Received 30 September 2019
Revised 10 March 2020
5 May 2020
15 July 2020
Accepted 4 September 2020

The use of public sector data analytics in the Netherlands

Anne Fleur van Veenstra
Department of Strategy and Policy, Netherlands Organisation for Applied Scientific Research TNO, The Hague, The Netherlands

Francisca Grommé
Erasmus School of Social and Behavioral Sciences, Erasmus University Rotterdam, Rotterdam, The Netherlands, and

Somayeh Djafari
Department of eLaw, Faculty of Law, Leiden University, Leiden, The Netherlands

Abstract

Purpose – Public sector data analytics concerns the process of retrieving data, data analysis, publication of the results as well as re-using the data by government organizations to improve their operations and enhance public policy. This paper aims to explore the use of public sector data analytics in the Netherlands and the opportunities and challenges of this use.

Design/methodology/approach – This paper finds 74 applications of public sector data analytics, identified by a Web search and consultation with policymakers. The applications are categorized by application type, organization(s) involved and application domain, and illustrative examples are used to elaborate opportunities and challenges.

Findings – Public sector data analytics is most frequently used for inspection and enforcement of social services and for criminal investigation. Even though its usage is often experimental, it raises concerns for scope creep, repeated targeting of the same (group of) individuals, personal data use by third parties and the transparency of governmental processes.

Research limitations/implications – Drawing on desk research, it was not always possible to identify which type of data or which technology was used in the applications that were found. Furthermore, the case studies are illustrative rather than providing an in-depth overview of opportunities and challenges of the use of data analytics in government.

Originality/value – Most studies either perform a literature overview or present a single case study; this paper presents a more comprehensive overview of how a public sector uses data analytics.

Keywords Data analytics, Big data, Open data, Artificial intelligence, Evidence-based policy-making, Data-driven policy-making

Paper type Research paper

This paper is based on the study "*Quickscan AI in de publieke dienstverlening*," which was commissioned by the Ministry of the Interior and Kingdom Relations of the Netherlands.

Transforming Government: People, Process and Policy
Vol. 15 No. 4, 2021
pp. 396-419
Emerald Publishing Limited
1750-6166
DOI 10.1108/TG-09-2019-0095

1. Introduction

Following developments in the private sector, governments around the world use data analytics to capture the value of data and improve their way of working (Kim *et al.*, 2014). Public sector data analytics concerns the data retrieval process, analysis of data, publishing the results as well as re-using the data to address societal challenges (Klievink *et al.*, 2017; Lnenicka and Komarkova, 2019; Ooijen *et al.*, 2019). It is driven by the increased availability of open and big data and data processing techniques (Janssen and Kuk, 2016; Van Veenstra and Kotterink, 2017). Furthermore, attention to data-driven methodologies is growing as governments aim to improve the effectiveness of their policies by making them more evidence-based (Höchtl *et al.*, 2016; Giest, 2017; Poel *et al.*, 2018). The use of public sector data analytics, however, has also led to concerns for the privacy of individuals and the transparency of government operations and decisions (Janssen and van den Hoven, 2015).

Studies of public sector data analytics in the literature on digital government often focus on data availability for public or economic value (Susha *et al.*, 2015; Millard, 2018). Actual usage has, so far, attracted much less attention and empirical evidence on which value is created or which concerns prove to be grounded is fragmented (Jagadish, 2015; Janssen and Kuk, 2016). Not surprisingly, few comprehensive empirical studies of data analytics in the public sector have been carried out; instead, research often presents a literature overview (cf. Mehr, 2017; Wirtz *et al.*, 2019; Lnenicka and Komarkova, 2019) or individual case studies (cf. Zheng *et al.*, 2018; Androutsopoulou *et al.*, 2019; Sun and Medaglia, 2019). Therefore, we aim to contribute to closing this gap in the literature by investigating usage in the Netherlands based on a large number of applications. By analyzing current use of public sector data analytics including opportunities and challenges, we substantiate the relevance of these opportunities and challenges. A study of the Netherlands, a digital frontrunner within Europe (cf. its third ranking in the Digital Economy and Society Index [1]), is expected to yield state-of-the-art insights.

Although the public sector has used data analytics for decades, we aim to investigate current developments and, therefore, focus on current usage and usage that ended in 2015 or later (also see the method section regarding selection and identification). Based on a Web search, we identify and analyze 74 applications in the public sector (see Appendix). We then further elaborate on the main findings using illustrative examples from Dutch practice. Before presenting these data, the next section provides a review of previous literature on the topic. We end the paper with a discussion, followed by conclusions and recommendations for further research.

2. Public sector data analytics

To investigate the use of public sector data analytics, we first look at its drivers, followed by an overview of different types of use, and opportunities and challenges. The use of public sector data analytics is driven on the one hand by technological developments, such as the increased availability of data for re-use and the advance of data processing technologies. Data availability is increased by the publication and re-use of governmental data as open data (Janssen *et al.*, 2012) and by the combination of a variety of data sets from different organizations (including the private sector) as big data (McAfee and Brynjolfsson, 2012; Manyika *et al.*, 2011). Data processing technologies includes artificial intelligence (AI), which refers to systems that solve problems, take decisions or carry out tasks that require intelligence (Russell and Norvig, 2010) enable government organizations to capture the value of the available data. On the other hand, public sector data analytics is driven by government organizations aiming to address societal issues and inform the different steps of policy-making by making it more evidence-based (Höchtl *et al.*, 2016; Giest, 2017).

Following these two drivers also makes it possible to discern different types of use. Several studies identified (technical) applications of data analytics (Mehr, 2017; Chui *et al.*, 2018; Wirtz *et al.*, 2019). Mehr (2017), for example, categorizes the types of (technical) government problems appropriate for the use of AI, which include resource allocation, large data sets, a shortage of expertise, predictable scenarios and procedural and diverse data. Based on an analysis of advanced usage in different industries, Chui *et al.* (2018) find three main categories to improve performance: predictive maintenance, logistics optimization and personalization. And a list of ten potential technical applications of analytics in the public sector is provided by Wirtz *et al.* (2019), ranging from process automation to speech analytics. These types of usage focus on technical possibilities, but do not link to specific roles of government organizations.

Others have identified types of usage that aim to improve policy-making (Santiso and Roseth, 2018; Poel *et al.*, 2018; Ooijen *et al.*, 2019). Santiso and Roseth (2018) and Ooijen *et al.* (2019) distinguish four types of analytics – descriptive, diagnostic, predictive and prescriptive – for different steps of policy-making. Poel *et al.* (2018) also distinguish different phases of policy-making, including foresight and agenda setting, monitoring and interim evaluation, problem analysis, identification and design of policy options, policy implementation and ex post evaluation and impact assessment. Furthermore, other types of usage are found by looking at individual illustrations of its use in public service delivery (Zheng *et al.*, 2018; Androutsopoulou *et al.*, 2019). Few of these studies have focused on actual usage, and none have looked at which types of governmental organizations use data analytics, in which domain, and which societal challenges are addressed [with the exception of Poel *et al.* (2018) that listed different policy areas].

Opportunities that are associated with the use of public sector data analytics are making governments' operations more efficient and effective (Janssen and Kuk, 2016; Klievink *et al.*, 2017) and increasing transparency, which is linked to openness and accountability of governmental processes (Meijer, 2009; Matheus and Janssen, 2015). Furthermore, opportunities for the use of data analytics for policy making are anticipatory governance, design and delivery and performance management (Ooijen *et al.*, 2019). There are, however, also challenges associated with the use of public sector data analytics.

Technical challenges are ensuring data quality and security (Bertot and Choi, 2013; Janssen *et al.*, 2012). Also the re-use of data requires the presence of a data infrastructure ensuring interoperability (Lnenicka and Komarkova, 2019; Ooijen *et al.*, 2019), and attention should be given to linking data semantically (Bizer, 2009), to allow for findability and re-use. Besides linking data technically, many studies have found that merely publishing data is insufficient to enable and stimulate re-use and, therefore, call for supporting collaborations with relevant stakeholders (Susha *et al.*, 2017; Styrin *et al.*, 2017) as well as for co-creation with citizens (Ferro *et al.*, 2013; Charalabidis *et al.*, 2014; van Veenstra and Kotterink, 2017).

Challenges associated with the use of data analytics for policy-making are the public sector's limited organizational readiness (Klievink *et al.*, 2017), including governments' hesitance to rely on new or emerging data sources (Poel *et al.*, 2018), decision-makers' unwillingness to be informed by data science (van der Voort *et al.*, 2019) and negative consequences for operational employees (Barocas and Selbst, 2016). Furthermore, research shows that the expectation of many government organizations to become transparent as a result of using data analytics too is often high (Bannister and Connolly, 2012). The emergence of bias as a result of the use of algorithms is also considered a major challenge (Janssen and Kuk, 2016). Bias among others originates in the training data used for developing and refining algorithms, and can eventually affect decision-making (Hacker, 2018). Finally, legal concerns include privacy and accountability of governmental decision-

making, for instance, when the application of a technology changes scope ("scope creep") and ceases to be proportional (Janssen and van den Hoven, 2015; Lourenço *et al.*, 2015; Zoonen, 2016, 2019; Agarwal, 2018).

This literature review makes clear that public sector data analytics is driven by the application of innovations that have the potential to improve policy-making and address societal challenges, but many technical as well as organizational and legal challenges exist and it is not yet clear how these opportunities and challenges are related to actual usage.

3. Method

The investigation of public sector data analytics in the Netherlands took place between November 2018 and March 2019. For the identification of applications of public sector data analytics, a structured Web search resulted in 74 examples, in which we included different government levels (municipal, provincial and national) as well as public and semi-public agencies. The Web search covered (academic) search engines and key government databases [2]; these were searched using the terms "AI," "AI AND government," "Data AND government" and "Algorithm AND government." Google, Google Scholar and PiCarta (the national library catalogue) were used for orientation and complementary information. Another source for orientation was LexisNexis, a research database covering a large range of print media in the Netherlands. For up-to-date information on public usage, we relied on the following government and semi-government databases: *Overheid.nl* (the main portal for government information) and the Pilot Starter database, which lists pilot projects conducted by municipalities. *Overheid.nl* is a central access point to all government information. We therefore searched this database for additional terms in full-text: "*kunstmatige intelligentie*" (AI), "experiment" and "pilot."

Using this combination of sources, several characteristics were captured and verified for each application, including application type, organization type, status (implemented or experimental) and domain of usage. These characteristics were chosen because they capture the nature and aims of usage (application type) or because they have not yet been structurally investigated (type of organization and domain of usage). The categorization of applications was performed by two researchers independently; when differences between the categorizations occurred, a discussion followed based on which a decision was made. The Web search results were reviewed by a panel of policymakers from different levels of government. This panel was formed by two representatives from the Ministry of the Interior, two from the Association of Dutch Municipalities and six from different municipalities (all involved in using data analytics). The review took place as a session during a workshop and was facilitated by one author of this paper, while another author took notes. The purpose of the session was to validate whether the applications represent types of use in the Netherlands. This panel also provided information on the current status of some applications and provided internal policy documents that helped to specify the types of data and analytics that were used (the latter details are often difficult to verify through a Web search).

Finally, we acknowledge that the resulting overview cannot provide a comprehensive record of all instances of public sector data analytics. First, we needed to balance the identification of applications with collecting and verifying the characteristics of each project. Furthermore, not all applications are made public online and we expect our search terms to miss a number of initiatives. In addition, public sector data analytics is a dynamic field which limits the extent to which any list can capture all usage. Not knowing which applications we have missed, it is not possible to determine how representative this list is. Nevertheless, the chosen government databases and additional sources do provide a basis

for identifying key types of usage and characteristics. We use illustrative examples (based on information from public documents, such as policy documents and newspaper articles) to elaborate on the main findings on these types of usage and characteristics (see Section 5).

4. Analysis of the applications

Based on the list of 74 applications, three analyses were undertaken: a categorization of the examples by application type and status; by type of organization and application type; and by application domain and type.

4.1 Types of applications

To the best of our knowledge, there is no established categorization of public sector data analytics that captures types of use. Our literature review found technological and policy-making oriented categorizations, but none focusing on of usage. Therefore, we categorized the 74 applications into 6 types of usage, inspired by the literature overview and refined based on the applications found online:

(1) *Personalization*: the tailoring of public service delivery to individual needs.
(2) *Resource allocation*: optimizing logistics for efficient use of resources.
(3) *Maintenance*: identifying potential risks to schedule repairs.
(4) *Inspection and enforcement*: predicting (behavioral) patterns to prevent misuse of public spending.
(5) *Crime investigation*: pattern recognition and prediction such as fraud.
(6) *Forecasting*: predicting macro-economic trends and variables.

These types of usage are a mix of operational issues that government organizations may wish to address in different phases of the policy-making process (problem definition, execution and monitoring) as well as for other roles government organizations (operations and service delivery) have. We found experimental applications, meaning that they are not yet part of the standard operational activities of government, as well as implemented practices that are fully operational and part of the standard activities of government organizations.

Regarding the categorization shown in Figure 1, the category with the largest number of data analytics applications in our list of examples is "inspection and enforcement" (20 out of

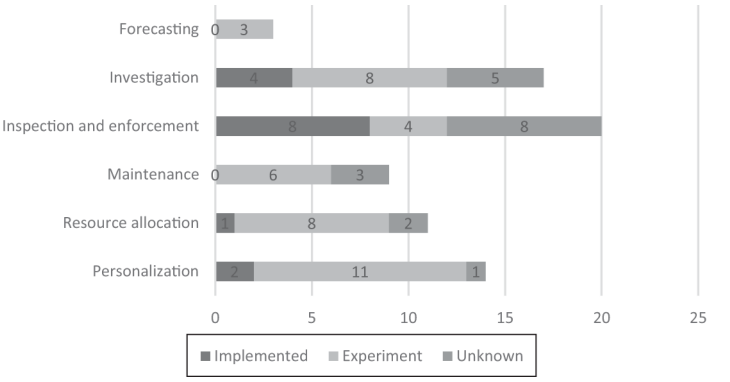

Figure 1.
The application domains per type of application

74). This category also includes the largest group of implemented applications (8 out of 20). A total of 17 out of 74 are categorized as "investigation"; 4 out of these 17 were found to be implemented. A total of 11 out of 74 applications fit the category of "resource allocation" and 9 applications are categorized as "maintenance." For the latter two categories, only one implemented application was found (for "resource allocation").

Of the 74 applications, 14 are categorized as "personalization"; 2 out of these 14 were implemented. Finally, the category for which we found the lowest number of applications is "forecasting" (3 out of 74); all 3 are experiments. Although the number of applications for each category can be an effect of the search strategy and availability, the findings are indicative of the important role of experimentation in all categories. It also suggests that inspection and enforcement, investigation and maintenance and resource allocation are active fields for experimentation and implementation.

4.2 Types of government organizations

The types of government organizations (municipality, central government, province or water board [regional], collaboration, executive or semi-public organization or other) involved in the use of data analytics are presented in Figure 2.

Of the 74 applications, 18 we found are collaborations between different levels of government or between public and semi-public or non-governmental organizations, such as companies and non-governmental organizations. Another 16 applications are collaborations between municipalities or regional governments and are categorized as municipal or regional. Apart from forecasting, we found a few (2–5 out of 18) applications for every application type within the identified collaborations, indicating collaborations are formed for various types of applications.

We found municipalities and executive and semi-public organizations to each be involved in 24 of the 74 applications, while 5 applications were found for "other," 2 applications for the national and 1 for the regional level. Although national and regional governments are also represented in several collaborations and the exact proportions may not reflect all current activity, these findings do suggest the active role of municipalities in public sector data analytics in the Netherlands.

The applications we found on the municipal level most often concern "inspection and enforcement" (8 out of 25), "personalization" (5 out of 25) and "investigation" and "resource allocation" (both 4 out of 25), while we found fewer applications for "maintenance" and

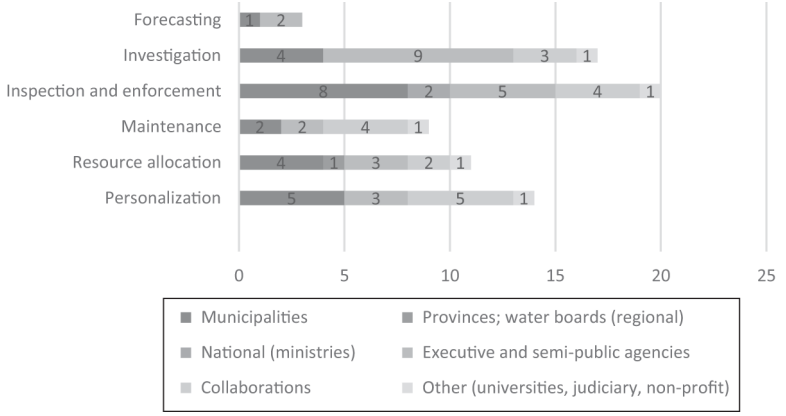

Figure 2.
Types of government organizations per type of application

"forecasting." Within the group of applications of executive and semi-public organizations, 9 out of the 24 applications are categorized as "investigation" and 5 out of the 24 as "inspection and enforcement." Only two or three applications were found for the other categories. The latter cover all types except for forecasting, for which no applications were found.

4.3 Application domain

To investigate which sectors use data analytics, finally, we focus on their application domain (Figure 3).

Most applications were found in the physical environment, which includes the public sphere, water management, mobility and infrastructure (22 out of 74). In this domain, all types of applications of data analytics were found. Most applications were found in the categories "maintenance" (7 out of 22), "personalization" (5 out of 22) and "resource allocation" (5 out of 22). In the physical domain, usage can thus be considered to comprise all application types.

Two other domains in which many applications were found are safety and security (20 out of 74) and social services (17 out of 74). Within the safety and security domain, the applications we found are overwhelmingly categorized as "investigation" (15 out of 20); in the social domain, a majority of applications concerned "inspection and enforcement" (10 out of 17). Compared to the physical domain, data analytics usage in these domains is more focused.

For the other domains (data infrastructure and finance, which includes applications linked to the governmental data infrastructure and finance, economy, labor market and education; and other, comprising applications from the legal domain and in education), few applications were found and with various application types. Therefore, no uniform conclusions can be drawn for these domains.

5. Key findings, opportunities and challenges of data analytics

In this section, we discuss four main findings based on the overview in Section 4. Our aim is to relate these findings to opportunities and challenges of public sector data analytics. The opportunities and challenges discussed in the context of each finding serve to indicate that research focused on gaining an overview of the field can also contribute to insights into how opportunities and challenges of data analytics emerge. These brief discussions are not

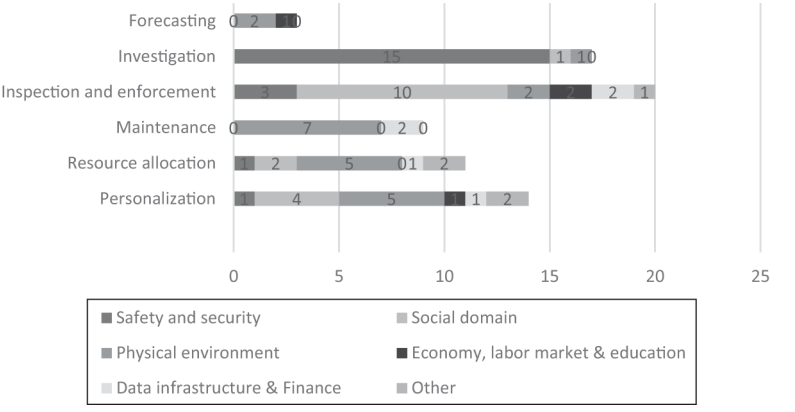

Figure 3.
The types of application and their implementation

meant to be comprehensive, instead, we highlight one or two opportunities and challenges in relation to each finding on the basis of prominent themes in the literature (Section 2). As noted in the literature review, among the opportunities are increasing efficiency, effectiveness and transparency. Transparency also is a relevant challenge related to data analytics, as are legal concerns (privacy and accountability), bias and organizational readiness.

A disadvantage of an overview study is that it does not support a more detailed understanding of types of projects that have been executed and how they develop in practice. This section therefore also presents illustrative examples of applications from the list of 74, drawing on publicly available documents. Without claiming to be generalizable, these examples (sensors in municipal waste containers; data mining for social welfare fraud; a chatbot; and data mining for crime investigation) were chosen because they represent typical uses of data analytics in the Dutch public sector, and we therefore expect them to be informative for our understanding of future developments.

5.1 Many applications are used for operational purposes

Many applications found are for operational usage, such as resource allocation and inspection and enforcement. Forecasting was the least common usage we found. The opportunity of using data analytics for everyday operations of public services is exemplified by the placement of sensors in household waste containers by the municipality of Rotterdam to improve resource allocation and maintenance (Gemeente Rotterdam, 2020). A total of 6,500 sensors were used to compute the most efficient collection route, thereby not only attempting to increase the quality of services but also to decrease CO_2 emissions. Furthermore, the sensors also keep track of container defects. After a pilot in 2017, the system has been scaled to the city level in 2018 (Gemeente Rotterdam, 2017).

A challenge characteristic for this type of usage is the collection of data about mundane aspects of citizens' lives by third parties that carry out activities for public service delivery. This is exemplified by the Rotterdam waste service, which relies on third parties for data collection and processing. For other operational services, some critics have noted that third party involvement is not only a privacy challenge but can also affect the transparency and accountability of public services as it can be difficult for citizens to find and address the third parties involved (Van Teeffelen and Naafs, 2017).

5.2 Most often identified applications concern "inspection and enforcement"

Inspection and enforcement is the most common usage category among the identified applications. Furthermore, half of these applications were found in the social domain. The use of data analytics is, thus, often seen as an opportunity to efficiently prevent misuse of government funds and decrease social service fraud. *Systeem Risico Indicatie* (SyRI) or "risk indication system" is an example of the promise of data analytics to this end. Discontinued in 2020, SyRI was a data mining application combining a variety of data types, such as data on taxes, properties, education, pension, debt, benefits and health insurance to search for anomalies and create risk profiles (Olsthoorn, 2016). The system was used from 2014 by varying constellations of government organizations, including municipalities, the Inland Revenue and the Inspection of the Ministry for Social Affairs.

An important concern relating to inspection and enforcement is its reliance on the analysis of large amounts of sensitive data. A risk is that such data can be collected and analyzed for large groups of people without specific grounds for suspicion. This risk is

related to a starting point of many data mining methods: a more open-ended analysis of large amounts of data to find previously unknown behavioral patterns (Olsthoorn, 2016). In the case of SyRI, civil rights advocates started a lawsuit against the state because of such practices, which they referred to as "fishing expeditions" (Platform Bescherming Burgerrechten, 2018). In February 2020, court agreed that such data usage is not proportional and ruled that SyRI was in breach of Article 8 of the EU Charter of Human Rights (the right to privacy). On top of this, court ruled that the SyRI program lacked transparency and accountability, as it did not provide access to the algorithm that generated risk profiles.

A second concern relevant to highlight regarding inspection and enforcement is that data analytics practices may display a bias toward vulnerable groups. This also characterizes the social domain, as governments often collect more data about these groups (Barocas and Selbst, 2016; Janssen and Kuk, 2016). SyRI, for instance, predominantly targeted people in low-income neighborhoods (about whom more data are available).

5.3 Many applications concern experimental usage

Over half of the applications found are pilots or experiments (even though for many applications, the implementation status could not be confirmed). Experimentation provides degrees of freedom needed to apply and develop a technology and explore its capacities. For instance, a chatbot piloted by the national service center for entrepreneurs (*Rijksdienst voor Ondernemend Nederland*, [RVO]) was used as a search engine for its website using natural language processing. The aim of this 2017 experiment was to facilitate entrepreneur compliance with complex legislation regarding agricultural manure policies (relevant to nitrogen emissions). The chatbot prototype was further developed and integrated into Facebook Messenger to redirect questions away from the call center (RVO, 2017).

While personalization offers opportunities to improve service delivery toward citizens, to tailor (often complex) government information to users and to cut costs on service delivery, a key challenge is to ensure accessibility because it involves direct interaction between information technology systems and citizens. The RVO chatbot is a good illustration of the problems that can emerge when this is not successful. During the development of the first version of the system, the RVO testers commented that the chatbot came across as "robotic," thereby lacking human nuance (RVO, 2018). Furthermore, call center employees were not able to ensure accessible service delivery at first because they could not assume control of the system.

Another opportunity of experimentation is to enroll stakeholders without demanding long-term commitment. FinPro is an example of criminal investigation that took advantage of the experimental format's flexibility. The name refers to a collaboration established for data experiments by platform organization MeetingMoreMinds in 2011, which included, among others, the Rotterdam police, the Chambers of Commerce, health insurance companies, travel organizations and bus companies (the collaboration has not formally been disbanded, although most activities were conducted before 2017). The main purpose was to identify behavioral patterns on an aggregated level. The experimental format allowed for trialing the *ad hoc* involvement of experts from different domains to analyze data and interpret findings; a feature that initially led to new insights (Roobeek, 2016). However, the use of experimental data analytics may entail transparency issues as not all pilots are well documented and made available to public scrutiny.

5.4 Many data analytics projects are executed by multi-stakeholder collaborations

Nearly half of the identified applications concern collaborations: between the same type of organizations, between different levels of government or between public and semi-public or non-governmental organizations. Collaborations allow for combining data sets to identify new patterns or anomalies in the data, and for attracting financial and technical resources, as illustrated by FinPro (Roobeek, 2016). Yet, a challenge of collaboration is "scope creep": when the application of a technology broadens its scope beyond its original intensions. This also means that legal concerns arise that were not identified in advance. For instance, the FinPro collaborators learned along the way that the outcomes of data analysis can often not be submitted as legal evidence (Jessayan and De Lange, 2016).

To return to the example of SyRI discussed above, enlarging the number of involved stakeholders entailed multiplying the number of interests and aims invested in the project. In SyRI, the scope was broadened over the years from welfare fraud to include other social issues such as harassment and nuisance (Raad van State, 2014). Scope creep thus raises legal concerns as the purpose of data collection and analysis may not be proportionate to the infringement of personal sphere.

To conclude, we elaborated on four main findings to indicate that research focused on improving our overview of the field can also contribute to insights to how opportunities and challenges of data analytics emerge; and support more detailed insights into types of projects that have been executed and how they develop in practice. We further discuss our findings in the next section.

6. Discussion

Our four main findings both corroborate and contribute to current research on public sector data analytics. First, we found that many applications aim for efficiency and effectiveness of government operations rather than for increasing transparency or facilitating evidence-based policy-making. This corroborates findings from Giest (2017) and Poel *et al.* (2018) that the use of data analytics for policy is still in its early days. Furthermore, third parties' data analytics activities in operational processes of the public sector lead to concerns of third party access to data about everyday citizen behavior and of transparency and accountability of these processes. These concerns have been amply addressed in the literature about smart cities (Zoonen, 2016) but are equally relevant to research on digital government.

Second, a frequent use type among the applications we identified is inspection and enforcement for social services (often used by municipalities). This implies that, within operational applications, data analytics is often used for investigation or enforcement of legislation. This makes the societal, ethical and legal concerns connected to this use type key in studies of public sector data analytics [see, for example, Janssen and van den Hoven (2015)]. Next to proportionality and invasiveness, the repeated targeting of (groups of) individuals based on their socio-economic class (or that of their neighborhood) also emerged as a concern. We know from the wider literature on the risk of bias in big data usage that when targeted more often, citizens are also at greater risk of becoming "anomalies in the data" and objects of further investigation (Barocas and Selbst, 2016), with an associated risk of stigmatization.

Third, as more than half of the identified applications are experiments, this implies that, as suggested by the literature, many applications of data analytics face difficulties moving beyond the experimentation phase because of technical and legal challenges [see, for instance, van Veenstra and Kotterink (2017)]. Similarly, personalization and tailoring of services still seem to be under development, implying that data analytics are neither easily

deployed effectively for this purpose nor lead to more accessibility in the experience of citizens. As emphasized in the literature (Klievink *et al.*, 2017), to gain from the opportunities that these technologies may offer, attention also needs to be given to organizational readiness and change.

As well as experimental, many projects are collaborative, which is our fourth finding. From two of our illustrative examples, we furthermore learn that these collaborations can involve changing stakeholder constellations. Operating in a multi-actor context, as is the case for many data analytics initiatives in the Netherlands, is an additional challenge for guarding the scope of projects. Furthermore, this coincides with an observation regarding the applications we identified: we find that much attention is given to data sharing among different stakeholders rather than to using more advanced processing technologies such as AI (Sun and Medaglia, 2019); applications of collaborative data analytics often combine data sets and search for behavioral patterns or anomalies.

While this study was one of a very few providing an overview of public sector data analytics based on a larger number of cases, a main limitation is its reliance on desk research. Therefore, it was often not possible to present details such as the type of analytics that was used. Consequently, it is impossible to draw conclusions based on this study about which specific technologies are used by government. A first avenue for further research, therefore, is to examine which technologies are used. A second avenue is examining the opportunities and challenges of public sector data analytics more structurally and in-depth, capturing also the views of those involved.

7. Conclusion

This study explores the use of public sector data analytics in the Netherlands and aims to contextualize opportunities and challenges identified in previous research. Based on a Web search, we find that many identified applications are used for operational processes, and are often deployed in processes of inspection and enforcement for social services. Furthermore, many applications are pilots or experiments rather than routine usage and they concern collaborations between different stakeholders. We thus find that advance data processing is still in its early stages. At the same time, the illustrative examples raise several concerns including third-party access to personal data, repeated targeting of the same (groups of) individuals, limitations to accessibility and transparency and scope creep, especially in multi-actor settings. This implies that the use of public sector data analytics requires developing organizational capabilities to ensure effective use, foster collaboration and scale up, as well as legal and ethical capabilities to carefully balance these concerns with their objectives, such as increased operational efficiency or effectiveness. As a major limitation of this study is its reliance on desk research, further research should perform more in-depth research structurally capturing the opportunities and challenges of the use of the application types of public sector data analytics.

Notes

1. The Digital Economy and Society Index is a composite index with digital public services as one of the components. For more information, see: https://ec.europa.eu/digital-single-market/en/desi
2. The source URLs are: google.com; scholar.google.com; picarta.nl; lexisnexis.nl; overheid.nl; and depilotstarter.vng.nl.

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Appendix

Table A1.
Applications of public sector data analytics in The Netherlands

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
SyRI	UWV, SVB, Inspectie SZW, Belastingdienst and municipalities	Social services	Inspection and enforcement	Implemented	https://wetten.overheid.nl/BWBR0013060/2019-01-01
Criminaliteits Anticipatie Systeem (CAS)	Politie	Safety/security	Investigation	Unknown	www.politie.nl/nieuws/2017/mei/15/05-cas.html
Infobox crimineel en onverklaarbaar vermogen (iCOV)	Openbaar Ministerie, Politie, Belastingdienst, FIOD and Financial Intelligence Unit, Inspectie SZW, Inlichtingen- en Opsporingsdienst van de Inspectie voor de Leefomgeving en Transport (ILT-IOD), Inlichtingen- en Opsporingsdienst van de Nederlandse Voedsel- en Warenautoriteit (NVWA-IOD), Commissariaat voor de Media	Safety/security	Investigation	Implemented	Stcrt. 2015, nr. 7509 and https://hetccv.nl/onderwerpen/veilige-vakantieparken/overzicht-maatregelen/analyse-icov/; www.securitymanagement.nl/big-data-fraude/?vakmedianet-approve-cookies=1&_ga=2.167311545.627848040.1548922282-359266002.1548922282
iRN_iColumbo	Politie	Safety/security	Investigation	Unknown	TK 2013–2014, 26 643, nr. 298, p. 16
Business Intelligence and Analytics (BI&A)	Belastingdienst	Government finances	Inspection and enforcement	Implemented	https://decorrespondent.nl/1766/Vergeet-de-politiestaat-Welkom-in-de-belastingstaat/90525160-5a2c27c2
Verwijzingsindex Recherche Onderzoeken en Subjecten (VROS-bestand)	Financial Intelligence Unit Nederland (FIU-Nederland)	Safety/security	Investigation	Implemented	https://wetten.overheid.nl/BWBR0041193/2018-07-25
Parkeersensoren voor een dynamisch verkeers-verwijssysteem	Municipality of Zoetermeer	Physical environment (mobility)	Resource allocation	Experiment	https://depilotstarter.vng.nl/projecten/omgevingswet/parkeersensoren-voor-een-dynamisch-verkeersverwijssysteem

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
Waterproef/ waterproof	Municipalities in Friesland, Groningen, Drenthe, SVB, Belastingdienst	Social services	Inspection and enforcement	Unknown	www.hoogeveen.nl/bis/dsresource?objectid=d3525063-c977-4300-b159-d114a3810a04
Project Regionale Coördinatiepunten Fraudebestrijding Noord, Overijssel, Gelderland, Flevoland	130 municipalities	Social services	Inspection and enforcement	Unknown	TK 2010–2011, 17050, nr. 414 (bijlage)
Schoon schip	Municipality of Amsterdam, UWV, Belastingdienst, SVB	Social services	Inspection and enforcement	Unknown	TK 2010–2011, 17050, nr. 414 (bijlage)
E-Discovery	Nationaal Archief, ICTU	Data management	Maintenance	Experiment	www.nationaalarchief.nl/archiveren/nieuws/e-discovery-machine-learning-en-e-mail
Kamer van Koophandel	Kamer van Koophandel	Economy	Inspection and enforcement	Implemented	TK 2010–2011, 17050, nr. 414 (bijlage)
DUO	DUO	Education	Inspection and enforcement	Implemented	TK 2010–2011, 17050, nr. 414 (bijlage)
WGA project Middengebied Vlissingen	Gemeente Vlissingen	Social services	Inspection and enforcement	Unknown	TK 2012–2013, 33 400-XV, nr. 5
Rechtmatigheids-controle Inlichtingenbureau	Inlichtingenbureau	Social services	Inspection and enforcement	Implemented	TK 2012–2013, 33 400-XV, nr. 5; www.inlichtingenbureau.nl/
Team Darkweb	Financial Intelligence Unit Nederland (FIU-Nederland)	Safety/security (criminal activity)	Investigation	Experiment	TK 2017–2018, 29 911, nr. 200, p.12
Organized Crime Field Lab	Financial Intelligence Unit Nederland (FIU-Nederland), Nationale Politie, Openbaar Ministerie, municipalities of Amsterdam and Rotterdam, Belastingdienst, FIOD, Inspectie SZW	Safety/security (criminal activity)	Investigation	Unknown	TK 2017–2018, 29 911, nr. 200, p.11

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
SIGMA	Nationale Politie, Koninklijke Marechaussee, Expertisecentrum Mensenhandel en Mensensmokkel, IND, Inspectie SZW, Openbaar Ministerie	Migration	Inspection and enforcement	Implemented	TK 2017–2018, 29 911, nr. 200, p.13; www.rijksbegroting.nl/2016/verantwoording/jaarverslag,kst233798_13.html +www.rijksictdashboard.nl/projecten/301498
DigiDijk	Rijkswaterstaat, Hoogheemraadschap Delfland	Physical environment (water management)	Maintenance	Unknown	https://zoek.officielebekendmakingen.nl/blg-820189.pdf
Landelijk Meetnet Luchtkwaliteit	–	Physical environment (air quality)	Inspection and enforcement	Experiment	www.overheid.nl
FinPro	Openbaar Ministerie, Municipality of Rotterdam, Programmabureau NPRZ, Politie	Safety/security (criminal activity)	Investigation	Experiment	www.meetingmoreminds.com/wat-doen-we/overige-projecten-initiatieven/
Debt Alert	CJIB	Government finances	Personalization	Experiment	https://ibestuur.nl/partner-minjenv/kennis-tanken-in-vier-pitstops
Hansken	Politie	Safety/security (criminal activity)	Investigation	Implemented	https://zoek.officielebekendmakingen.nl/blg-849198.pdf
De Raffinaderij	Politie	Safety/security (criminal activity)	Investigation	Unknown	https://zoek.officielebekendmakingen.nl/blg-849198.pdf
MyStatLab	Universities	Education	Personalization	Unknown	www.overheid.nl
Schengen Informatie Systeem II (SIS II)	Politie	Safety/security (criminal activity)	Investigation	Implemented	www.overheid.nl

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
Image recognition: 50.000 birth certificates	IND, TNO	Migration	Resource allocation	Experiment	https://socialmediadna.nl/innovatiecongres-justitie-en-veiligheid/
Logeerfraude	Municipalities	Safety/security (criminal activity)	Inspection and enforcement	Unknown	www.wrr.nl/publicaties/working-papers/2016/04/28/big-data-voor-fraudebestrijding
Diagnose Plan en Sturingsinstrument	Municipality of Boxmeer	Safety/security (criminal activity)	Inspection and enforcement	Implemented	www.binnenlandsbestuur.nl/sociaal/achtergrond/achtergrond/het-bijstandswonder-van-boxmeer.699608.lynkx
Quin-technologie	Pandora Intelligence and TNO	Safety/security (criminal activity)	Investigation	Unknown	https://beveiligingnieuws.nl/nieuws/kunstmatige-intelligentie-voorspelt-vluchtroute-criminelen
Alert	Municipalities of Utrecht, Tilburg, Nijmegen, Middelburg, Hilversum, Amersfoort, Leiden, Almere, Groningen, Zwolle, Tiel, Drechtsteden	Social services	Inspection and enforcement	Unknown	Uitspraak Gerechtsh of Den Haag 28 January 2014; ECLI:NL:GHDHA:2014:71
SmartBox	UWV, SVB, Belastingdienst, DUO, Justid, CJIB, RDW	Safety/security (criminal activity)	Investigation	Experiment	https://zoek.officielebekendmakingen.nl/blg-814167.pdf
LAA - Adreskwaliteit BRP	Ministry of BZK	Data management	Inspection and enforcement	Unknown	www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2016/03/21/rapport-landelijke-aanpak-adreskwaliteit/rapport-landelijke-aanpak-adreskwaliteit.pdf
Monitor vitale vakantieparken	Municipalities of Putten. Heerde, Epe, Harderwijk, Ede, Ermelo, Province of Gelderland	Physical environment (public sphere)	Maintenance	Experiment	http://vitalevakantieparken.nl/default.aspx

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
AI bij meldingen openbare ruimte	Municipality of Dordrecht	Physical environment (public sphere)	Maintenance	Experiment	www.smartcitydordrecht.nl/gemeentelijke-projecten/dordrecht-koploper-in-onderzoek-gebruik-artificial-intelligence-ai-bij-meldingen-openbare-ruimte
Transparantie informatie over de arbeidsmarkt	VNG	Labor market	Forecasting	Experiment	https://depilotstarter.vng.nl/projecten/datagedreven-werken/transparante-informatie-over-de-arbeidsmarkt
Themacontrole mbv machine learning in het sociaal domein	VNG	Social services	Inspection and enforcement	Experiment	https://depilotstarter.vng.nl/projecten/datagedreven-werken/themacontrole-mbv-machine-learning-het-sociaal-domein
Opsporing ondermijning	Municipality of Zaanstad, VNG	Safety/security (criminal activity)	Investigation	Experiment	https://depilotstarter.vng.nl/projecten/datagedreven-werken/opsporen-ondermijning-met-data-analyse
Brid.ge	Municipality of Enschede, Saxion, Winkelhart Enschede, Twente University, Both Social, eLabbs, Marotura, Present Media, Squal Media, Think Public	Physical environment (public sphere)	Personalization	Experiment	http://techforfuture.nl/onderzoek/afgerond/brid-ge/
Thermometer vandalisme	Municipality of Noordoostpolder	Physical environment (public sphere)	Maintenance	Unknown	www.destentor.nl/noordoostpolder/thermometer-voor-vandalisme-in-dronten~a375445d/
Gegevens-vergelijker	Municipality of Súdwest-Fryslân	Physical environment	Inspection and enforcement	Experiment	https://github.com/EduardWitteveen/GegevensVergelijker + www.geoinformatienederland.nl/agenda/gin-bijeenkomst-themagroep-noord-bij-de-gemeente-sudwest-fryslan
Proeftuin binnenstad-monitoring	Municipality of Groningen	Physical environment (mobility)	Forecasting	Experiment	https://groningen.nieuws.nl/gemeente/736506/innovatieve-sensoren-moeten-binnenstad-toegankelijker-maken/

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
Cold case	Politie	Safety/security (criminal activity)	Investigation	Experiment	www.politie.nl/nieuws/2018/mei/23/00-nieuwe-technologie-in-oude-politiezaken.html
Warme frontoffice	Belastingdienst, DUO, CJIB, Raad voor Rechtsbijstand, bureau WNSP	Social services	Personalization	Experiment	www.slimmernetwerk.nl/2014/05/doorbraak-doetank-schuldhulpverlening-in-zicht/
Dashboard Veiligheid Tilburg – SpotOn	Municipality of Tilburg	Safety/security	Investigation	Experiment	https://hetccv.nl/onderwerpen/informatiepositie-gemeenten/voorbeeldgemeenten/gemeente-tilburg/
Verwijsindex Risicojongeren	VNG, Municipality of Tilburg	Social services (youth care)	Personalization	Experiment	https://hetccv.nl/onderwerpen/informatiepositie-gemeenten/voorbeeldgemeenten/gemeente-tilburg/ + https://vng.nl/files/vng/20160223_verwijsindex_risicojongeren_hv.pdf + https://vng.nl/onderwerpenindex/jeugd/jeugdhulp/verwijsindex-risicojongeren-vir%20
Big data Pilot Apeldoornse Jeugd	Municipality of Apeldoorn	Social services (youth care)	Investigation	Experiment	http://bigdatagemeenten.nl/wp-content/uploads/2017/10/Presentatie-Big-Data-gemeenten_27092017.pdf
Scorecard data management	Municipalities of Enschede, Almelo, Bloemendaal, Heemstede, Loon op Zand, Sudwest-Fryslan, Borger-Odoorn, Leerdam, Terneuzen, Leiden, Venray, Eindhoven, Noordoostpolder, Zoetermeer	Data management	Maintenance	Experiment	https://depilotstarter.vng.nl/sites/default/files/project_bestand/overzicht_resultaten_publicatie_0.pptx
Geo-data in sociaal domein	Municipality of Uden	Social services	Personalization	Implemented	www.digitale-sociale-kaart.nl/uden

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
Website en surfgedrag	Municipalities of 's-Hertogenbosch, Vught, Utrecht, Veenendaal, Zeewolde, Veldhoven, Den Haag, Heerlen, Oss, Schijndel	Not domain-specific	Personalization	Experiment	https://depilotstarter.vng.nl/sites/default/files/project_bestand/rapport-exploratief-onderzoek-digitaledienstverlening20met20huisstijl.pdf
Viralcom – Egg	Municipality of Dordrecht	Physical environment (safety on the water)	Resource allocation	Experiment	www.smartcitydordrecht.nl/projecten-innovatiefonds/viralcom-egg
c6Volg	Municipalities of Zwijndrecht, Dordrecht	Social services (youth care)	Resource allocation	Experiment	https://depilotstarter.vng.nl/sturen-op-resultaten/nulmeting-effectmeting-kosten-sociaal-domein + https://depilotstarter.vng.nl/sites/default/files/project_bestand/stapeling_in_het_sociale_domein_de_100_van_dordrecht.pdf
Geniq	GGZ instellingen	Social services (mental health care)	Resource allocation	Unknown	www.pinkroccade-healthcare.nl/product/geniq-ggz/
Dashboard slachtoffers van huiselijk geweld	Municipality of Zaanstad	Social services (mental health care)	Inspection and enforcement	Experiment	https://depilotstarter.vng.nl/sites/default/files/project_bestand/monitor_huiselijk_geweld.docx
Pronto-app	Municipality of Rotterdam/ Havenbedrijf Rotterdam	Physical environment (infrastructure)	Personalization	Experiment	https://ferm-rotterdam.nl/nl/nieuws/havenbedrijf-rotterdam-lanceert-pronto-app-voor-serieuze-efficientieverbetering
Artificial inspector	Rijkswaterstaat	Physical environment (infrastructure)	Maintenance	Unknown	www.fabriek.ai/casus-rijkswaterstaat/
Slimme laadpunten	Provinces of Overijssel, Gelderland	Physical environment (infrastructure)	Resource allocation	Experiment	www.rtlnieuws.nl/economie/artikel/4278011/gelderland-en-overijssel-plaatsen-2250-slimme-laadpalen

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
Pilot Jeugdbeleid Rotterdam	Municipality of Rotterdam, TNO, Ministry of BZK	Social services (youth care)	Personalization	Experiment	www.tno.nl/nl/aandachtsgebieden/strategische-analyses-beleid/expertisegroepen/strategy-policy/het-policy-lab-datagedreven-beleidsontwikkeling/
Slimme Camera's	Rijkswaterstaat, Innovatiecentrale, ViNotion	Physical environment (infrastructure)	Resource allocation	Experiment	https://staticresources.rijkswaterstaat.nl/binaries/Project%20Slimme%20Camera%27s_tcm21-107650.pdf
Digitale identificatie en verificatie	VNG	Data management	Resource allocation	Experiment	www.digitaleoverheid.nl/actielijn/onderzoek-naar-gebruik-automatische-gezichtsherkenning-en-andere-vormen-van-biometrische-identificatie/
Opsporen 'onbekende' bedrijven met milieurisico	Municipality of Eindhoven	Physical environment (environmental services)	Investigation	Experiment	https://depilotstarter.vng.nl/projecten/omgevingsdomein/opsporen-onbekende-bedrijven-met-milieurisico-door-data-analyse
Brandweerradar	Brandweer, TNO	Safety/security	Resource allocation	Unknown	www.brandweer.nl/media/4153/bom0716-def-lr.pdf
Chatbot Wout	Politie Oost-Nederland	Safety/security	Personalization	Experiment	www.tubantia.nl/regio/politie-oost-nederland-krijgt-hulp-van-chat-robot-wout~a3de02a5/
Detectiesysteem vuurwerkoverlast	Six municipalities	Safety/security	Inspection and enforcement	Unknown	www.amersfoort.nl/nieuws/sensoren-helpen-vuurwerkoverlast-tegen-te-gaan.htm
Amsterdam Discovery Challenge-app	Municipality of Amsterdam, app-developer	Physical environment (tourism)	Personalization	Implemented	www.computable.nl/artikel/nieuws/overheid/6161734/250449/app-moet-toeristen-verspreiden-over-amsterdam.html
Rijenradar	City marketing organization Amsterdam Marketing, Municipality of Amsterdam	Physical environment (tourism)	Personalization	Experiment	www.computable.nl/artikel/nieuws/digital-innovation/6002561/250449/rijenradar-toont-wachtrijen-amsterdamse-musea.html

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Table A1.

Application (name)	Organizations involved	Domain	Type of application	Status	Source URL
Smart Roof 2.0	Municipality of Amsterdam, Waternet, Drain Products, Aedes Real Estate, KWR Water Cycle Research Institute, Marineterrein Amsterdam	Physical environment (water management)	Maintenance	Experiment	https://amror.nl/smart-roof-2-0/
Kunstmatige Intelligentie Kennissysteem voor de rechtspraak	Rechtbank Oost-Brabant	Judiciary	Resource allocation	Experiment	www.rijksoverheid.nl/binaries/rijksoverheid/documenten/kamerstukken/2018/12/19/ek-artificiele-intelligentie-en-algoritmen-in-de-rechtspleging/ek-artificiele-intelligentie-en-algoritmen-in-de-rechtspleging.pdf
Watson RVO	RVO, Jibes	Physical environment	Personalization	Experiment	Eindverslag Pilot Watson RVO
Digital we	Manifestgroep, Municipality of Amsterdam, SIVI, Bvolve, Innovalor	Not domain-specific	Personalization	Experiment	Presentatie bestuurlijke bijeenkomst 19 nov, 2018
Waterbeheer SR	Tauw, HAL24k	Physical environment (water management)	Maintenance	Experiment	Data challange inzending Tauw_Hal24k
Statistiek van nieuwbouw-transacties	CBS, Kadaster	Physical environment	Forecasting	Experiment	www.kadaster.nl/-/cbs-en-kadaster-maken-statistiek-van-nieuwbouwtransacties?redirect=%2Fweb%2Fkadaster.nl%2Fterzake
Slimme sensor afvalcontainers	Municipality of Rotterdam	Physical environment	Resource allocation	Implemented	www.ad.nl/rotterdam/afvalcontainers-voorzien-van-slimme-sensor~af64633b/
Opsporing arbeidsuitbuiting (mensenhandel)	ABNAmro, University of Amsterdam, Inspectie SZW	Social services	Inspection and enforcement	Implemented	https://nos.nl/artikel/2273390-mensenhandel-opgespoord-via-bankgegevens.html; www.bnr.nl/podcast/internet-vandaag/10370844/abn-amro-jaagt-met-algoritmes-op-mensenhandel

About the authors

Dr Anne Fleur van Veenstra is a Senior Scientist in ICT Policy at TNO's Strategy and Policy Department. Her research focuses on public sector data analytics, data-driven policy-making and public sector innovation. She has published on data-driven policy, digital government, open data and public value management. Before joining TNO, she worked as a Researcher in the field of electronic government at the Department of Technology, Policy and Management of Delft University of Technology, where she wrote her PhD thesis, entitled "IT-induced public sector transformation."

Dr Francisca Grommé is an Assistant Professor at the Organisational Dynamics of the Digital Society. Her research focuses on digitalization in relation to organizational knowledge practices: how digitalization changes the way data are collected, analyzed and verified by the state and in the digital economy. She has published about topics such as surveillance, identity, nationhood, digital work and citizenship. She previously worked at the Netherlands Organisation for Applied Scientific Research (TNO) and Goldsmiths, University of London. Her PhD thesis was written at the University of Amsterdam (AISSR) and concerns the role of technology experiments in policing. Francisca Grommé is the corresponding author and can be contacted at: gromme@essb.eur.nl

Somayeh Djafari, LLM is a Senior Lawyer at the Ministry of Health, Welfare and Sport. She is also a PhD Candidate at the Law Faculty of the University of Leiden, where she is working on balancing the interests of the community as a whole and the right of the individuals affected by the legislation to respect for their private life and home in embedding the algorithm(s) by administrative authorities in the Netherlands. This article is written in a personal capacity.