc. Sci. Q.* 81.
- Bosio, E., Djankov, S., Glaeser, E., Shleifer, A., 2020. Public Procurement in Law and Practice NBER Working Paper No. 27188.
- Bott, M., Young, G., 2012. The role of crowdsourcing for better governance in fragile state contexts. *Praxis* 27, 47–70.
- Brito, J., 2011. Hack, mash & peer: crowdsourcing government transparency. *SSRN Electron. J.* doi:10.2139/ssrn.1023485.
- Carril, R., 2021. *Rules Versus Discretion in Public Procurement* Barcelona GSE Working Paper Series: Working Paper no 1232.
- Castells, M., 2000. Materials for an exploratory theory of the network society. *Br. J. Sociol.* 51 (1), 5–24.
- Charoensukmongkol, P., Moqbel, M., 2014. Does investment in ICT curb or create more corruption? A cross-country analysis. *Public Organ. Rev.* 14 (1), 51–63.
- Chêne, M., 2012. Use of Mobile Phones to Detect and Deter Corruption Available at https://www.transparency.org/files/content/corruptionqas/280_Mobile_phones_to_detect_and_deter_corruption.pdf.
- Chêne, M., 2014. The Impact of Corruption On Growth And Inequality Available at https://knowledgehub.transparency.org/assets/uploads/helpdesk/Impact_of_corruption_on_growth_and_inequality_2014.pdf.
- Cheeseman, N., Peiffer, C., 2020. The Unintended Consequences of Anti-Corruption Messaging in Nigeria: Why Pessimists Are Always Disappointed. SOAS University of London, London SOAS ACE working paper 024.
- Correa, A.S., Souza, R.M.de, Silva, F.S.C.da, 2019. Towards an automated method to assess data portals in the deep web. *Gov. Inf. Q.* (November 2018) 1–15.
- Cuillier, D., Piotrowski, S.J., 2009. Internet information-seeking and its relation to support for access to government records. *Gov. Inf. Q.* 26 (3), 441–449.
- Davies, T., Fumega, S., 2014. Mixed Incentives: Adopting ICT Innovations for Transparency, Accountability, and Anti-Corruption. *Chr. Michelsen Institute U4 Issue* 2014 No. 4.
- Elbahnasawy, N.G., 2014. E-Government, Internet Adoption, and Corruption: an Empirical Investigation. *World Dev.* 57, 114–126.
- Fazekas, M., Cingolani, L., Tóth, B., 2018. Innovations in Objectively Measuring Corruption in Public Procurement. In: Helmut, K.A., Matthias, H., Mark, A.K. (Eds.), *Governance Indicators. Approaches, Progress, Promise*. Ch. 7. Oxford University Press, Oxford.
- Gandomi, A., Haider, M., 2015. Beyond the hype: big data concepts, methods, and analytics. *Int. J. Inf. Manag.* 35, 137–144.
- Gerardino, M.P., Litschig, S., Pomeranz, D.D., 2020. Distortion by Audit: Evidence from Public Procurement. Centre for Economic Policy Research Discussion Paper (12529-2).
- Gillwald, A., Milek, A., Stork, C., 2010. Towards Evidence-based ICT Policy and Regulation: Gender Assessment of ICT Access and Usage in Africa. Research ICT Africa Policy Paper 5 https://www.ictworks.org/sites/default/files/uploaded_pics/2009/Gender_Paper_Sept_2010.pdf.
- GISWatch, 2012. The Internet and Corruption: Transparency and Accountability Online APC and HIVOS: Global Information Society Watch report. Available at https://www.giswatch.org/sites/default/files/giswatch12_web.pdf.
- Grönlund, Å., Heacock, R., Sasaki, D., Hellström, J., Al-Saqaf, 2010. Increasing Transparency and Fighting Corruption Through ICT Empowering People and Communities SPIDER ICT4D Series no. 3 (2010). Available at <https://spider1.blogs.dsv.su.se/wp-content/blogs.dir/362/files/2016/11/Spider-ICT4D-series-3-Increasing-transparency-and-fighting-corruption-through-ICT.pdf>.
- Gupta, S., Davoodi, H., Alonso-Terme, R., 1998. Does corruption affect income inequality and poverty? *Econ. Gov.* 3, 23–45.
- Gurin, J., 2014. Open governments, open data: a new lever for transparency, citizen engagement, and economic growth. *SAIS Rev. Int. Aff.* 34 (1), 71–82.
- Heeks, R., 2003. *Most E-Government-For-Development Projects Fail How Can Risks be Reduced?* Igovernment Working Paper Series. University of Manchester, Manchester No. 14.

- Helbig, N., Ramón Gil-García, J., Ferro, E., 2009. Understanding the complexity of electronic government: implications from the digital divide literature. *Gov Inf Q* 26 (1), 89–97.
- Hellström, J., Bocast, B., 2013. Many “Likers” Do Not Constitute A Crowd: The Case Of Uganda’s Not In My Country. University of Stockholm, Stockholm Spider ICT4D Series No. 6.
- Huter, M., 2018. Compliance and Digitalisation: How technology Can Foster Transparency in African countries. Alliance for Integrity and Strategic Partnership Digital Africa, Berlin.
- I Paid A Bribe, 2020. I Paid a Bribe: Bribe-trends Accessed on the 20/2/2020 <http://ewww.ipaidabribe.com/reports/all#gsc.tab=0>.
- International Telecommunications Union, 2017. ICT Facts and Figures 2017. International Telecommunications Union, Geneva Available at <https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2017.pdf>.
- Jain, A.K., 2001. Corruption: a review. *J. Econ. Surv.* 15 (1), 71–121.
- Johnston, M., 1996. The search for definitions: the vitality of politics and the issue of corruption. *Int. Soc. Sci. J.* 48 (149), 321–335.
- Kelman, S., 2005. Unleashing Change: A study in Organizational Renewal in Government. Brookings Institution Press Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.473.3731>.
- Kim, K., Kang, T., 2017. Does Technology Against Corruption Always Lead to Benefit? The Potential Risks and Challenges of the Blockchain Technology Retrieved from <https://www.oecd.org/leangovbiz/Integrity-Forum-2017-Kim-Kangblockchain-technology.pdf>.
- Klitgaard, R.E., 1988. Controlling Corruption. University of California Press.
- Kossov, N., Dykes, V., 2018. Embracing Digitalisation: How to Use ICT to Strengthen Anti-Corruption Available at https://www.giz.de/en/downloads/giz2018-eng_ict-to-strengthen-Anti-Corruption.pdf.
- Kshetri, N., 2017. Will blockchain emerge as a tool to break the poverty chain in the global south? *Third World Q.* 38 (8), 1710–1732.
- Kuriyan, R., Bailur, S., Giger, B.-S., & Park, K.R. (2011). Technologies for transparency and accountability. Implications for ICT Policy and Implementation, 1–67.
- Lagunes, P., 2021. The Eye and the Whip. Corruption Control in the Americas. Oxford University Press, Oxford.
- Lämmerhirt, D., Rubinstein, M., Montiel, O., 2017. The State of Open Government Data in 2017. Open Knowledge International Available at <https://blog.okfn.org/files/2017/06/FinalreportTheStateofOpenGovernmentDatain2017.pdf>.
- Lewis-Faupel, S., Neggers, Y., Olken, B.A., Pande, R., 2016. Can electronic procurement improve infrastructure provision? Evidence from public works in India and Indonesia. *Am. Econ. J. Econ. Policy* 8 (3), 258–283.
- Li, X., Juhola, M., 2014. Country crime analysis using the self-organizing map, with special regard to demographic factors. *AI Soc.* 29 (1), 53–68.
- Lima, M.S.M., Delen, D., 2019a. Predicting and explaining corruption across countries: a machine learning approach. *Gov. Inf. Q.* 37 (1).
- Lindgren, I., Madsen, C.Ø., Hofmann, S., Melin, U., 2019. Close encounters of the digital kind: a research agenda for the digitalization of public services. *Gov. Inf. Q.* 36 (3), 427–436.
- López-Iturriaga, F.J., Sanz, I.P., 2017. Predicting public corruption with neural networks: an analysis of Spanish provinces. *Soc. Indic. Res.* 140, 975–998.
- Mackey, T.K., Cuomo, R.E., 2020. An interdisciplinary review of digital technologies to facilitate anti-corruption, transparency and accountability in medicines procurement. *Glob. Health Action* 13 (1).
- Marquette, H., Peiffer, C., 2018. Grappling with the “real politics” of systemic corruption: theoretical debates versus “real-world” functions. *Governance* 31, 499–514.
- Mauro, P., 1995. Corruption and growth. *Q. J. Econ.* 110 (3), 681–712.
- Mergel, I., Gong, Y., Bertot, J., 2018. Agile government: systematic literature review and future research. *Gov. Inf. Q.* 35, 291–298.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2009. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 6 (7), 1000097.
- Mistry, J.J., Jalal, A., 2012. An empirical analysis of the relationship between e-government and corruption. *Int. J. Digit. Account. Res.* 12, 145–176.
- Mungiu-Pippidi, A., 2006. Corruption: diagnosis and treatment. *J. Democr.* 17 (3), 86–99.
- Mungiu-Pippidi, A., 2011. Contextual Choices in Fighting Corruption: Lessons Learned. Norwegian Agency for Development Cooperation, Oslo.
- Mungiu-Pippidi, A., 2013. Controlling corruption through collective action. *J. Democr.* 24, 101–115.
- Nam, T., 2018. Examining the anti-corruption effect of e-government and the moderating effect of national culture: a cross-country study. *Gov. Inf. Q.* 35 (2), 273–282.
- Natarajan, H., Krause, S., Gradstein, H., 2017. Distributed Ledger Technology and Blockchain. World Bank, Washington DC FinTech Note, No. 1 Available at <https://openknowledge.worldbank.org/handle/10986/29053>.
- O’Donovan, J., Wagner, H.F., Zeume, S., 2019. The value of offshore secrets: evidence from the panama papers. *Rev. Financ. Stud.* 32 (11), 4117–4155.
- OECD, 2017. Anti-Corruption Reforms in Ukraine. Fourth Round of Monitoring of the Istanbul Anti-Corruption Action Plan. OECD, Paris.
- Olaszewski, D., 2014. Fraud detection using self-organizing map visualizing the user profiles. *Knowl. Based Syst.* 70, 324–334.
- Open Data Barometer, 2017. Global Report: Fourth Edition. World Wide Web Foundation Available at <https://opendatabarometer.org/doc/4thEdition/ODB-4thEdition-GlobalReport.pdf>.
- Pacific Council on International Policy, 2002. Roadmap For E-government in the Developing World: 10 Questions E-Government Leaders Should Ask Themselves. Pacific Council on International Policy, Los Angeles Available at https://www.itu.int/net/wsis/docs/background/themes/egov/pacific_council.pdf.
- Pathak, R.D., Singh, G., Belwal, R., Smith, R.F.I., 2007. E-governance and Corruption-developments and Issues in Ethiopia. *Publ. Organ. Rev.* 7 (3), 195–208.
- Pyman, M., Heywood, P., 2021. The Sector Focus & Reformulation Approach (SFRA). Curbing Corruption and Global Integrity, Washington DC Global Integrity-ACE Working Paper 5.
- ReSPA, 2013. Abuse of Information Technology (IT) For Corruption. Regional School of Public Administration, Danilovgrad Available at <https://www.respaweb.eu/download/doc/01+Abuse+of+IT+for+Corruption+ENG.pdf/3150c827ad9bae7b31ba4e04e69ad1af.pdf>.
- Salbu, S.R., 2001. Information technology in the war against international bribery and corruption: the next frontier of institutional reform. *Harvard J. Legis.* 38 (1), 67–101.
- Sassi, S., Ben Ali, M.S., 2017. Corruption in Africa: what role does ICT diffusion play. *Telecommun. Policy* 41 (7–8), 662–669.
- Schuppan, T., 2009. E-Government in developing countries: experiences from sub-Saharan Africa. *Gov. Inf. Q.* 26 (1), 118–127.
- Sharma, A., 2010. Crowdsourcing Critical Success Factor Model. London School of Economics, London Available at <https://irevolution.files.wordpress.com/2010/05/working-paper1.pdf>.
- Shim, D.C., Eom, T.H., 2008. E-government and anti-corruption: empirical analysis of international data. *Int. J. Public Adm.* 31 (3), 298–316.
- Shirky, C., 2011. The political power of social media: technology, the public sphere, and political change. *Foreign Aff.* 90 (1), 28–41.
- Soper, D., 2007. ICT Investment Impacts on Future Levels of Democracy, Corruption, and E-Government: acceptance in Emerging Countries Recommended. Arizona State University: AMCIS 2007 Proceedings, p. 227.
- Srimarga, I.C., 2010. Open Data Initiative of Ministry of Finance on National Budget Transparency in Indonesia Available at <http://webfoundation.org/docs/2017/09/Ind-Open-Data-Initiative-of-Ministry-of-Finance-on-National-Budget-Transparency-in-Indonesia.pdf>.
- Subhajoyti, R., 2012. Reinforcing accountability in public services: an ICT enabled framework. *Transform. Govern. People Process Policy* 6 (2), 135–148.
- Suleiman, M.M., 2017. A Review of Improving Good Governance through ICT Revitalization. Rano Kano State Polytechnic University, Kano.
- Swiderski, B., Kurek, J., Osowski, S., 2012. Multistage classification by using logistic regression and neural networks for assessment of financial condition of company. *Decis. Support Syst.* 52 (2), 539–547.
- Torero, M., Straub, S., von Braun, J., 2006. Information and communication technologies for development and poverty reduction: the potential of telecommunications. *Econ. Dev. Cult. Change* (56) 724–727.
- UN Department of Economic and Social Affairs, 2014. United Nations E-Government Survey 2014: E-Government For The Future We Want. United Nations, New York.
- United Nations Office on Drugs and Crime, 2016. Grand Corruption Definition with Explanation Available at https://www.unodc.org/documents/NGO/Grand_Corruption_definition_with_explanation_19_August_2016_002_1.pdf.
- Walport, M., 2015. Distributed Ledger Technology: Beyond Block Chain UK Government Chief Scientific Adviser report Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/492972/gs-16-1-distributed-ledger-technology.pdf.
- Wickberg, S. (2013). Technological innovations to identify and reduce corruption. Available at: https://www.transparency.org/files/content/corruptionqas/376_technological_innovations_to_identify_and_reduce_corruption.pdf
- World Bank, 2014. Report on the Session Digital Records Management: Good Practices For Anti-Corruption Authorities 3rd Biennial Meeting of the World Bank’s International Corruption Hunters’ Alliance. World Bank, Washington, DC.
- World Bank, 2016. World Development Report 2016: Digital Dividends. World Bank, Washington DC.
- Zipparo, L., 2001. Factors which deter public officials from reporting corruption. *Crime Law Soc. Change* (30) 273–287.