# Governance by Dashboard

## A Policy Paper

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## FOREWORD

Data dashboards – interfaces which display complex data to a user, often displayed in real time, and typically drawn from multiple sources – are an increasingly important way in which government departments make decisions. Hundreds of them are used across government every day, from city planning to strategic spending decisions.

According to their advocates, dashboards promise a smooth, data driven decision making environment: cutting costs, providing new insight into citizens' concerns, and allowing for smarter policy and operational choices.

However, dashboards signal a potentially very significant shift in the way government operates. While the opportunities are considerable, dashboard use in government does present several challenges. They introduce new skills, dynamics, pressures, opportunities and challenges into the practice of governance. Data presented on a dashboard is rarely as straightforward as it appears. Dashboards condense data for easy digestion, which can obscure a user's knowledge of how trustworthy or accurate that data is. By presenting often very complex, messy and varied data in simplified forms for consumption via a dashboard, sometimes subtle changes take place in how that data is understood. Most notably, by introducing a new emphasis on metrics, indicators and measures, it can create a greater focus on operational issues rather than longer-term strategic ones. And as with any new discipline, new types of expertise become valued, and new sources of authority become established.

The purpose of this paper is not to present a new philosophy of government.[1] It aims to sketch out the broad implications of dashboard governance, that is, of governing with and through dashboards. We suggest that dashboards are not simply a tool to make the task of everyday government activity easier and rather that dashboards contain, in their very design, specific tendencies which actively rework and rub against government practice. Our account aims to incorporate both theoretical and practical insights.[2] First, we briefly cover the growth of dashboards from the private sector into government. Second, we present a series of brief case studies illustrating different types of dashboard use of relevance to people working in the public sector. Third, we examine some of the new dynamics that dashboard use introduces into the public sector. Finally, we sketch out the challenges of successful implementation of dashboards in the public sector. Based on this work, we set out **three principles** which should shape any government use of dashboards.

First, identify purpose and use**.** Dashboards are a broad, generic approach to collecting, analysing and acting on large data sets. In and of themselves, they are not necessarily the best way of understanding all categories of problems, or research questions. Dashboards must be carefully designed to match real organisational needs, their design and purpose carefully assessed in relation to the hoped-for purpose. Once the purpose of the dashboard has been identified, it is important that this purpose is communicated clearly to all relevant stakeholders, including any developers, designers or product managers working on the dashboard, as well as its intended users. If the dashboard has multiple uses, each 'use scenario' should also be clearly identified.

Second, select the right framework of analysis and understand limitations. There are several factors that may lead to poor, biased, insufficient, or irrelevant data being used in dashboards. The limitations of dashboards need to be acknowledged and, where possible, amended. On a practical level, this data may simply not effectively measure what it seeks to, instead being cut and scraped until it 'looks right'. Users can be blinded by large numbers, or have insufficient understanding of the strengths and weaknesses of the data they are using. Dashboards have the potential to mislead as well as inform. One particular danger is that the focus on design principles contributes to the obscuring of certain types of bias. Dashboard bias needs to be carefully considered before decision making.[3]

Third, select the right staff and skills**.** The skills needed to create and manage dashboards are extremely valuable and sought after by both the private and public sectors. There is the risk that these highly skilled individuals will be difficult to find in large quantities, and/or that they will be poached from public services by private firms. Those who are able to decipher algorithms or critically engage with big data sources will inevitably be in high demand. A whole new generation of analysts will be required who can combine a new combination of skill sets; ranging from data analytics, design, social science, and public policy.

## INTRODUCTION

In late 2012, the Government Digital Service created a new way for the Prime Minister to keep on top of events. Around the Cabinet Office, it was known as the 'Number 10 Dashboard'.[4] This bespoke iPad app provided performance indicators on a number of government services, real-time information on aspects of the economy, trends from social media and expert commentary, all integrated into a single screen and with the capacity to 'drill down' as needed.

It signalled a change: that government, too, was becoming part of the big data revolution, recognising that a 'datafied' UK opened new possibilities for everyday governance and public service delivery. It wasn't surprising. Governments have long emulated business in how they organise and operate. From the Weberian bureaucracies of the early 20th century and their emphasis on hierarchy, authority and standardisation of services, to the efficiency and accountability drives of new public management in the 1980s, and the more recent introduction of 'agile' and 'joined up governance', each wave of commerce-inspired reform has changed how public goods are developed and delivered.

The latest business thinking is orientated around 'big data': with its promise of data analytics, real time responsiveness, and networked organisations.[5] The dramatic increase in the volume and nature of data being produced – the so called big data revolution – has created new possibilities to understand trends, spot patterns, and collect intelligence, fuelling a burgeoning industry around 'data analytics'.[6] Dashboards typically bring varying types and quantities of data into a single user-friendly interface for visual representation, and they are the visible face of this revolution. They have become increasingly important as a way to help decision makers navigate an increasingly complicated data environment.[7]

The big data revolution is beginning to be felt across the spectrum of government, well beyond intelligence agencies and statistics offices, and its traces are already visible. There are, for example, over 800 dashboards that have been built by the Government Digital Services team within the Cabinet Office for use by government departments. These were made possible by the renewed interest in government transparency following the 2009 expenses scandal, and the more general shift towards opening up government data. These 800-odd dashboards display a number of key performance indicators for each service and are used for a number of purposes.[8] These service dashboards are just one of a number of different types of dashboards

being developed and rolled out across different government departments.

This signals a significant shift in the way governments operate. Dashboards introduce new dynamics, skills, pressures, opportunities and challenges into the practice of governance. They signal a broad epistemological and organisational realignment in that they introduce new capacities to know, new criteria for what counts as good knowledge, and new ways of acting in relation to its forms of knowledge. For example, data dashboards bring about increased emphasis on metrics, indicators and measures. They encourage more intensified forms of monitoring and analysis. Through their increased presence, they change the empirical basis from which decisions are made and also the criteria for what counts as a good decision. Some dashboards serve a public function, being displayed on large screens in offices or other public areas. These help bring about a new 'ambience of performance', whereby members of staff or the public become more attuned to how whatever is measured is performing.

Despite any specific functions such screens have, they serve a broader purpose of changing the 'feel' of a space.[9] Dashboards also rely on new centres of expertise with requisite new vocabularies, ways of evaluating quality and specific skills. Data scientists, who possess the skill sets necessary to understand, manipulate and communicate with data, are the most obvious and visible new data experts. Data scientists are placed to play an increased role across many areas of government. Perhaps less visible, but no less important, is an increased reliance on design expertise. In the new digital landscape, it is designers who shape and modify products, services and interface 'experiences'. These are some instances of what we mean by a broad epistemological and organisational realignment.

Beyond that, technology's interaction with the social ecology in which it operates often has consequences beyond its immediate purpose.[10] It is difficult to predict how these new trends will play out, especially as we are still in the foothills of the data revolution. But data dashboards speak to a new future, where government work increasingly resembles 'no collar', creative work. Mirroring the new creative and tech business culture, some government workplaces have moved from offices and cubicles to hot desks, lounges, laptops and Wi-Fi. Public servants are put into small interdisciplinary teams and managed by 'agile' leaders, where the tempo and flow of work resembles that of software development.

## THE RISE OF THE DATA DASHBOARD

Dashboards display complex data to a user, often displayed in real time, and typically drawn from multiple sources. Stephen Few, a leading writer on the subject, says dashboards must be 'arranged on a single screen so the information can be monitored at a glance', ensuring the dashboard interface remains 'intuitive to use' whilst remaining insightful.[11]

Dashboards are often, although not always, interactive, allowing the user to 'drill down', query, edit, rearrange and generally explore and analyse data. When not being used to directly engage with and manipulate data, dashboards have generally served as monitoring devices, allowing users to get a quick overview of a situation.[12]

Although 'data warehouses' and data driven business intelligence became an important part of large business operations through the 1980s and 1990s, the growth of large data sets and new types of data (known as 'big data'[13]) and the capacity to connect to data streams easily through 'APIs' and 'light' business intelligence solutions, mean that today's dashboards are rather different to those found in early 'decision support systems'. Big data and dashboards, although not synonymous, tend to co-occur in business organisations: with the latter as the 'way into' the former. Author Keith Rickles pinpoints 2000 as the year data-driven *digital* dashboards grew,[14] using as his prime example Kaplan and Norton's influential 'balanced scorecard' which was amongst the first to venture beyond financial data in its measurement of organisational performance.[15]

Over the last decade, the growth in the amount and variety of digital data being created, documented and shared, has equally resulted in a growth of the use of dashboards in organisations. Indeed, dashboard use has been expanded to individuals, where web and phone applications present a dashboard or dashboard-like feature as their main user interface. Often these apps are health, fitness or activity related, but there are a number of other notable uses such as the emergence of mood and wellbeing apps.[16] Everything from sleep, heart rate, diet, steps, stairs, moods, and weight can be tracked, measured, monitored and compared with standard commercial fitness devices ('wearables') and related applications.[17]

According to the Gartner Survey, 73 per cent of organisations have already invested or plan to invest in big data by 2016.[18] At the time of writing, two providers of data visualisation software packages, *Tableau* and *Qlik,* claim to collectively provide 70,000 customers with the tools to build their own digital dashboards.[19] Given the low and falling cost of creating, capturing and storing data, and the ongoing challenge of

communicating data to non-experts, the use of dashboards and dashboard-like visual formats are likely to continue to rise.

Increasingly digital interfaces are pre-designed for modes of data capture.[20] Mayer-Schönberger and Cukier identify the trend of 'datafication', the process of 'taking information about all things under the sun…and transforming it into a data format to make it quantified'. The UK government has committed itself to embracing these changes, as part of a very broad digitisation agenda. First, there is a growing interest in using digital tools to increase transparency in government, in particular the growth of 'open data' provided by government departments about their own operation. Second, a 'digital by default' policy coordinated by the Government Digital Service aims to increase the number of citizens accessing services online. Third, over recent years the government has committed itself to investing in data infrastructures and data-driven analytical techniques. In 2013, 'big data' was identified by the government as one of the UK's 'eight great technologies', and in February 2016 Parliament's Science and Technology Committee published its report 'The Big Data Dilemma', which urged the government to commit to developing 'data analytics' skills and digital infrastructures in its forthcoming Digital Strategy.[21]

## DASHBOARDS IN ACTION

Dashboards are used in very diverse organisational and private contexts that extend far beyond business and are used to display data on everything from an individual's sleep patterns to a nation's economic performance. They are found in a number of governmental contexts, from local councils, city councils, government departments and defence, to matters of the economy. Below, we set out an illustrative set of examples of how they are currently being employed, with a particular focus on the public sector.

### Public service delivery dashboards

The most visible and well-known examples of the UK government's use of dashboards are the service delivery performance dashboards produced by Government Digital Services (GDS). GDS is a unit of the Cabinet Office tasked with transforming the provision of government digital services. It was formed in April 2011 to implement the 'Digital by Default' strategy proposed in a report for the Cabinet Office in 2010 called 'Directgov 2010 and beyond: revolution not evolution'. According to its website, GDS' role is to 'help government make digital services and information simpler, clearer and faster. We put users' needs before the needs of government'.[22] GDS mainly works with other departments to improve digital services, including the creation of dashboards to monitor the performance of these services. As of September 2016, GDS lists 803 active service dashboards, which work across a large number of departments and government offices; a further 49 web traffic dashboards (which display the number of visitors to a page, most popular content, and the device used to access the page, amongst other things); and 19 'other' dashboards, most of which are part of the Cabinet Office, centred on civil service reform.

GDS dashboards aim to serve a number of broad purposes: data transparency, improved decision-making, lowering expenses and monitoring service performance. One example is the Department of Health's 'European Health Insurance Card (EHIC). In line with GDS's specification for key performance indicators, this dashboard collates metrics on transactions per year (2.09m), the total cost of the service (£2.48m), the cost per transaction (£1.19), the proportion of users accessing the service online (95.2%), as well as change over time for each of these measures.[23] For some services, the corresponding dashboard displays data on user satisfaction and user completion rate. In total, the government service dashboards measure 2.4bn individual transactions per year, displaying performance data for government managers, journalists, researchers, and the public.

## Voting information dashboards

The Democratic Dashboard, run by the LSE's Democratic Audit group, harmonises data from a wide range of sources, including the Electoral Commission, House of Commons library, ONS and UK Data Service to show, for the first time, data on voting patterns and other electoral information about each constituency in a single place. The dashboard asks users to enter a postcode, from which the dashboard generates information about the current sitting MP, each party's vote share in the area, how voting habits have changed over time, what each vote is 'worth' and the amount each party is spending in your constituency.[24]

## City dashboards

Dashboards are bringing together multiple sources of 'urban data' to visualise and better understand how towns or cities are functioning. The writer and academic Rob Kitchin notes that data dashboards are part of a 'data-driven urbanism', made possible by networks of sensors, actuators, transponders, cameras, and smart phones. Together, it has been claimed these data streams represent 'the city *as it actually is*'; they 'translate the messiness and complexities of cities into rational, detailed, systematic, ordered forms of knowledge'.[25] Kitchin led the team responsible for the 'Dublin Dashboard', which provides urban info-metrics and visual analytics compiled from a range of sources (including Dublin's open data portal, Dublinked). According to Kitchin, city dashboards are used to monitor the performance of and manage urban services, to provide context in the formulating of policy, and for creating public knowledge about the city, which could also be used in a critical capacity. Thus, among these typical managerial functions, his Dublin Dashboard seeks to keep residents and visitors informed of real-time Dublin developments, and encourages users to utilise the data readily available for their own purposes.[26] (Through his dual role as academic and dashboard developer, Kitchin has also reflected critically on the limitations of 21st century dashboards and we integrate these into our discussion below.)[27]

The 'CityDashboard', created by the Centre for Advanced Spatial Analysis at UCL, has built individual dashboards for 8 large UK cities: Birmingham, Brighton, Cardiff, Edinburgh, Glasgow, Leeds, London and Manchester, and draws in data from several sources, with the aim of helping support decision makers across sectors.[28] For London, the dashboard displays live data on various measures of transport infrastructure performance (tube line status, number of available bikes for cycle hire, random traffic camera displays), as well as environmental metrics (weather and air pollution), and live local and stock market news. Although the dashboard was designed as an early prototype, its API was used in 2013 to create an 'iPad wall' mounted in London City Hall allowing the Mayor of London to 'look over the capital digitally as well as physically'.[29] In very similar language to the Dublin Dashboard,

the Mayor's Office of Policing and Crime (MOPAC), argues that it means 'Londoners have access to more information about the performance of their police and justice system'; not only enhancing transparency but also using them to aid decision making.[30]

## Local authority dashboard

Using 50 million items of open data, a dashboard profile has been collated for every local authority in England by the Department for Communities and Local Government's OpenDataCommunities platform. It's possible to search for a Local Authority by entering a postcode or browsing by name, and the dashboard then offers visual representations of data on each Local Authority through a series of charts and maps. For Birmingham's Metropolitan District Council, for example, the dashboard presents metrics on housing (e.g. homelessness rate of 2.67 per 1,000 households), finance (e.g. £5,302 of service expenditure per household), deprivation (e.g. 13/326 in deprivation index ranking), as well as metrics on wellbeing and geography.[31] A Leeds City Council dashboard initiative, 'Data Mill North' provides citizens in Leeds and Bradford with various dashboards, including two datasets that contain rubbish bin collection details for every household in the area. The idea is to enable people and organisations 'to explore the different complex relationships between the city's services and businesses'.[32]

## DASHBOARDS TRANSFORMATION

Dashboards are the result of new dynamics in the way information is captured and stored. How they present this data, and how it is acted upon, in turn create new modes of behaviour, attitudes and norms within the organisations that use them. Below we set out the five key changes dashboards introduce: an increased focus on data and measurement, new biases, a focus on design, new types of 'knowledge' and new forms of expertise.

### Increased focus on data and measurement

Many features of dashboards have a long history. Bar charts, for example, can be traced back to William Playfair (1786). The gauges and indicators on dashboards are borrowed from early automobile design at the begging of the 20th Century. But these elements attain new significance in the present because our culture is increasingly quantified. Dashboards are designed to measure and present this numerical data, to bring focus to what has been called the 'data deluge'. Dashboards bring data into the realm of organisational decision-making. They make possible new types of insights (based on patterns, comparisons, trends) conducted on accelerated time frames. Dashboards in hospitals, for example, can provide fine grained metrics on everything from the average cost of equipment used in a procedure or operation times per surgeon, to the increased chances of incidents occurring while staff are on break. These data can be benchmarked within and across hospitals and enable hospital executives a 'data-driven' view of the performance of their organisation.

In other settings, keyword and hashtag analysis is used to track population health, complementing and sometimes supplanting existing health statistics that operate on slower time cycles. Web page usage data or 'web analytics' can help determine where people commonly 'get stuck' when completing an online transaction. This data can inform the redesign of these pages and possibly the larger 'user journey' for which the unique page is a part. Data on who accesses different services on different devices at different times and across different regions can also provide important information about how to design services for those users. Embedding RFID chips into everyday objects, such as garbage bins, can allow local councils to monitor and track non-digital services in new ways as well. Further, creating a single 'interface', dashboards are able combine these multiple, and often very different, data sets into a single platform.

This increased focused on data and measurement can be seen as an extension of 'evidence-based' policy and decision-making, in that it increases the expectations that decisions are backed by data. In order

to further accommodate data into decision making procedures, some organisations now have specially designed 'decision rooms' where data can be explored together. In addition, commercial dashboard software now commonly includes a 'storytelling' component, where elements of the dashboard can be worked into a more traditional presentation format.

## New biases

Data presented on dashboards is not as straightforward as it appears. Dashboards condense data for easy digestion, but what data? How good is that data? What are the weaknesses? By making the 'interface' separate from the data collection itself, a new layer of obfuscation is introduced that might hide significant weaknesses, assumptions and biases.

Writer Shannon Mattern has outlined a rubric for critically analysing urban interfaces, suggesting that dashboards are 'epistemological pastiche', and that they embody ways of rendering data representable but do not help the user make any sense of it. Mattern argues that dashboards are 'sanitized, decontextualized, and necessarily partial'.[33] Like all visualisations of data, dashboards necessarily distort the information that they are attempting to present neutrally by defining *how* a variable is to be understood and by excluding any data which isn't compatible with this definition.

By presenting often very complex, messy and varied data in simplified forms for consumption via a dashboard, sometimes subtle changes take place in how that data is understood. Dashboards require similar data measurement across multiple sources in order to be presented in a meaningful and intuitive way. Data that is consistently captured and available may become prioritized over that which might be important but can't be easily presented. A related example includes the prioritising of short-term over long-term data. Due to storage space (or licensing restrictions) a dashboard might focus on things occurring in present or recent past – responses, surges, spikes – rather than longer-term trends.[34]

It is also important to look beyond the quality or 'providence' of data or the representativeness of a measure or visualisation. Screen size, the positioning of elements on the screen, information refresh rates, and the use of colours and other visual cues all guide the user's attention to preferred interpretations of the data on display.[35]

## Design

The design of a dashboard has profound consequences in shaping the priorities of its user, and dashboard designers should be acutely sensitive

to the agency of a dashboard's architecture in shaping the meaning that the dashboard's user gleans from its interface.

Dashboards privilege certain metrics, determine which indicators desire attention, their temporality, what measures are included and which are not. If there is no such thing as raw data, as interpretations of data all dashboards are (at least) two levels of abstraction away from the things and processes they 'interpret'.

According to the writer Stephen Few, 'most dashboards say too little, and what they do say requires far too much effort to discern'. Data visualisation – the specific ways that information is presented, such as the format, icon style, graph displays, manipulation options, and so on – is increasingly important to how people engage with the information presented. This brings new disciplines into play. But not all data analysts or researchers are familiar with the established literature on data visualisation and design.

## New types of 'knowledge'

Perhaps even more significant than the actual data itself is the way that data changes how broader knowledge is constructed. The academic, danah boyd, has pointed out that new types of data infrastructure change the theory that goes with it, creating new 'systems' of knowledge. Dashboards, like 'big data', are starting to reframe key questions about the constitution of knowledge, the process of research and how we engage with information. (In one infamous example, criticised by many academics, Wired editor Chris Anderson wrote in 2008 that big data 'replaces every other tool that might be brought to bear…Who knows why people do what they do? The point is they do it, and we can track and measure it with unprecedented fidelity. With enough data, the numbers speak for themselves.')

Within the broader data paradigm, researchers have described the increased role of 'correlational analysis', where the relation between a number of variables can be plotted and analysed. Conversely, an explanation for how and why different variables are related – that is, their 'cause' – has become less important. Dashboards perpetuate this tendency to show things as they are (and are related) but without any attempt to explain why. (There is, according to dannah boyd, a tendency among those who use any big data analytics to become blinded by large numbers and compelling visualisations, which lends an aura of objectivity and accuracy; while the writer Will Davies has argued that big data poses new problems for deriving facts from raw statistics. Massive volumes of data make it far easier to derive multiple and mutually-contradictory 'factual' conclusions from the same set of statistics.[36]) By presenting multiple indicators, numbers, graphs and

gauges all at once, and with each of these elements changing or 'refreshing' at regular but differing time scales, dashboards display a 'present' that is in motion. They depict a world that can tracked, measured and benchmarked, but which fundamentally remains uncertain. The purpose of dashboards is to help deal with this uncertainty that they also reproduce and indeed rely on. Through dashboards, data are less markers of an objective and factual state of affairs – as is, say, an accounting spreadsheet – and a more a way of 'sensing' or indeed 'signalling' what is happening in the moment. This is why a dashboard is associated with a 'driver' or 'pilot' who drives or steers an organisation.

This type of moving knowledge is fundamentally orientated towards 'operational decisions', which generally takes the shape of somehow improving the performance of an organisation. In this regard, it is very different to a set of guidelines or rules of conduct in the workforce. Dashboards provide a way of knowing the present and, in order to do that well, they need to change from one moment to the next.

## New forms of expertise

As with any new discipline, new types of expertise become valued, and new sources of authority become established. Data dashboard use – and big data techniques more generally – necessitate a corresponding wave of data analysts, with the technical skills and know-how to generate value and insights with data. For the *Harvard Business Review*, data scientist is 'the sexiest job of the 21st century' and in 2015 the White House appointed a former LinkedIn statistician as its own first Chief Data Scientist.[37]

Dashboards also require users. Indeed, dashboards are the tool that communicates the work of data scientists, designers, developers, information architects and other technical experts to people whose expertise lies elsewhere. 'The rise of the data scientist' has been heralded by commentators who have noted the increasing reliance of organisations on statisticians in order to retain a competitive advantage in a digital economy.[38] There is, then, a shift in the hierarchy of expertise, where knowing how to present with data, how to navigate and use dashboards competently, and knowing about the broader backend of business intelligence all become more valuable. These forms of expertise are also likely to alter the perception of a team or organisation as successful or not. This perception of being up to date can go some way in determining if an organisation will hire more data savvy staff and incorporate dashboards.

## FACTORS FOR SUCCESSFUL 'DASHBOARD IMPLEMENTATION'

The promise of dashboard use in government is of a smooth, data driven decision making environment: the introduction of technology and elegant design principles into public service delivery. According to the Government Digital Service (GDS), this means 'better operational, policy and economic decisions', cutting costs, improving the way government works, helping citizens understand government more, and even boosting the economy.' Just like the private sector, dashboards might allow the government to understand its citizens' needs more intimately, allowing the state to streamline existing modes of public service delivery to suit needs more efficiently; but it also flags questions surrounding privacy and ethics. It introduces new modes and trends in analysis, and perhaps even a new approach to government, which has occurred quickly and generally passed unnoticed by most political commentators and academics. While the opportunities are considerable, dashboard use in government does present several challenges.

We have covered a number of ways dashboards are currently being used in government and we project this trend to expand as more aspects of public administration become amenable to data collection and analysis. Without denying the value of using data dashboards, we have observed that well thought out implementation is vital if the benefits of using dashboards are to be realised. Indeed, a growing number of writers and analysts have likewise begun to consider the challenges of good dashboard use. According to the writer Keith Rickles, from the year 2010 dashboards began being used beyond their abilities in what he calls the 'too much' phase of dashboard implementation. Because 1) there are more data available for visualisation, 2) dashboards can handle many forms of data, and 3) creating dashboards has become very easy, with a number of free tools now available, we are in a situation where a dashboard can be made with very little consideration of its function and purpose. Below, we set out what we see as the major challenges for successful dashboard implementation within government. We limit our comments to what we have observed in our research of government, commercial and civil dashboards, adding relevant literature where appropriate.

### Purpose

Some months into our study, a manager of a 'smart city' initiative within a city council invited one of the authors to talk to their team, who were in the early stages of building a new 'city' dashboard. During the consultation, we learned that the team had been told from senior leaders that their city 'needed a city dashboard'. There may have been good reasons for requesting a dashboard, but these had not been

effectively communicated to the team assembled to build it. The team had access to any number of data flows, from real time car parking, transport and social media 'sentiment' data, to public utilities data, but without a clear sense of what the dashboard was for it was very difficult to make concrete decisions about what to include. Further, without a clear understanding of purpose, it's difficult to gauge whether the dashboard is successful or indeed if a dashboard is needed in the first place. For example, if a city dashboard is supposed to improve the experience of tourists, perhaps a city portal website or app is a better option. Perhaps only a small amount of the team's current data is useful. Alternatively, if the purpose of the dashboard is to aid emergency response teams, perhaps an email or phone alert system would more appropriate. Identifying the purpose of the dashboard from the beginning is very important.

Clarity over purpose is doubly important given growing citizen concern about data and privacy. Once built, dashboards can suffer from 'mission creep', meaning they become used for tasks and purpose beyond their original purpose. The wide availability of large scale data sets and powerful analytics tools potentially places more power in the hands of individual analyst to conduct research work, intelligence gathering, that would otherwise have required significant resources and capability. Even manually, government agencies have demonstrated their willingness to comb through social media profiles in search of incriminating evidence that might justify, for example, cutting off welfare provisions. Local authorities have admitted to cross-referencing Facebook profiles with the personal details submitted in a welfare claimant's application.[39] These practices could be repeated far more efficiently and systematically with the enhanced analytical insight into big data granted by a dashboard, and the architects of such systems have a duty to ensure that they are not used to invade the privacy of public service users.

Clarity over use and purpose should also limit possible misuse. Government departments in the UK are expected to conduct research under certain standards relating to research ethics. The extent to which legal or ethical considerations come into play is likely to be driven by which organisation is conducting the work, and for what purposes. However, it is not always clear the extent to which dashboards constitute 'research' and therefore whether they might be required to conform to research ethics frameworks. One challenge in particular is determining which data can reasonably considered to be open, and what might be considered in some senses private and therefore potentially require lawful warranting to access. This, to our knowledge, is not applied to dashboard type work. However, a solid methodology and ethical framework should still be necessary.

Dashboards with a clear purpose are usually backed by user research and align clearly with existing organisational goals. Managers, developers and users should all be able to identify what the dashboard is for and how it relates to their respective roles. Managers and teams should have a clear sense of what a successful implementation will look like within their organisation, and may consider ways to monitor and evidence the process.

## User

Successful dashboard implementation requires identifying and designing for its users. Designing for what designers call 'user needs' sounds simple, but it isn't. Often there are multiple users with different needs, some of which may be in conflict or may pull the dashboard design in different directions. User groups can also change over time, as can the purpose of the dashboard. Practical and economic considerations may also necessitate design compromises.

Designing for users means more than inviting feedback once a dashboard has been made. In one of our studies, the dashboard team had identified four user groups. The user groups were diverse, with some located inside the organisation and quite well known to the team, and others outside the organisation and not known at all. Web page analytics showed that the 'outside users' were rarely using the dashboard. The designers were faced with a number of decisions which could significantly reshape the dashboard design in future. They could, for example, focus on the internal users and forget about the other user groups, which may enable more 'sensitive' data to be incorporated on the dashboard because the dashboard would no longer be public. The dashboard could also become more advanced (with more user training) and incorporate analytical functions designed for more specific tasks. Alternatively, the designers could prioritise the external users and try to better identify their needs. This could be costly and redesigning for this group could lessen the appeal for the others. Indeed, it may be that users outside the organisation do not require a dashboard at all. The designers needed to decide which user groups were essential and which function or purpose needed to be prioritised. Since the use and purpose of a dashboard are inseparable, it is important to maintain a dialogue with users throughout and after the design phase. Figuring out what a 'user needs' must go beyond offering a choice between dashboard displays.

Once the user has been identified, it is important to establish user buy in. During our study, we found several situations where dashboards were not being used. One dashboard was designed for users who worked so closely with the data feeding into the dashboard, they had no use for

the dashboard itself. During one interview at a government department, the public dashboard screen was only turned on when our researcher arrived. This dashboard was displayed on a large screen at the entrance of the department office space. Clearly, this dashboard was not being used. Another situation involved the design of a dashboard for a team who were already using dashboards for other aspects of their job and there was confusion over how the two dashboards related to one another. If there is confusion over the value of the dashboard, more work needs to be done establishing its purpose and main uses. Poorly conceived dashboards are likely to be rejected by users.

Once identified, some user groups may require training. While dashboards are designed to be user-friendly, this does not mean no skill is required to use them effectively. It is dangerous to assume the user will intuitively understand how to use a dashboard. Depending on the type of use, training may cover three areas. First, users will need to learn the basic functionality of the dashboard. They should be able to answer 'What can the dashboard do?' with confidence. Second, users need to understand the visual elements of the dashboard. There is a vast literature on information and data visualisation and most of it does not need to reach the user. However, users do need to know what the visualisation techniques on their dashboard are designed to do. Bar charts, for example, a good for comparing values. Line charts show change over time. Pie charts display the relation between values, but also as part of a whole. A gauge is good for highlighting the value of a single measure, and adding an additional interpretive layer (via colour coding) for how a measure should be understood (e.g. an arrow in the red is bad, while green is good). Beyond understanding the basic common visualisation types, users need to have a general awareness of how the data is framed. For example, selecting different ranges for the X and Y axis on a line or bar chart can dramatically alter how a visualisation appears and is thus perceived. What looks like a large change over a week may be insignificant over a month or year. Third, users need a basic understanding of the different types of data feeding into the dashboard. Contemporary dashboards often mix a number of data types. Some may derive from traditional data warehouses and contain data on organisation operations. Other data may come from web traffic or social media, or from any number of publicly available data sources. The data may also be used to make predictions or projections. Users need to know how reliable the different types of data are and when they are looking at visualisations of actual data versus a prediction based on a model.

## Danger of 'off the shelf'

In our research, we have noticed that one key decision is about whether to use an existing dashboard provider or make a bespoke dashboard. This initial choice has significant implications. There are a large number of commercial providers (IBM, SAP, Tableau, Qlik, Geckoboard, and others) and they vary significantly in what they offer. Some providers offer comprehensive services and command large fees, while others offer light weight versions of their software at no cost. Selecting a commercial provider can place limitations on the appearance of the dashboard and which visual elements can be included. They also carry the risk of 'software lock-in'. However, commercial software has a number of upsides. The visual elements of commercial software (charts, graphs, gauges, etc.) are likely to have been pre-tested, as is the display overall. Commercial software is generally well supported, easy to learn, and providers often offer training courses. If staff turnover is high, a commercial dashboard is generally easier to 'hand over' to the next user. Critics of commercial software complain about large fees, having to rely on external expertise, slow implementation and a general lack of control.

Bespoke dashboards, by contrast, may allow more flexibility and more tailored design. They can be 'lighter' and easier to update and modify. If there is in-house expertise, they can be cheaper to test and implement. However, bespoke dashboards can also suffer from inferior design if they are not well resourced. Their success within an organisation can depend much more on a few individuals. Documentation and training information can be less comprehensive or entirely absent and it can be more challenging to maintain these dashboards over time. It is worth mentioning, however, that increasingly even bespoke dashboards incorporate pre-existing software. There are a number of open source software and free visualisation tools that are commonly used for low-scale dashboard design.

## Understanding limitations

One of the main selling points for a dashboard is that they enable users to see more, to have up to date information and to make 'data-driven' decisions. There is a well-established field of inquiry which has studied the role of numbers, facts and data in organisational life. These studies show that while numbers (and we can extend this to numerical visualisations) can appear clear, objective and 'transparent', this appearance can be misleading. Every measure, comparison, data type or visualisation that ends up on a dashboard is the result of a human decision somewhere along the line.

As we have noted above, by their very nature dashboards leave out far more than they include and can present data without the user really knowing how it was created. This is sometimes called the 'black box' problem, whereby, as Rob Kitchin notes, an algorithm and its calculations are hidden and not open to scrutiny.[40] Sitting behind a dashboard is a complicated world of data scraping, API calls, word based sampling methods, natural language processing algorithms – and other technical modes of collection and analysis. Some of these are highly complicated and difficult even for experts to comprehend, while others are alarmingly simple and reductionist. Despite this, we have never seen a dashboard that shows margins of error or incorporates commentary on data weakness.

Dashboard encourage some cognitive capacities (e.g. monitoring, comparison, pattern detection), which may marginalise other more reflexive or dialogical approaches to a specific problem or a routine decision. Since many dashboards are explicitly made to manage organisational performance, some commercial dashboards can reproduce a 'performance bias'. That is, the dashboard can pull your data as well as the actions of a team in a specific direction. Finally, once integrated into an organisation, dashboard metrics and KPIs can be gamed like any other rule or metric. For all these reasons, users should foster a critical disposition toward their dashboards, and constantly remind themselves of the dashboard's limits.

# NOTES

[1] This is a policy-focused report, which draws from the ESRC-funded project titled 'Interrogating the Dashboard: Data, Indicators and Decision-making' (ref: ES/M00077X/1).

[2] In doing so, this paper also hopes to move the discussion of the relationship between big data and society into new territory that reaches beyond the 'surveillance' debate.

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[12] 'Big Data Dashboards and how to make them work for you, https://www.matillion.com/insights/big-data-dashboards-and-how-to-make-them-work-for-you/ The origins of the modern dashboard are the horse and carriage, which had a protective barrier between the driver and the horse, keeping the driver from the mud and water. As cars became the primary mode of transport, eventually this 'dash-board' became the way the driver was shown vital information about the performance of the vehicle, meaning he or she didn't need as much technical knowledge of the car's engine in order to drive. Dashboards remain the primary interface for conveying performance information to the driver, such that the act of driving always involves a degree of 'dash-boarding'.

[13] The term 'big data' first appeared in 1999 in the Journal of the Association for Computing Machinery. Since then it has become shorthand for data sets so large and complication that traditional data processing applications – especially manual ones – are inadequate to deal with them. It's more than just volume: big data is also understood to refer to data that can be searched, aggregated, and cross referenced. It's become a

new asset class, a discipline, a buzzword, and, for many companies, an area of significant investment.

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